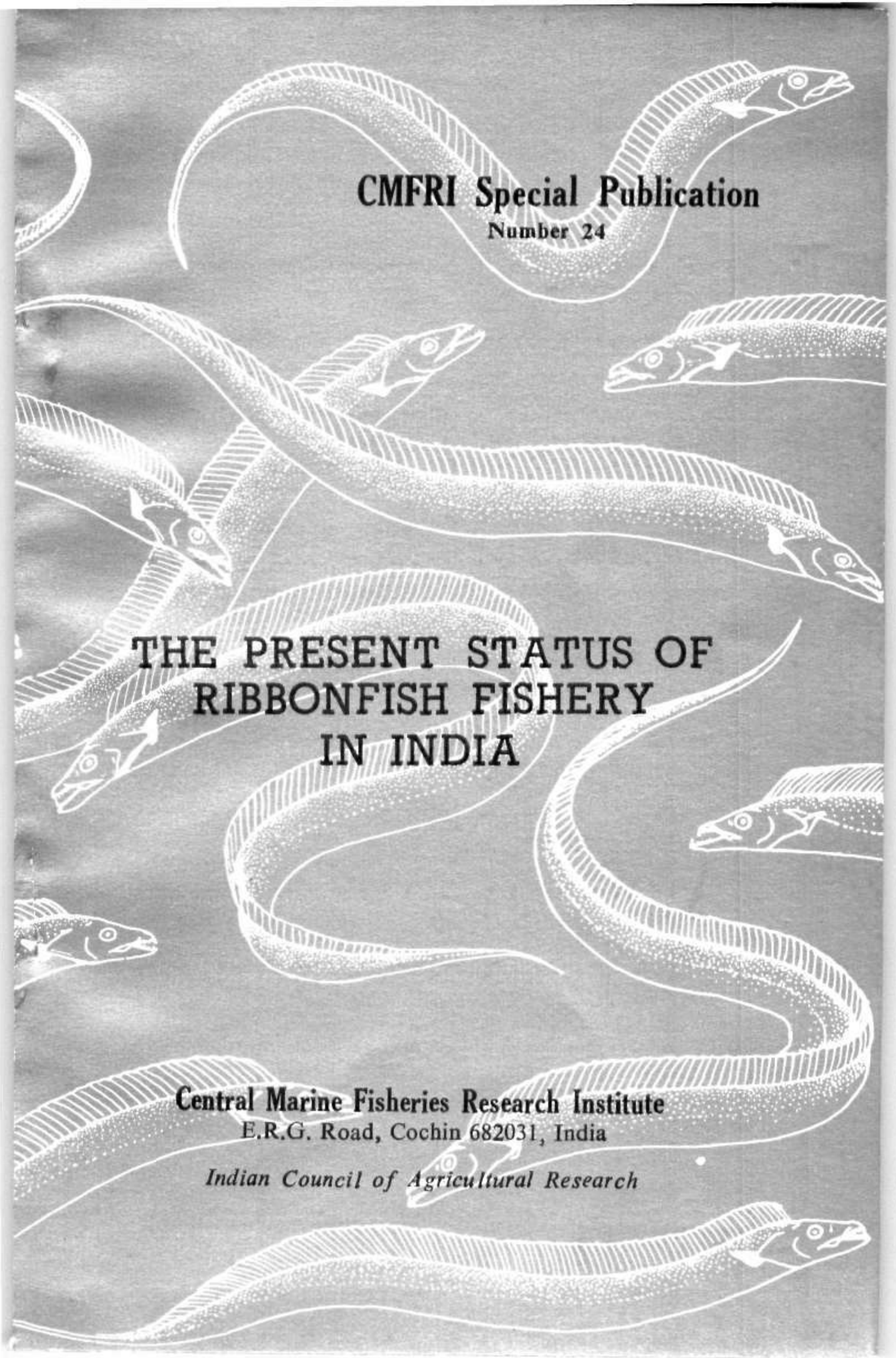

CMFRI Special Publication

Number 24

THE PRESENT STATUS OF RIBBONFISH FISHERY IN INDIA

Central Marine Fisheries Research Institute

E.R.G. Road, Cochin 682031, India

Indian Council of Agricultural Research

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March 1986

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PREFACE

Ribbonfishes constitute one of the most important commercial fisheries of India. They are distributed along both the coasts, but recent data indicate that commercial concentrations abound off the coasts of Andhra Pradesh, Tamil Nadu, Kerala, Maharashtra and Gujarat

In the past, these fishes were exploited mostly by the coastal gears like bag nets and shore-seines, especially when they moved in schools in inshore areas. Of late, these fishes are increasingly captured by trawl nets in deeper waters; their share in trawl catches being quite significant in recent years in the States of Andhra Pradesh, Karnataka, Maharashtra and Gujarat.

Very high potential resources of ribbonfishes in deeper waters, especially between 20 and 75m, have been estimated; but these resources await commercial exploitation. The UNDP/FAO Pelagic Fishery Project had estimated that the ribbon fish constituted nearly 7% of the fish biomass of the shelf waters of the project area (Ratnagiri to Tuticorin). The average standing stock estimated was of the order of 67,000 tonnes during the 1972-1975 period. Highest estimates were obtained during the May-September period. Observations made by the Institute's scientists at different centres also indicated possibilities of increasing the catches, if appropriate methods were employed.

In view of the future scope for development of this resource and to provide the necessary background information on the biology and fishery of these fishes for future exploitation, the present status of this fishery is reported in this special publication. It is hoped that such information would lead to better and rational exploitation of ribbonfishes in future. Similar information on other marine fisheries resources is proposed to be published in this series as and when adequate information becomes available.

P. S. B. R. James

Cochin-18 Director

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PRESENT STATUS OF RIBBONFISH FISHERY IN INDIA

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ABSTRACT

The ribbonfishes, of the family Trichiuridae, an important group of food fishes in India, registered an average annual catch of 53,475 tonnes during 1970–81. In this period, forming 4.25% of the total marine fish catch, they formed the 7th exploited fish group in the order of predominance.

There are 8 known ribbonfish species in India (an identification key to the species is given in the beginning of thearticle). The information available on the various aspects of biology of each of these species is summarised, which clearly indicates that while our knowledge on the biology of *Trichiurus lepturus, Lepturacanthus savala, Eupleurogrammus muticus* and *Eupleurogrammus glossodon* is considerable, we know little about the other species.

Traditionally, the ribbonfishes are caught by boatseines, shoreseines, bag nets and gill nets, operating from nonpowered country crafts. But, during the last two decades, the small

mechanized vessels (10-15 m long, with 15-100 hp engines) that are operating otter trawls, too, are increasingly landing ribbonfish. The fishery is confined to the depth-zone usually shallower than 50 m. *T. lepturus*, the most widely distributed, forms the mainstay of the ribbonfish fishery, contributing to the bulk of the landings along almost all our coastline. Data on spatial and seasonal variations in abundance, size and age composition in the commercial catches and diurnal movements and depthwise distributions of shoals of this species are therefore reviewed.

Stock assessment studies show that, in the shelf region from Ratnagiri on the west coast round to Gulf of Mannar on the east, there had been an average standing stock of 67,200 tonnes of ribbonfish (mostly *L. Lepturus*) in 1972-75, which is about 4 times what was actually landed from the region during the period.

It therefore follows that a doubling of the catch will not adversely affect the stock in the region. Studies on the population dynamics of *T. lepturus* from the Kakinada area during 1967-71 has shown that the fishing mortality and the exploitation rates are low, at 0.3 and 0.17 respectively. The average annual stock and average standing stock along the Andhra and Tamil Nadu coasts are estimated at 85,000 and 48,000 tonnes, respectively, for *T. lepturus*, against an estimated annual average catch of 14,400 tonnes during 1967-71. It thus appears that the stock of *T. lepturus* along the east coast also is likewise underfished.

The need for extension of fishing operations into the Exclusive Economic Zone with larger vessels, equipped with suitable gears like bottom and pelagic trawls, is emphasized. Suggestions on future lines of research are given.

INTRODUCTION

Ribbonfishes constitute an important commercial fishery at several places along the Indian coast. They are mainly consumed in fresh and salted conditions by the poor and middle-classs people. Several authors have made observations on the systematics, biology and fishery of this commercially important group of fishes at a number of localities along the Indian coast. In this paper the available information is reviewed and the areas where more work is needed are stressed, which work would help to develop further this resource from the seas around India.

SYSTEMATICS

At present, eight species of ribbonfishes of the family Trichiuridae, namely, *Trichiurus lepturus* Linnaeus (1758), *T. pantului* (Gupta 1966), *T. auriga* Klunzinger (1844), *Lepturacanthus savala* (Cuvier, 1829) and *L. gangeticus* (Gupta, 1966) of the sub-family Trichiurinae, *Eupleurogrammus muticus* (Gray, 1831) and *E. glossodon* (Bleeker, 1860) of the sub-family Lepidopodinae and *Benthodesmus tenuis* (Gunther 1877) of the sub-family Aphanopodinae are known from the Indian seas. Dutt and Thankam (1966) described two new species, *Trichiurus russelli* and *Lepturacanthus serratus* which have been considered synonyms of *T. pantului* and *L. gangeticus* respectively (James, 1967).

Among the recent workers on the *Trichiuridae*, Tucker (1956) and James (1967) have discussed the systematic position of the nominal species, *Trichiurus haumela* (Forskal, 1775), *T. japonicus* Bleeker (1857), *T. malabaricus* Day (1865), *T. auriga* Klunzinger (1884), *T. coxii* Ramsay and Ogilby (1887) and *T. nitens* Garman (1889), all synonyms of *T. lepturus*; *Trichiurus armatus* Gray (1831) and *T. roelandti* Bleeker (1860) synonyms of *L. savala;* and *Trichiurus medius* Griffith (1834) and *T. glossodon* Bleeker (1880)/synonyms of *Eupleurogrammus intermedius* (Gray). Silas and Rajagopalan (1975) considered *T. auriga* Klunzinger (1884) as a valid species. Wheeler (1971) pointed out that the name *E. intermedius* (Gray, 1831) should be changed to *E. glossodon* (Bleeker, 1860).

KEY TO THE IDENTIFICATION OF THE FISHES OF THE FAMILY TRICHIURIDAE FROM THE INDIAN SEAS

The key given by Silas and Rajagopalan (1975) is modified to include *Benthodesmus tenuis* recorded from the Arabian sea at Alleppey (Tholasilingam *et al*, 1964). The data given by earlier workers (Tucker, 1956; James, 1959, 1967, 1969; Gupta 1966, 1967 a) are incorporated in the key.

1. Frontal ridge not elevated, no sagittal crest. Profile of head rising very gently from snout tip to dorsal . .... **Sub family Aphanopodinae**

   Ventral fins inserted before anterior end of pectoral base. Dorsal rays 120-133; anal elements as i+I+70-76 with external rays throughout; vertebrae 123-131; lateral line strongly developed (less than 15 times in hight at pectoral). ....
   ... . *Benthodesmus tenuis* (Gunther)

2. Posterior confluence of frontal ridges elevated, forming a prominent sagittal crest at the nape, which may or may not be continued forward as a ridge-like elevation of the ethmo-frontal region.

   Pelvic fins present. Lateral line gently sloping from upper angle of operculum to tip of tail, so much so distance between it and ventral profile at vent is more than half distance from lateral line to dorsal profile. Lower hind margins of operculum convex .... Subfamily Lepidopodinae 3.

Pelvic fins absent. Lateral line abruptly decending from upper angle of operculum and running along lower half of body, so much so distance between it and ventral profile at vent is less than half distance from lateral line to dorsal profile. Lower hind margins of operculum concave ..... Subfamily Trichiurinae 4.

3. D III, 123-131; vertebrae 31-35 + 125-131 (= 157-163), origin of anal below D. 31-34. Caudal fin present in young stages and absent in adults................................

.... *Eupleurogrammus glossodon* (Bleeker)

D III, 139-147; vertebrae 38-42 + 159-169 (= 198-201). Origin of anal below D. 38-42. Caudal fin present in young stages and absent in adults ....*Eupleurogrammus muticus* (Gray)

4. Postal anal scute not enlarged and less than width of pupil of eye .... Genus *Trichiurus* Linnaeus 5.

Postal anal scute prominent and dagger-like, size about half diameter of eye .... Genus *Lepturacanthus* Fowler 7.

5. Fang-like teeth with barbs; Dorsal with more than 120 rays; Anal with more than 90 spinules; teeth on palatines multiserial (in 4 or 5 irregular rows)............................ 6.

Fang-like teeth without barbs; Dorsal with less than 120 rays; Anal with less than 90 spinules; teeth on palatines in two irregular rows.....................*Trichiurus auriga* Klunzinger

6. Head shorter, length 2.84—3.22 in snout-vent length and 7.88—8.76 in total length; posterior anal spines serrated (?) ....*Trichiurus pantului* Gupta

Head longer, length 2.63—3.06 in snout-vent length and 6.78—7.62 in total length; posterior anal spines not serrated .... *Trichiurus lepturus* Linnaeus

7. Pectoral spine serrated; D. 120-133; gill rakers 4-7 / 7-11 .... *Lepturacanthus gangeticus* (Gupta)

Pectoral spine not serrated; D. 110-117; gill rakers 2-5/4-9 .... *Lepturacanthus savala* (Cuvier).

BIOLOGY OF THE SPECIES

1. *Trichiurus lepturus*

The length-weight relationship was studied by Prabhu (1955), who gave the equation $W = 0.0004935\ L^{3.0819}$. Narasimham (1972 a) found no significant difference between males and females and the combined equation is written as $\text{Log } W = -4.0197 + 3.4637 \text{ Log } L$ where W = weight in grams and L = Length in cm. The exponent was found to be significantly different from 3. The relative condition factor was studied by Narasimham (1972 a) and he stated that the sexual cycle does not seem to affect the relative condition of the fish, at least directly, while high intensity of feeding influences the K_n. There is a sudden fall in K_n at 625 mm fish length where 90% of fish attained sexual maturity.

Vijaraghavan (1951) from Madras listed teleosteans, *Acetes, Lucifer,* mysids, amphipods, copepods, ostracods, sergestids, zoaea of brachyura, megalopa of crabs, polychaetes, leptocephalus along with algae, green matter, prawns, cumacea, hermit crabs, *Squilla*, copepod nauplii, *Sepia*, larval gastropods and bivalve larvae. The items of food recorded by Prabhu (1950, 1955) were *Hemiramphus* spp, *Therapon* spp, *Dussumieria* spp *Kowala covel, Mugil* spp, *Caranx* spp, *Sardinella* spp, *Leiognathus* spp, *Sciaena* spp, *Trichiurus* spp, *Stolephorus* spp, *Penaeus* spp, *Metapenaeus dobsoni, Acetes, Sepia* and silicoflagellates. His observations have shown that the immature, mature and spent fishes differ in the degree of feeding as well as the nature of diet. The immature ones have been found to be voracious feeders, even resorting to cannibalism. He found slackness in feeding just prior to spawning and active feeding after spawning. Srinivasa Rao (1967) observed that teleosts formed the dominant component (98.7

to 100%) in the stomachs. A qualitative analysis of the stomach contents of the fish collected from Palk Bay, Gulf of Mannar, Kerala, Andhra coasts and the west coast of Ceylon showed that the fish feeds on *Stolephorus*, *Acetes*, 'fishes', *Lucifer*, mysids, *Sardinella*, *Kowala coval*, *Thrissocles*, polynemids juvenile fishes, *Metapenaeus*, young ones of *Sepia* and megalopa larvae (James 1967). Diurnal variation in the feeding activity was absent and, when the size of the prey was big, the same was bitten into pieces and swallowed. George *et al.* (1971) also observed that the fish feeds predominantly on teleosts. On a few occasions they had noted the presence of penaeid prawns, notably *Metapenaeus dobsoni*, and stomatopod larvae.

Narasimham (1972 a) found that in the Kakinada area the food of the adult fish consisted predominantly of fishes, followed by crustaceans. The feeding intensity was high in October-November in males and in August and November in Females. Food of young fish (37-120mm T.L.) was found to be composed mainly of copepods followed by other crustaceans (Narasimham 1972 b). No seasonal variation was found in the feeding intensity in young fish.

At Tuticorin, Mahadevan Pillai (1974) observed that intensive feeding occurred in October and November; in August and December feeding was moderate. In the remaining months it was poor.

In a more detailed study from the Mangalore region James *et al.* (1983) indicated that qualitatively the food consisted of teleostean fishes, prawns, shrimps, cephalopods and stomatopods in that order of abundance. Although about 50 different fish species were caught by the trawls the stomach contents of *T. lepturus* included only a few of them indicating that the fish exercises a certain amount of selectivity in food. It is noteworthy that the oil sardine and the mackerel are also important items of food of *T. lepturus* of Mangalore. Prawns were often represented by *Metapenaeus dobsoni* and *Parapenaeopsis stylifera*, and cephalopods, which occurred to a limited extent, by *Sepia* and *Loligo*. The stomatopods, represented by *Oratosquilla nepa*, though abundant in the area, are consumed in negligible quantities.

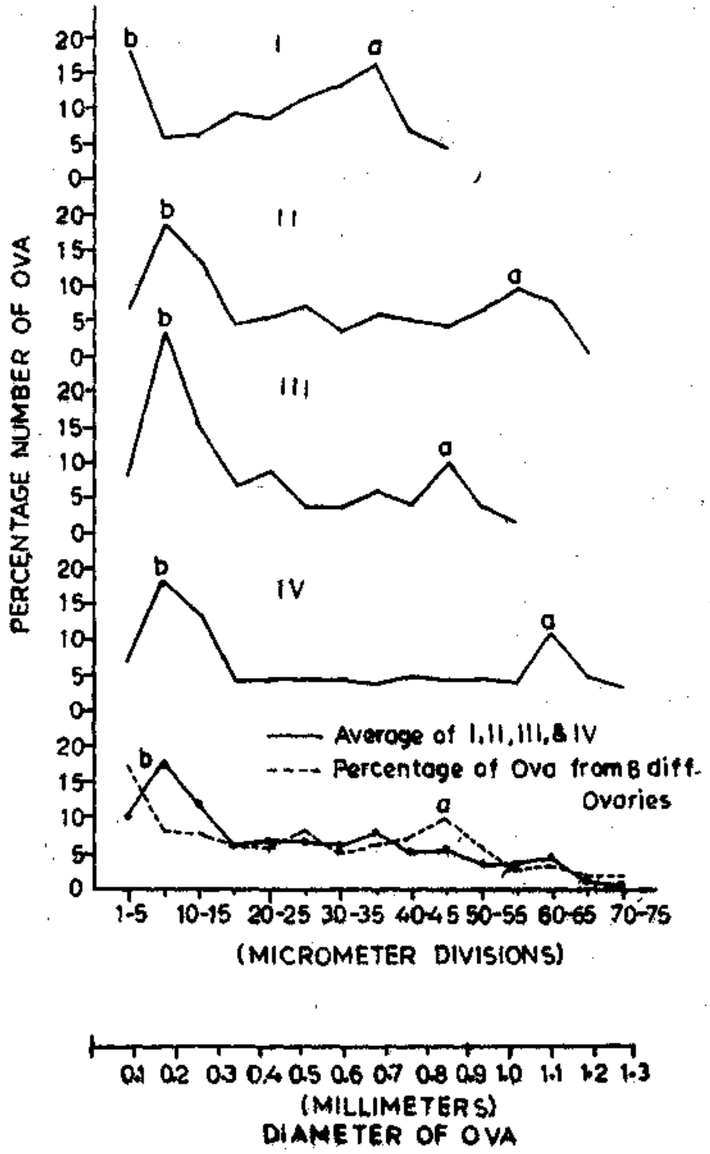


Fig 1. Ova-diameter frequency polygons in *Trichiurus lepturus* (after Prabhu 1955)

As to the seasonal differences in the food of *T. lepturus*, fishes and prawns were consumed in all the months but cephalopods were found during January-March and stomatopods between November and January. Observations on the intensity of feeding indicate that active and reduced feeding rates are found interspersed in all the months and this appears to be correlated with prolonged spawning of the species. However, the percentage of empty stomachs was very high in almost all the months. Details of the percentage occurrence of various food items in different size groups of *T. lepturus* indicate no striking change in the food of the fish from young to adult stage except that bigger fish had a greater variety of organisms as food compared with smaller fish.

Prabhu (1955) found that in a mature ovary (Fig 1) the mature stock of ova (mode b) is more or less sharply differentiated from the immature stock (mode a) indicating that the spawning is of short duration, once in a year in June. In a recent study James and Baragi (1980) stated that in this species two major lots of ova seem to mature and succeed one another, each lot being released in at least three batches (Fig. 2.) This suggests fractional spawning. Tampi *et al* (1971) found that the fish spawns more than once in a year along the Madras coast and the two seasons are roughly around May-June and November-December. James *et al* (1983) found that, off Mangalore coast, the species spawns almost throughout the year, individual fish spawning more than once. Narasimham (1972 b) based on the occurrence of early juveniles stated that at Kakinada this species spawns from January to September with peak in February-June period in the offshore waters beyond the 30 m depth. Rao *et al* (1977) suggested that the species breeds over an extended period; probably with two intensive spawning periods, namely December to January and May to August in the shelf area along south-west coast. Prabhu (1955) gave the minimum size at first maturity as 470-480 mm and over 50% maturity as 510 mm length (from his table 3) while James et al (1972) found it to be 412 mm in males and 431 mm S.L. in females. Narasimham (unpublished) observed that over 50% of fish attained maturity at 525 mm T.L. Studies on the sex ratio indicated highly significant dominance of females over males in most of the months (James *et al* 1983).

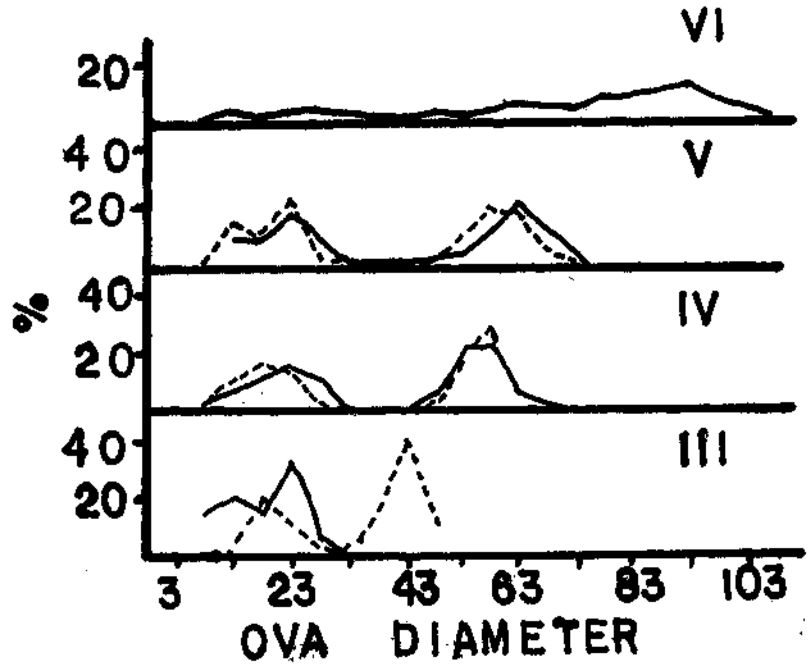


Fig. 2. Ova-diameter (in micrometer divisions) frequency polygons in *Trichiurus lepturus*. Ovaries of normal and partially spent (broken lines) fish are shown. (after James and Baragi 1980.)

Prabhu (1955) studied the fecundity of fish below 60 cm in length and gave the formula $F = 0.0004119\ L^{4.3475}$ where F and L represent fecundity in thousands and length in cm respectively. The fecundity was found to increase with length at a rate substantially greater than the fourth power of length (Fig. 3). In larger fish (74.3 to 87.2 cm) Tampi *et al* (1971) estimated the number of mature ova at 24288 to 61595. James *et al* (1983) observed that the number of mature ova varied from 1,000 to 1,34,000 in fishes measuring 136 mm to 381 mm S. V. length. The relationship between fecundity and S. V. length is described by the equation $Y = 0.00156\ X^{3.3217}$ and $Y = 0.002038\ X^{2.8201}$ where X = S. V. length and Y = number of mature ova. These two formulae are equally correlated and the correlation coefficients are 0 78 and 0.80; for the second formula the regression coefficient indicates almost cubic relationship. The relationship between fecundity (Y) and fish weight (X) is described by the equation Y=102.47X—4865. Also the relationships between fecundity and ovary weight and fish weight were studied (James *et al.* 1983). The post-larval stages were described by Nair (1952) and James (1967) while the occurrence of early juveniles were recorded by Vijayaraghvan (1951), Prabhu (1955), Basheeruddin and Nayar (1962) Narasimham (1972 b) and Rao et al. (1977).

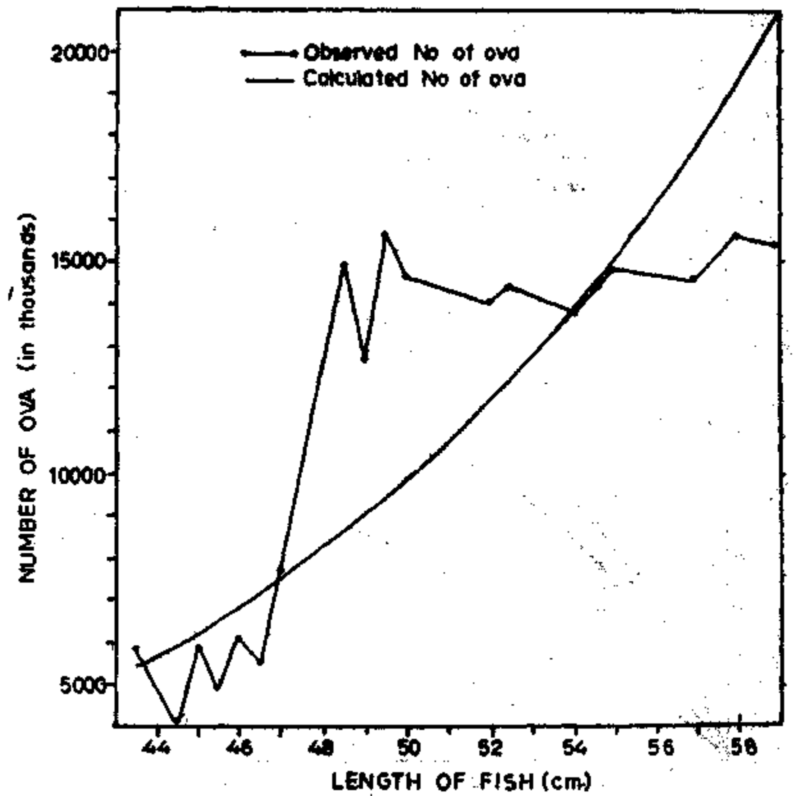


Fig 3. The relationship between length and number of ova in *Trichiurus lepturus* (after Prabhu 1955).

According to Prabhu (1956) the species attains a length of 18 cm in the first year, 30 cm in the 2nd year, 46 cm in the 3rd and 54 cm in the 4th year (Fig. 4). Tampi et al. (1971) suggested that the fish would grow to an average length of 30 cm at the end of first year. James *et al.* (1972) stated that the species attains 391, 587, 708 and 828 mm at the end of 1st, 2nd, 3rd and 4th year of its life. However, Narasimham (1978) found the lengths to be 41.6, 69.0 & 88.5 cm at the end of 1st, 2nd & 3rd years respectively. He estimated the parameters of the von Bertalanffy growth equation as $L\infty = 145.4$ cm, $K=0.29$ and $t_0=0.20$ years. The estimated lengths at ages 1 to 5 are 42.7, 68.6, 87.9, 102.4 and 113.2 cm T. L. respectively.

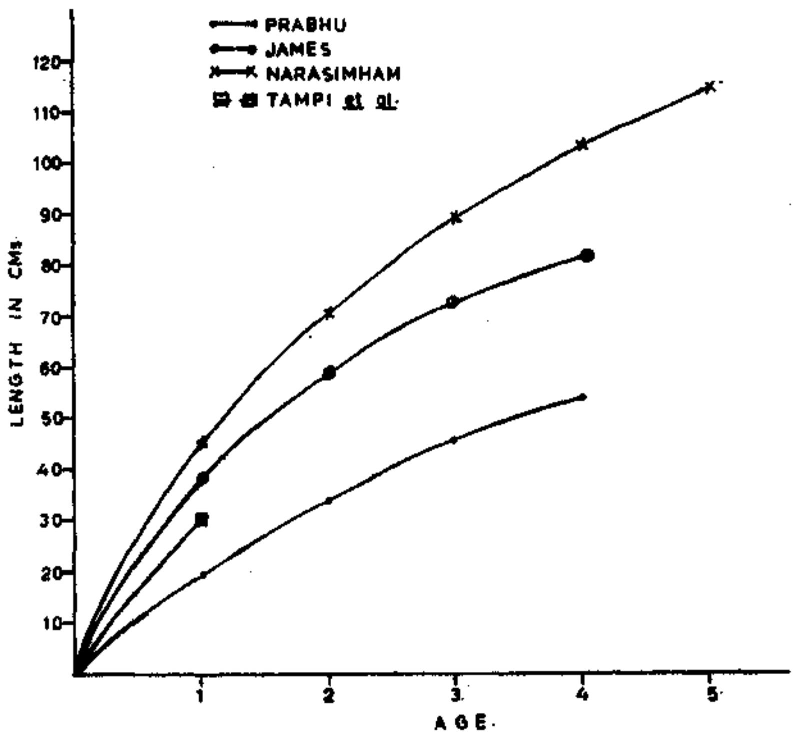


Fig. 4. Growth curves in T. *lepturus* as given by various authors

2. *Trichiurus auriga*

Limited information is available on the biology of this species (Silas and Rajagopalan 1975). The food consisted of myctophid fishes and deep water shrimps. Like other ribbon fishes, this species also exhibits carnivorous habits. The number of ova per gram body weight varied from 180 to 330 in fish weighing 8.5-33.0 g in total weight. Females may attain

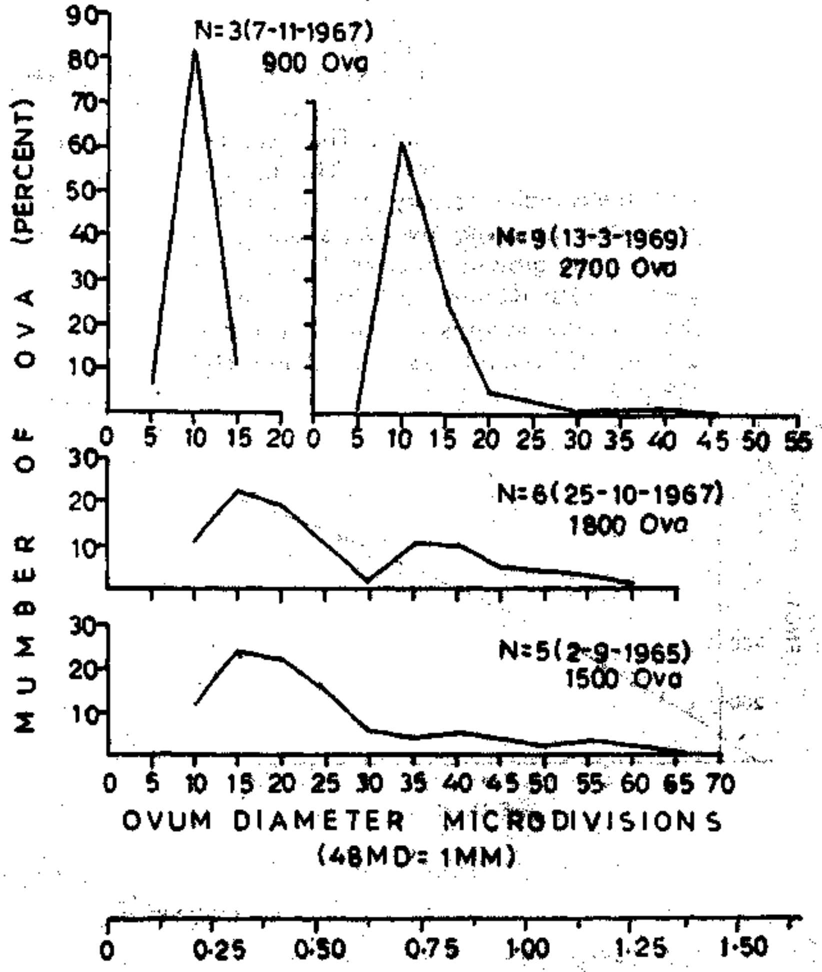
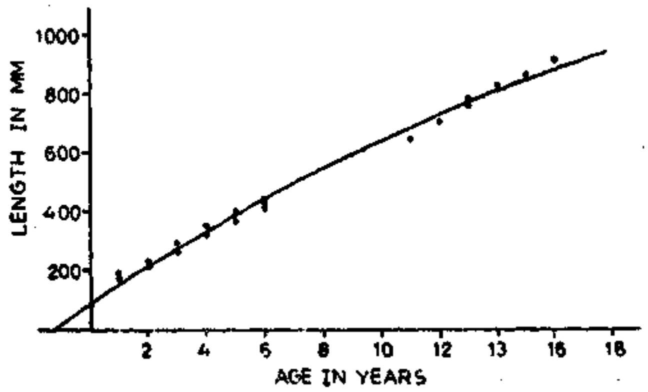


Fig. 5. Ova diameter frequency polygons in *Trichiurus auriga* (after Silas and Rajagopalan 1975).

maturity at a size below 241 mm and males at 217 mm total length. Fully mature ovaries may have developing ova showing more than one mode (Fig 5) and the data were scanty for a satisfactory study of the spawning periodicity in this species. Spawning may take place during or just prior to October and the fish may spawn more than once.

3. *Trichiurus pantului*

The work of Gupta (1968 a) is the only source of information. The length-weightrelation ship was found to be Log W = -5.1365 + 3.1318 Log L, where W = weight in grams and L = snout-vent length in mm. The exponent was found to be significantly different from 3. The food of this species studied from the Hooghly estuary indicated that prawns formed the dominant item followed by fishes and megalopa larvae. The von Bertalanffy growth equation was fitted which has the parameters L_∞ = 1735.64 mm, K = 0.041357 and t_0 = — 1.30401 years. The estimated lengths in mm (T.L.) at ages 1 to 6 are 157.73, 221.67, 283.00, 341.85, 398.29 and 452.48 mm respectively (Fig. 6). According to Gupta at 16 years of age the



Growth curve of Trichiurus pantului obtained by fitting von Bertalanffy equation Dots represent the estimates of lengths at ages by length - frequency analysis.

Fig. 6 Growth curve of *Trichiurus pantului* (after Gupta 1968 g).

fish would attain 887.10 cm length. The relative condition factor showed a sudden fall at 162 mm snout-vent length which may be associated with the attainment of first maturity.

4: *Lepturacanthus savala*

Gupta (1967b) found the length-weight relationship as Log W = $\bar{5}$.5398 + 3.30715 Log L where W = weight in grams and L = snout-vent length in mm. The exponent was found to be significantly different from 3. He studied the age and growth by fitting the von Bertalanffy growth equation which has the parameters $L\infty$ = 1057.14 mm, K = 0.0887 and t_0 = — 0.03957 years. The estimated lengths in mm (T.L) at ages 1 to 6 are 93.10, 174.96, 249.82, 318.35, 381.06 and 438.44 mm respectively (Fig 7).

The decline of relative condition factor at 409 mm total length is attributed by him to attainment of first maturity and spawning. The fish attained the peak condition between February and April, apparently due to developing gonads. It starts loosing condition from May and continues till September when it reaches the minimum, probably due to spawning.

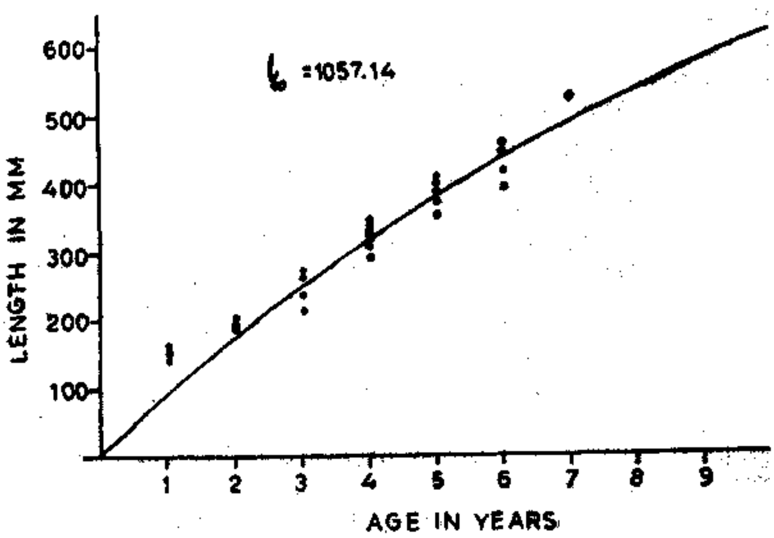


Fig. 7. Growth curve of *Lepturacanthus savala* (after Gupta 1968 b).

The food of the species is mainly constituted by prawns followed by fishes. The most common prawn species found in the stomach contents was *Parapenaeopsis sculptilis*. Fishes include *Harpodon nehereus*, *Setipinna* sp., *Anchoviella* sp., *Trichiurus* sp., and *L. savala*. Cannibalism was observed. In the food of this species from Madras, Vijayaraghvan (1951) listed teleosteans, *Acetes*, *Lucifer*, copepods and their nauplii prawns, cirripeds, bivalve larvae, polychaetes, algae and green matter, stomatopods and their larvae, anomurans, palaemonids, mysids, *Leander*, cumaceans, ostracods, megalopa of brachyuran crabs, zoaea of crabs, pycnogonids, porcellanids, pteropods and *Sepia*. The food and feeding habits of this species from the Palk Bay and Gulf of Mannar were analysed by James (1967). The results indicated that "fishes" form its major diet, followed by *Acetes*, and prawn (*Penaeus* and *Metapenaeus*). *Squilla*, *Lucifer*. *Octopus*, *Sepia* and zoaea larvae were preyed upon whenever available. Of the fishes special mention may be made of *Stolephorus*, *Sardinella*, *Dussumieria* and *Caranx*. A comparison of the stomach contents of *L. savala* with fishes and other organisms landed in the nets along with it revealed that this species also exercises a certain amount of selectivity for certain varieties of fishes like *Stolephorus*, *Sardinella*, *Dussumieria*, prawns of the genera *Penaeus* and *Metapenaeus* and shrimps represented by *Acetes*. Fish were devoured whole, but occassionally cutting them up before taking in. Examination of stomach contents of fish collected at night revealed that they were in varying degrees of fullness indicating that the species feeds at night also. Three ripe fish collected in May, 1959 had their stomachs empty indicating a probable cessation of feeding during spawning season. In the ripe fish the gonads occupy almost the entire body cavity, displacing the empty stomach. A specimen of *L. savala* measuring 46 cm had in its stomach exclusively three broken bits of *E. glossodon*.

In a mature ovary (Fig 8) three distinct groups namely the transparent immature stock (not shown in figure), maturing group and the mature group of ova are discernible (James 1967). It is suggested that in individual fish spawning at a time is of short duration and the fish may spawn more than once in a year. Information on the spawning period of this species is absent. Chacko (1950) mentioned that the eggs of *L. savala* measure 2.15-2.40 mm with a 0.7 mm yellowish oil globule. The larva is characterised by paired black pigment spots near the ear vesicles and 34 preanal and 126 postanal myotomes. A 61 mm specimen was described by James (1967).

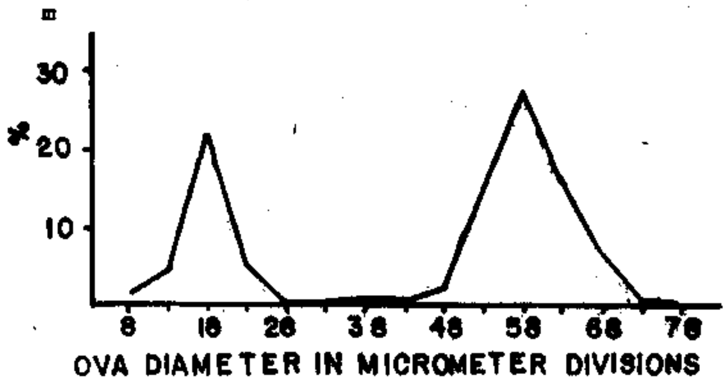


Fig. 8. Ova diameter frequency polygons in *Lepturacanthus savala* (after James 1967)

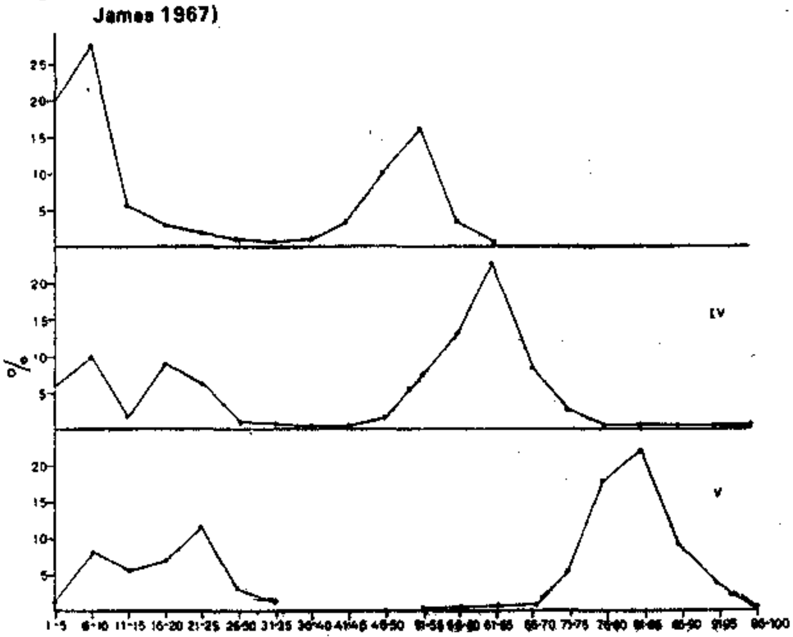


Fig. 9. Ova diameter (in micrometer division) frequency polygons in *Lepturacanthus gangeticus* (after Sastry 1980).

5: *Lepturacanthus gangeticus*

Sastry (1980) found the length-weight relationship to be $\text{Log } W = -4.4385 + 2.8615 \text{ Log } L$, Where W = weight in gms and L = snout-vent length in mm. In the ova diameter frequency study Sastry (1980) stated that only one batch of ova are separated from the parent stock to become mature and be released in one spawning (Fig. 9). The spawning season was found to be May-July, off Kakinada. Information on other aspects of biology of this species is not available.

6: *Eupleurogrammus glossodon*

Detailed information is given by James (1967). The length-weight relationship was found to be $\text{Log } W = -3.9268 + 3.4445 \text{ Log } L$, where W = weight in g and L = standard length in cm. The exponent was found to be significantly different from 3. Changes in relative condition factor are probably related to factors other than the reproductive cycle and the intensity of feeding. Fishes (*Stolephorus, Trhisssocles, Leiognathus, Sardinella, Dussumieria, Sphyraena, Hemiramphus, Kowala coval, Atherina, Tetrodon, Eupleurogrammus glossodon*), fish eggs and larvae, crustaceans, prawns, *Acetes, Squilla,* mysids, isopods, *Lucifer,* copepods and molluscs (*Octopus and Sepia,* constituted the important items of food However, the species has been found to be predominantly piscivorous. The diet was more or less uniform, without showing any differences in relation to place, time or size of the fish, and dependent more on the availability of the particular organisms The only change observed as the fish grows was the increase in the number of items added particularly in the variety of fishes. The species is not an indiscriminate feeder but exercises certain amount of selectivity depending upon availability. Variations in feeding intensity were not related to spawning. Abundance of favourite food items is not always associated with intense feeding. The fish feeds mainly on the surface both during day and night. Only mature fish exhibited cannibalism.

The ova diameter frequency polygons at various stages of development showed that in a mature ovary three distinct groups of ova comprising the immature, maturing and mature are present (Fig 10). Individual fish spawns more than once and spawining at a time may be of a short duration. The species spawns almost throughout the year, with peak spawning in

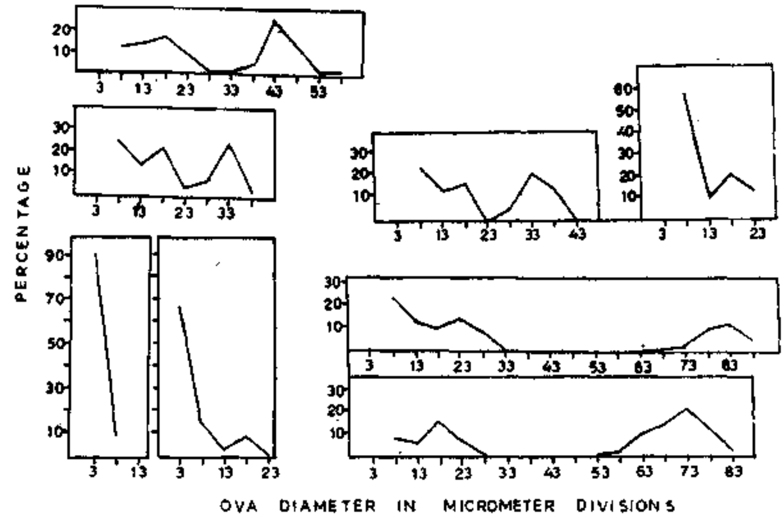


Fig. 10. Ova diameter frequency polygons in *Eupleurogrammus glossodon* (after James 1967).

March-April, August-September and November-December. Although a few female fish mature at 30-32 cm, majority of females attain maturity at about 38 cm. Males appear to mature earlier than females at 28-30 cm and information is lacking about the size at which majority of the males attain maturity. The potential stock of eggs present in individual fish range from 2236 to 9950, irrespective of the number of batches each of them could have already spawned. Although the fecundity of individual fish of the same length may vary considerably, James (1967) observed that generally the number of eggs increased with the size of the fish (Fig 11). Sexes were found to be disproportionate in the commercial catches, the females outnumbering the males. Post larvae were described by James (1967). Narasimham (1976) recorded them from Kakinada.

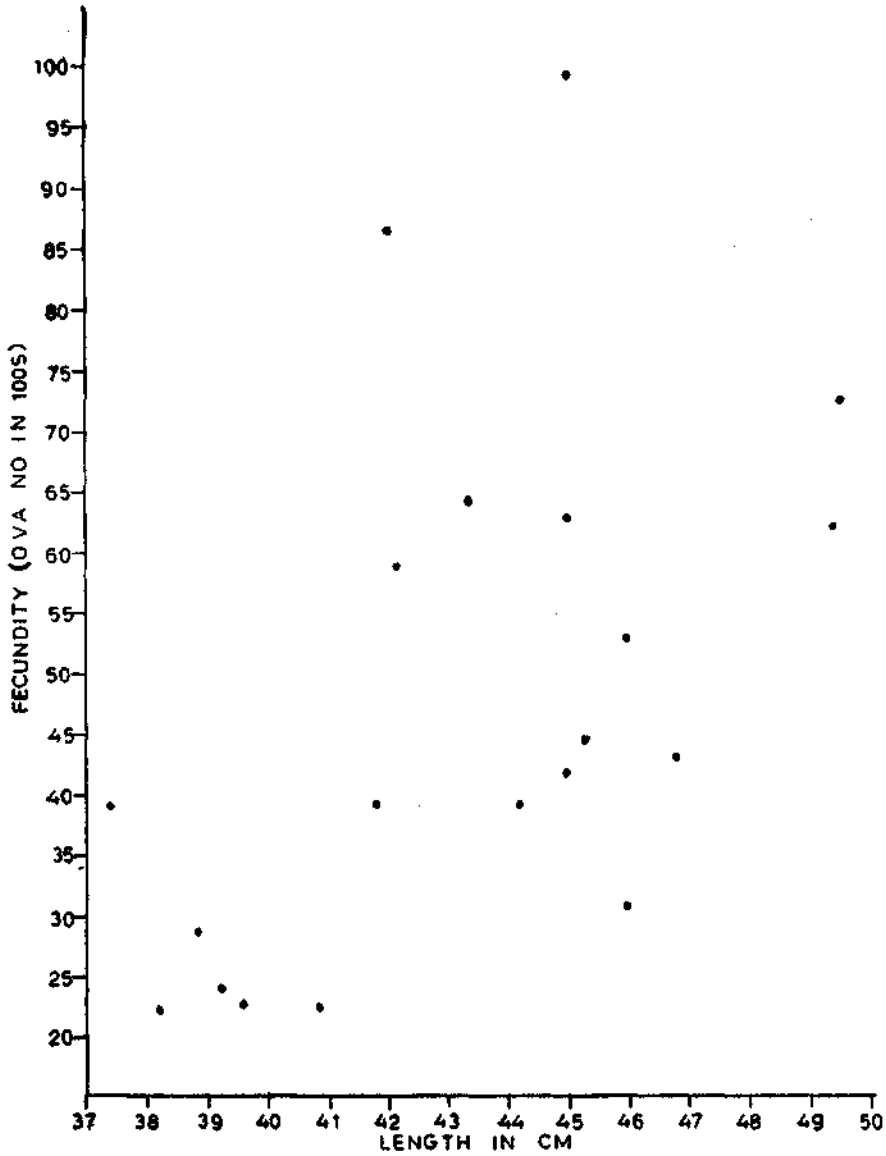


Fig. 11. Length-fecundity in *Eupleurogrammus glossodon* (after James 1967).

The species attains a size of 21, 33 and 43 cm at the end of 1, 2 and 3rd year, respectively. as determined by length frequency studies. Studies on otoliths indicated a similar growth pattern. Since a few fish above 43 cm are met with in the commercial catches, the life span of *E. glossodon* may be at least 4 years. Differential growth rate in the sexes was observed, males being smaller than females of same age. Size groups above 43 cm are represented by females only (James, 1967).

Fish from Palk Bay and Gulf of Mannar did not differ in six morphometric characters analysed (James 1967).

7. *Eupleurogrammus muticus*

Narasimham (1976) studied its biology from Kakinada. The length-weight relationship was found to be $\text{Log } W = -4.2165 + 3.5233 \text{ Log } L$, where W = weight in g and L = length in cm. The regression coefficient was found to be significantly different from 3. In the post-larvae (43-120 mm), high percentage (22%) of empty stomachs was encountered. Among the gut contents fish were dominant, mostly represented by anchovy larvae followed by calanoid copepods. In juveniles (130-410 mm), the incidence of empty stomachs was low (6.8%). Among the important food items, fishes (larvae and juveniles of clupeoids, carangids etc.) ranked first, followed by prawns (*Acetes* sp, postlarvae and juveniles of penaeids), *Lucifer* and crabs. In adults, only 5.4% of the fish had empty stomachs. Cannibalism was rare and only in two instances it was observed. The fish showed marked preference for prawns (*Acetes* and penaeids) followed by fish, mostly juveniles of *Stolephorus* and *Sardinella*. Stomatopods ranked third and were represented by alima larvae only. James (1967) also found that the most common items of food were *Lucifer*, *squilla*, fishes and zoea larvae in the fish collected off Bombay and Puri coasts. Narasimham (1976) stated that majority of fish (61.1%) mature at 43 cm. The smallest fish with spent gonads measured 40.5 cm. The ova diameter frequency studies (Fig 12) indicate that in a mature ovary 3 groups of ova consisting of small translucent group (not represented in figure) developing group (B) and mature group(A)are present(Narasimham 1976).

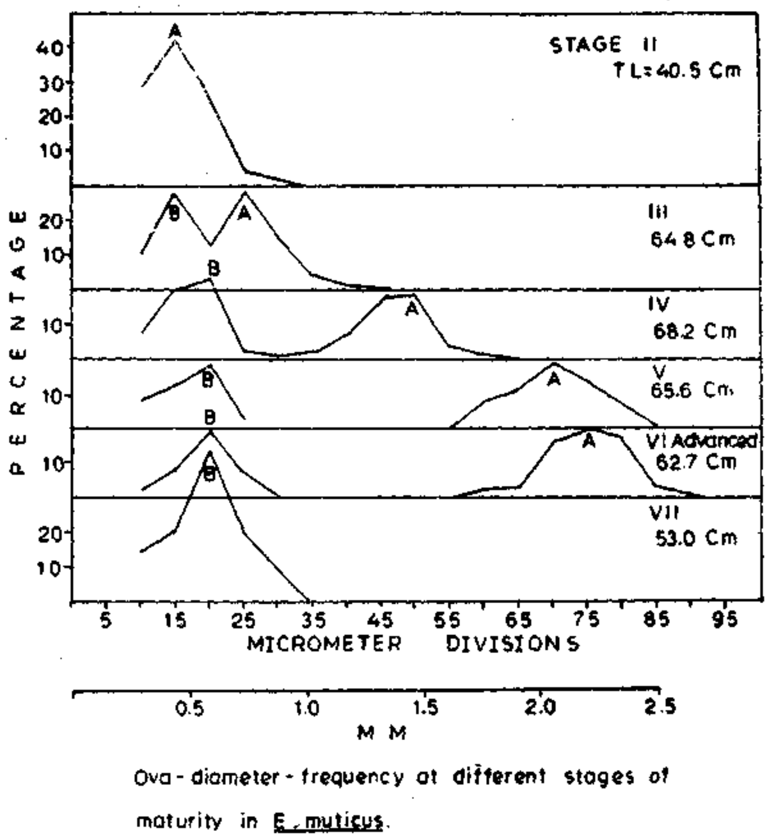


Fig. 12. Ova diameter frequency polygons of *Eupleurogrammus muticus* (after Narasimham 1976).

The compact mature and the sharp differentiation of group A ova from group B ova indicates that in individual fish the duration of spawning for group A ova will be of a short time. It is suggested that individual fish may spawn more than once during the spawning season. Active spawning takes place during May-November. The fecundity varied from 2362 to 4853 ova per fish and generally increased with increase in fish length (Fig 13). Fecundity per gram-weight of fish varied from 19.3 to 35.5 ova.

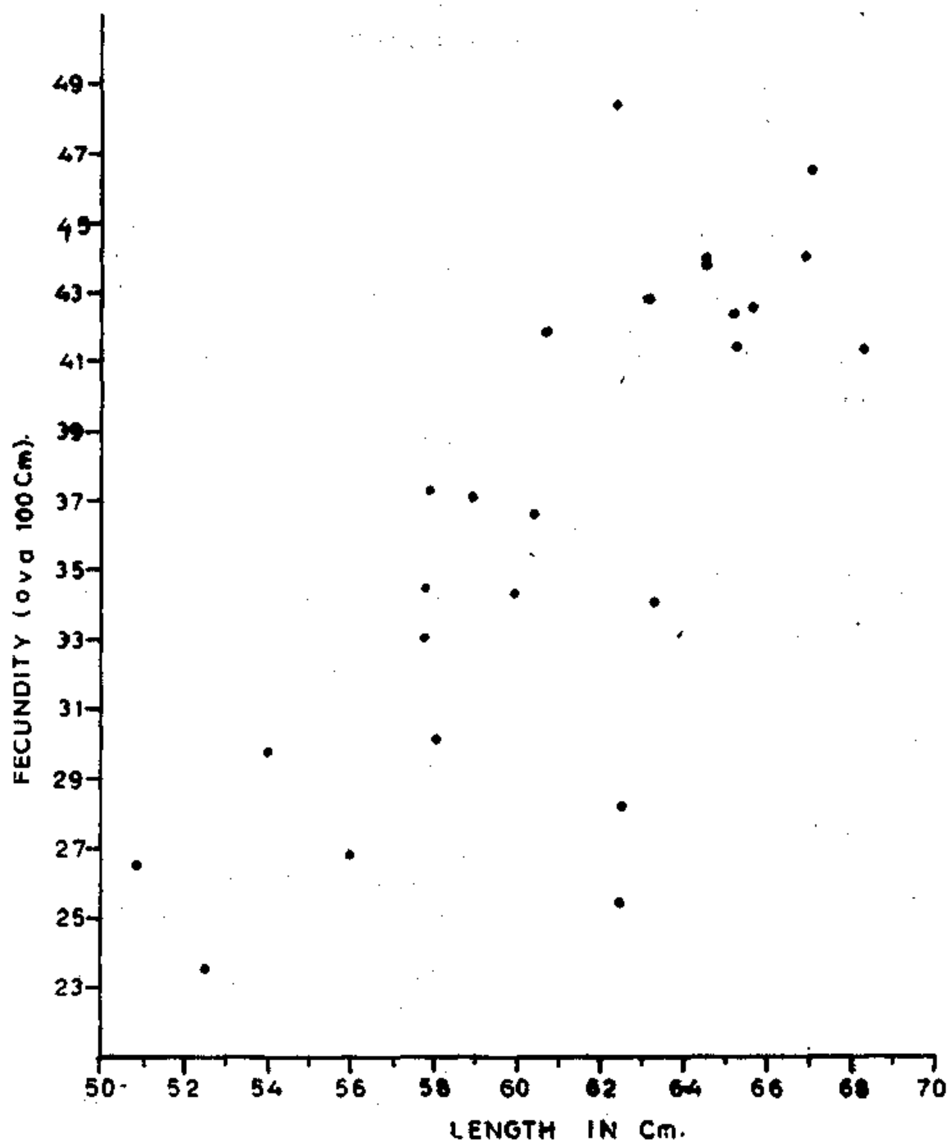


Fig. 13. Length-fecundity relationship in *Eupleurogrammus muticus* (after Narasimham 1976.)

Post-larval stages were described by the same author.

8: Benthodesmus tenuis

Information on the biology of this deep water fish is not available.

COMPARISON OF BIOLOGICAL DATA

Food and feeding habits : The studies on the food of *Trichiurus* spp from the West Coast by Venkataraman (1944) and Jacob (1949) and from Madras coast by Devanesan and Chidambaram (1948) indicated that the ribbon fish are carnivorous devouring a variety of commercialy important fishes and prawns.

It is generally agreed by authors that the ribbon fishes are mainly piscivorous, supplementing their diet by a wide variety of other organisms. Although they are carnivorous, they exhibit certain amount of selectivity in diet (James 1967 and Prabhu 1955) Observations made by several authors indicate that young ribbonfish feed on small fishes and shrimps whereas adults prey upon big organisms. Competition between species for different kinds of food is usually not keen when they occur together. Also when they consumed common organisms like *Acetes* and *Lucifer* it was observed that the size of the prey differed in each species. This specificity in selection of food probably enables different species to live together in the same habitat. Regarding the size of prey *L. savala* usually caught big sized prey followed by *T. lepturus, E. glossodon* and presumably *E.muticus* occupies the last position. Details of the structural adaptations with reference to feeding habits have been discussed by James (1967). Of the 4 species *L. savala* has definitely the most powerful caniniform teeth and lengthy jaws to seize and accommodate the big sized prey effectively in the mouth cavity before swallowing it. The small number of teeth, and their arrangement with bigger interspaces and the rudimentary nature of gill rakers point out the high degree of carnivorous nature of this species as compared with others. The greater number, closer agreement, less powerful teeth, relatively shorter jaws compled with slightly better development of the gill rakers in *T. lepturus* and *E. glossodon* are suitable for feeding on small sized prey. In *E. muticus* all these adaptive features are yet more pronounced to facilitate feeding on smaller organisms to a larger extent. Although Prabhu (1955) believed that instances of cannibalism in *T. lepturus* is probably due to absence of other food items and overcrowding of shoals, James (1967) observed in *E. glossodon* cannibalistic tendency only at times of intensive feeding and this phenomenon may not be due to overcrowding of shoals. While Venkataraman (1944) stated that the guts of ribbon fishes are literally clogged with macerated fish eggs, subsequent workers did not come across this item in any appreciable extent. However there is near unanimity among workers that the diet of ribbon fishes consists mostly economically important food fishes and prawns. Jacob (1949) stated that ribbon fishes being predators on other economically important fishes, their overfishing can hardly do harm to the fisheries as a whole. However, Jacob (1949) observed that young ribbon fish form forage for other fishes like *Chirocentrus dorab, Polynemus tetradactylus* and *lactarius* while James (unpublished) noted an instance of *Muraenasox talabanoids* feeding on *T. lepturus*.

Available information does not indicate any diurnal variation in the feeding habits of ribbon fishes. Also except for *L. savala* complete cessation of feeding associated with sexual cycle was not noticed. While Prabhu (1955) reported slackness in feeding of *T. lepturus* such a phenomenon was not noticed in *E. glossodon* (James 1967).

Maturity and spawning :

A comparision of the spawning habits of the four ribbon fish species *T. lepturus, L savala, E. glossodon* and *E. muticus* for which considerable information is available shows that they spawn more than once in a year as revealed by studies on the ova diameter measurements. Three groups of ova, the immature, maturing and mature are apparent in the ovaries. The maturing and mature groups of ova are sharply differentiated in the mature ovaries of all the four species indicating their spawning at a time to be of short duration The presence of a second batch of eggs (maturing group) in the ovaries suggests that individual fish spawns more than once. Although Prabhu (1955) indicated a short definite spawning, once in a year in June for *T. lepturus,* observations by subsequent authors indicate a prolonged spawning of the species spread over the major part of the year or spawning twice a year. Prabhu (1955) gave the upper limit of 16,000 ova for fecundity of this species and this appears to be an underestimate since upto 1,34,000 ova were estimated by James *et al* (1983). This species was observed to move in great schools in the inshore waters after June at many places along the Indian coast. Since majority of fish in such schools were above 45 cm (47-48 cm being the size at first maturity) and in spent and spent recovering stages, it is possible that this schooling behaviour is associated with spawning. These migrations into inshore waters may as well be called post-spawning migrations.

The duration of spawning both in *E. muticus* and *E. glossodon* is prolonged and takes place during the major part of the year(Narasimham,1976 and James,1967).

Age and growth: Data on age and growth of *T. lepturus T. pantului, L. savala* and *E. glossodon* are available from Indian waters. James *et al* (1983) and Narasimham (1978) agree that *T. lepturus* grows at a faster rate than stated by Prabhu (1955) and Tampi *et al.* (1971). The largest specimen of this species collected in the commercial catches at Kakinada measured 115 cm (T. L.) and considered as 5 years old (Narasimham 1978). For *E. intermedius* the presence of fish beyond 43 cm in length indicates that it has a life span of at least 4 years (James 1967). Comparison of the growrh rate between *T. lepturus* and *E. glossodon* indicates that it is faster in the former where the maximum size attained is also higher. The length at age data for *L. savala* (Gupta 1967 b) and *T. pantului* (Gupta 1968 a) indicate a life span of 6 and 16 year respectively for the two species. More information is called for on these two species.

It is of interest to note that the regression coefficient in the length-weight relationship in various ribbon fish species studied by several authors was found to be significantly different from 3, suggesting that growth is not isometric.

Osteology: The comparative osteology of *T. lepturus, L. savala, E glossodon* and *E. muticus* and their phylogeny was studied by James (1961). The elongation of the skull bones, especially those of the preorbital region in all the four species shows the adaptation for predaceous feeding habits.

Embryonic and larval development:

It is significant to note that although several species of mature ribbon fish regularly occur at a number of centres along the Indian coasts the eggs, larvae and young stages are extremely rare. This has led several workers to suggest that the ribbon fishes spawn in the offshore waters, beyond the present fishing grounds traditionally exploited by the fishermen.

Observations on the post-larval forms indicate that there is some similarity in the structure and transformation of the young ones of all the species, especially in the precocious development of the anterior portion of dorsal fin and the distribution of melanophores on the body. The diagnostic characters of the species like the decurved or median lateral line, the presence or absence of ventral fins, the caniniform teeth and prominent or rudimentary nature of anal spines are distinct in post-larvae (James 1967). The presence of a caudal fin in the post larvae and its complete atrophy in the juveniles of *Eupleurogrammus* is a significant character of this genus.

THE FISHERY

The reports indicate that various species of ribbon fishes constitute substantial fishery in the states of Andhra Pradesh, Tamil Nadu, Kerala and Maharashtra, showing considerable variations in the species composition, seasonal abundance and production trends.

Distribution of the species, fishing methods and season:

The distribution of ribbon fishes a long the Indian coast is more or less continuous with *T. lepturus* occurring throughout the coast and other species occurring rather discontinuosly (Fig. 14).

In the Hooghly and Matla estuaries except for *T. auriga* and *B. tenuis* other 6 species occur with *T. lepturus* and *L. savala* dominating the catches. These species are fished in the lower reaches of the estuary during November to February. Ribbon fishes in this area are caught mostly in bag nets locally known as behaundijal, behutijal, baintijal, binjal or thorjal which are ideally suited for operation in tidal zones (Gupta 1968b).

Along the Orissa coast three species viz. *T. lepturus, L. savala* and *E. muticus* were recorded (Fig 14) and the latter appears to predominate in the fishery. These fishes are caught in shore-seines called Berjal and the season extends from July to about November.

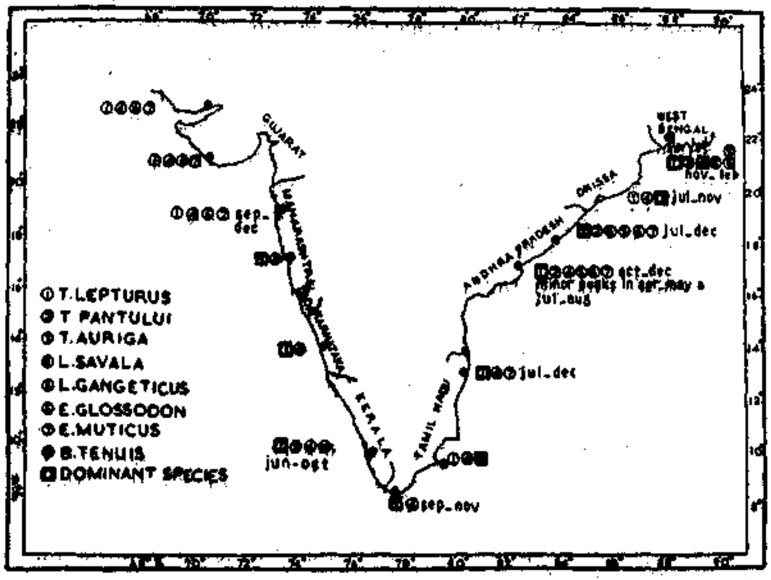


Fig. 14 Distribution of ribbon fish species and seasonal abundance of the fishery along Indian coast.

Along the Andhra coast the ribbon fishes are called 'Savallu' and 6 species contribute to the catches (fig 14) with *T. lepturus* accounting for a greater proportion of the catches. They are caught in shore seines called Pedda vala, or Alivi vala

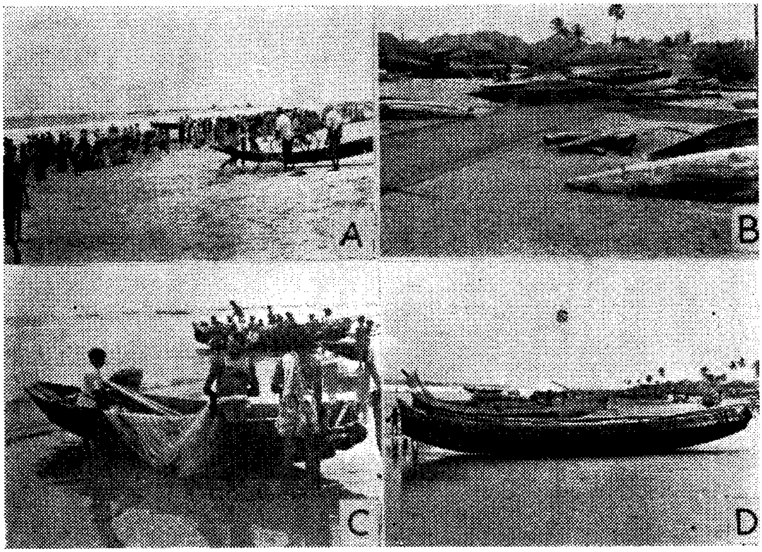


PLATE 1. **A,** View of Uppada fish landing centre near Kakinada, where artisanal fisherman beach-land the nonpowered country crafts. **B.** Boat seine, showing the central bag and the wings. **C.** Synthetic gill-net. **D.** Kakinada nava, a plank-built boat

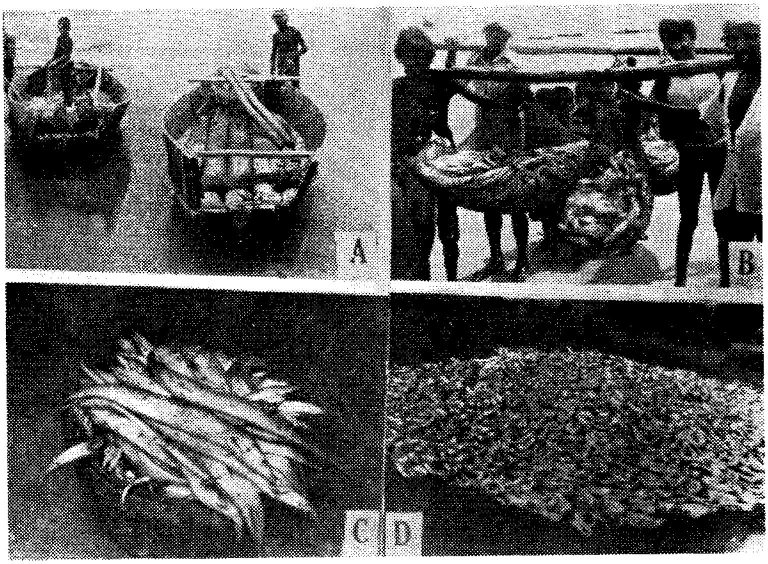


PLATE 2. Catamarans made of logs. B. *Trichiurus lepturus* catch from boat-seine units C. *T. lepturus* measuring 70-80 cm, ready for auction. D. Sun-drying of *T. lepturus*

and bagnets or boat seines called Irega vala or Thuri vala operated from plank built boats or catamaran (plate I Dand II A) From the Kakinada region during 1967–71 the ribbon fish formed 1.6 to 10.4% in shore seines, 23.1 to 54.9% in boat seines, (plate I B). 0.5 to 2.3% in gill nets (plate I C) and 3.0 to 10.2% in otter trawls of the total fish landed. Ribbon fishes are reported to be common after August upto about December in this region.

In Tamil Nadu, *T. lepturus, L. savala, E. muticus* and *E. glossodon* were reported to occur (fig 14). All the species are generally called as 'Savalai'. While in the Mandapam area the last species is predominant, at a number of other centres along this coast line *T. lepturus* is dominant in the catches. At Madras the fishery extends from July to December and in the extreme south-east coast the peak catches are landed during September-November. The gear operated for ribbon fishes are shore seines (Karai valai) and boat seines (Madi valai).

Along Kerala, ribbon fishes are called 'Vala' and 4 species viz, *T. lepturus, L. savala, T. auriga* and *B. tenuis* are recorded of which *T. lepturus* seems to be common. They are caught in bagnets called Thattu madi and Thalayan vala (which is used exclusively for catching ribbon fishes). Large shoals of *T. lepturus* are common during June-October with peak landings in July along this region. (Luther *et al.* 1982).

Along the Karnataka coast *T. lepturus* and *L. savala* occur, the former being common. They are locally called 'Pambole' and are mostly caught in shore seines (ranpans). At Vengurla, Malvan and Ratnagiri along the Maharastra coast *T. lepturus* and *L. savala* occur, the former being the common species. They are abundant during September to December. At Bombay four species namely *T. lepturus, L. savala, E. muticus* and *E. glossodon* are recorded and *E. muticus* appears to be the common species. The ribbon fishes are called 'pitiurkti', 'Pitiwagti' and 'Bala'. Ribbon fishes are commonly caught in bag nets called 'Dol nets'. They are reported to be common along this part of the coast from November to about March.

Along the Gujarat coast at Veraval and Kandla the above mentioned four species have been recorded although they do not form a substantial fishery in this region. They are caught in 'Dol nets'.

In addition to the traditional gear mentioned above which is operated by country craft such as non-powered catamarans, plank built boats and dug out canoes, during the last two decades, considerable quantities of ribbon fish are landed at a number of centres by small sized (10 to 15m long fitted with 15-100 H. P. engine) mechanised vessels operating otter trawls.

In general bag nets are operated in estuaries, shore seines, boat seines and gill nets in inshore waters and otter trawls from small mechanised boats both in inshore and deeper waters upto 50 m

The following interesting features emerge with regard to the distribution of ribbon fishes along the Indian coast.

(i) *T. lepturus* which has a wide distribution in the Indo-Pacific and the Atlantic, occurs almost all along the Indian coast and is the dominant species in Indian waters.

(ii) Four or more species of ribbon fishes may be found along the coasts of West Bengal, Andhra Pradesh, Tamil Nadu, Kerala, Maharastra and Gujarat.

(iii) *Eupleurogrammus* species have not been recorded from the West coast of India south of Bombay. Along the East coast *E. muticus* was recored from West Bengal to Madras and its distribution appears to be restricted when compared to its congener.

(iv) While *T.pantului* and *L. gangeticus* are reported from the Hooghly estuary to Kakinada both *T. auriga* and *B. tenuis* were recorded along the south-west coast of India.

Trends in Ribbon Fish Production

The ribbon fish catch during the period 1950 to 81 showed considerable variation. The lowest catch of 16,452 tonnes was obtained in 1963 while a record catch of 77,785 tonnes were landed in 1978 (Fig 15). The percentage composition of ribbon fish in the marine fish production varied from 1.98% in 1960 to 9.68% in 1953 (Fig. 15). For the last 12 years (1970-81) the average annual production of ribbon fish was 53, 475 tonnes which accounted for 4.25% of total marine fish catch in India. During this period the ribbon fishes occupied 7th position following oil sardine, Prawns, Mackeral,

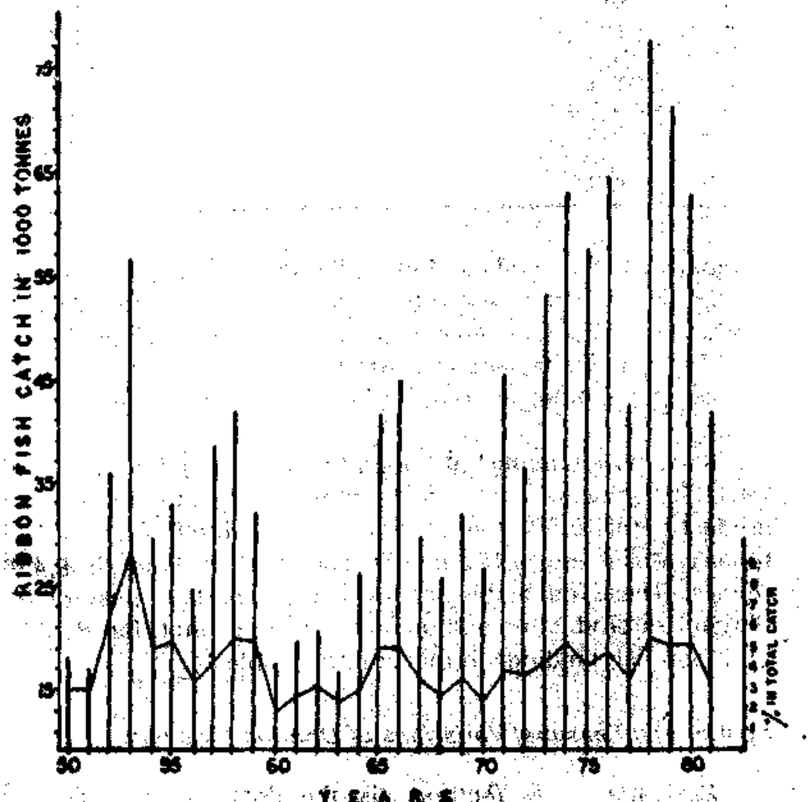


Fig. 15. Ribbon fish production in India during 1950-1981. The broken lines indicate the percentage composition of ribbon fish in total marine fish production.

Table 1. All-India Statewise

Year	West Bengal & Orissa	Andhra-Pradesh	Tamilnadu	Pondichery	Kerala
1970	1470	6473	6833	322	4922
1971	825	7432	10897	96	17380
1972	530	9585	10498	402	10469
1973	902	3761	9625	434	23897
1974	560	11634	8369	236	30192
1975	1252	11701	17782	314	15175
1976	831	12443	19054	428	7687
1977	480	8546	4694	143	7440
1978	1017	5505	28664	139	24207
1979	907	6337	21040	129	25718
1980	1070	15646	7862	179	12937
1981	1166	8207	7605	217	7068
Average	916	8456	12735	253	15590
% of Total	1.71	15.81	23.81	0.47	29.16

Bombayduck, Sciaenids and other Sardines. Barring 1952 and '53 the ribbon fish always formed less than 6% of marine fish production. Thus the percentage occurrence of ribbon fish in total fish catch was generally steady and the fluctuations in marine fish landings are reflected in ribbon fish catches also.

State-wise landings of ribbon fish (Table 1) for the period 1970-78 indicate that Kerala ranks first with an average production of 15,590 tonnes, followed by Tamil Nadu 12,735 tonnes, Maharastra 9,152 tonnes and Andhra Pradesh 8,456 tonnes. These four states occupy a very important position for ribbon fish production and on an average account for 85.88% of ribbon fish landings in the country (Table 1).

Spatial and Seasonal Variations of Dominant Species

Kakinada : *T. lepturus* is the dominant species and accounted for over 90% of ribbon fish catch during 1966-73. Appearance of large shoals of this species measuring 60-80cm in the inshore waters and timely operation of boat seines, *Ribbonfish Landings in Tonnes*

Karnataka	Goa	Maharashtra	Gujarat	Andamans	Lakshadweep	All India Total
280	60	4968	1656	Nil	Nil	26984
330	23	6562	1145	Nil	Nil	44690
748	12	8644	1447	Nil	Nil	36225
136	48	13363	936	Nil	Nil	52106
303	111	9565	1849	Nil	Nil	63029
219	365	9435	1097	Nil	Nil	67339
683	1123	10052	12341	Nil	Nil	64542
237	449	6338	14180	Nil	Nil	42407
404	504	10400	6944	1	Nil	77786
1193	548	10983	4491	1	Nil	71347
1499	1089	11550	10856	Nil	Nil	62650
235	684	8048	8327	24	Nil	41569
514	417	9152	5439	2	Nil	53475
0.96	0.78	17.11	10.17	0.004		

which are by far the most efficient gear to catch ribbon fishes, contribute to a successful season. During the last one decade there was a substantial increase in the quantity of ribbon fish landed by small sized mechanised boats operating otter trawls. The last quarter is the most productive for ribbon fish and the first quarter the least productive.

Madras : Here also the dominant species is *T. lepturus.* The fishery declines in the first quarter, disappears subsequently and starts again in June–July period. Better catches are generally obtained in the second half of the year, expecially in October-November period.

Tuticorin : T. lepturus is caught in trawl nets but is scarce from January to March end abundant during May–June.

Mandapam : E. glossodon is fairly abundant round the year on the Palk Bay side. The second common species *L. savala* is fished during the north-east monsoon period. Generally, the season for the fishery extends from August to about March with peak landings during November to February.

In the commercial catches *E. glossodon* had the size range 14-35 cm, *L. savala* 12-35 cm and *T. lepturus* 50-75 cm.

Calicut : *T. lepturus* is the common species. While the catches are good in the first quarter, they are poor in the third and fourth quarters and absent in the second quarter.

Mangalore : *T. lepturus* is the dominant species and is caught essentially in trawl nets from September to May *T. lepturus* moves in large schools during August to October from east to west around Cape (James 1973).

Continental Shelf Between Ratnagiri and Gulf of Mannar

Studies made in this region indicate that generally adult ribbon fish are found in shoals and the juveniles in dispersed state, Adult *T. lepturus* having modal sizes from 45 to 50 cm were dominant in the catches from August to December and larger fishes with modal lengths 80 to 85 cm were caught over a number of months in wide areas between 7° to 11° N and 12° to 13° N mainly from waters deeper than 50 m bottom depth. Juveniles with modal sizes from 2.5 to 12.5 mm were generally captured in appreciable numbers from December to February and from May to August from the northern and central shelf areas (Rao *et al* 1977). Big concentrations of young *T lepturus* (20-25 cm) were located in March 1973 at 250 m depth on the southern side of Wadge Bank which is probably an important nursery ground for the species

The studies made by Rao *et al* (1977) throw considerable light on the migratory behaviour of ribbon fish in space During February-March the ribbon fish is distributed discontinuously in two wide belts from 14° to 16° N and 9° to 12° N. The recordings during April-May were also discontinuous but with scattered concentrations off Ratnagiri, Karwar, Cochin and Quilon. During May/June recordings were wide spread in a continuous belt all along the coast with medium to high concentrations between Ratnagiri and Karwar and another between Kasaragod and Cochin. During July/August ribbon fish recordings were made in two wide belts one between Mangalore and Karwar and the other Cannnanore and Quilon.

Within these belts high concentrations were found in patches mainly on the middle shelf regions off Karwar, Calicut and Cochin and the bulk of the stock was generally located in the central sector. Eventhough nothing definite could be said it appears that there is a general trend of southward shift in the concentrations of ribbon fish beginning from April till July-August. (Rao *et al* 1977). It is of interest to note that the ribbon fish is abundant on the Western shelf when it is covered with oxygen deficient water during the south west mansoon months. Studies made by Rao *et al.* (1977) show that ribbon fish can thrive in oxygen deficient waters as low as 0.5 ml/l indicating that their oxygen requirements are much less than that of other fish species.

Depthwise abundance of ribbon fish in trawl catches is given in Table 2. Ribbon fish was caught in good quantities in waters of 21-50 m bottom depth from Ratnagiri to Mangalore during January to May. In the region between Mangalore and Quilon they were taken in considerable quantities from May to

Table 2: Showing depthwise relative abundadce (in % Weight) of Ribbon fish in trawl catches during 1974 & 75. (Source Rao et al. 1977).

Regions	1974			1975		
	0-19	20-49	50-79	0-19	20-49	50-79
Ratnagiri - Mangalore	—	37.6	3.4	12.6	33.2	6.6
Mangalore - Quilon	8.4	26.4	18.5	3.8	16.9	14.3
Quilon - Gulf of Mannar	0.6	5.1	—	7.5	6.3	—
Total	9.0	69.1	21.9	23.8	56.3	20.9

November in waters of 21 to 80 m bottom depth In the southern region from Quilon to the Gulf of Mannar, ribbon fish was occasionally taken in good numbers upto 50 m bottom depth.

The echo recordings of ribbon fish are dark, dense and elongated with distinct boundaries. The ribbon fish undertakes regular diurnal vertical migrations to some extent. During day time they are found close to the bottom and at night ascend to the vertical water column and disperse (Rao *et al.* 1977).

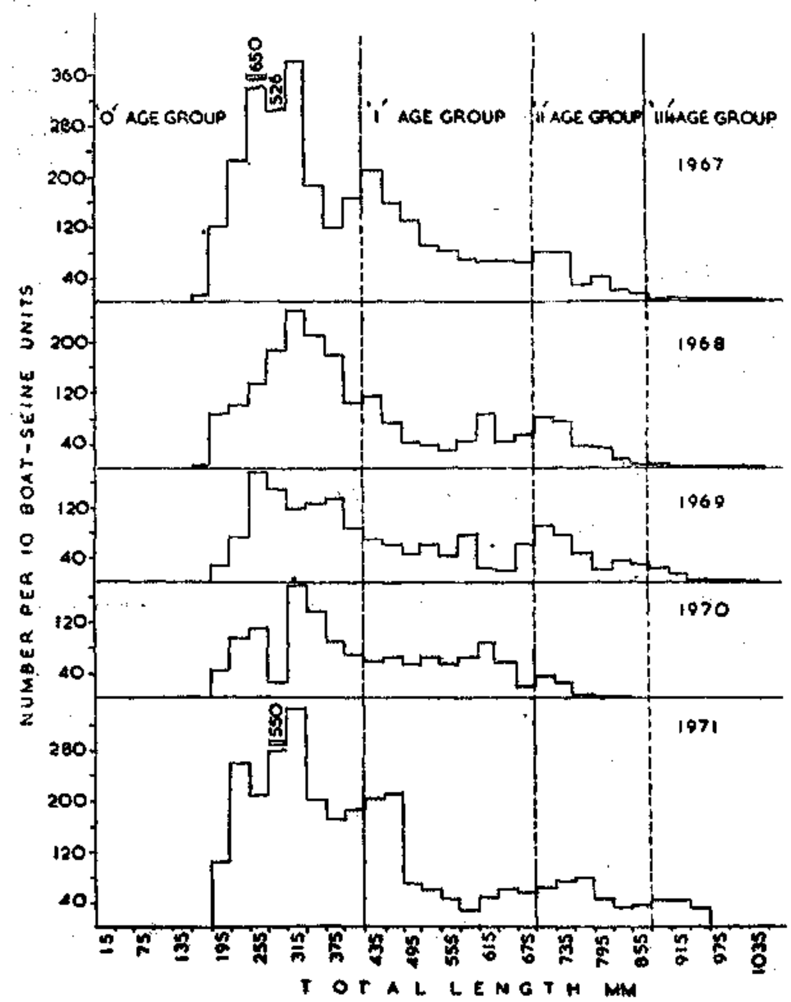


Fig. 16. Annual age composition of *Trichiurus lepturus* per standard effort from Kakkinada region during 1967-71 (after Narasimham 1983)

AGE Composition of T. Lepturus in Commercial Catches

Kakinada : The annual age composition of *T. lepturus* per standard effort in terms of 10 boat seine units for the period 1967-71 are given in Fig 16 (Narasimham 1983). It may be seen from the figure that the fish become vulnerable for exploitation at 20 cm length (4 months old). The contribution to the fishery by '0' age group varied from 53.3 to 67.3%, '1' age group 24.0 to 38.7%, '2' age group 4.5 to 17.2% and '3+' age groug (three year olds plus older) fish nil to 3.5% during different years.

Estimated Resources and Scope for Exploitation

The biomass estimate of the ribbon fish resource in the area from Ratnagiri to Gulf of Mannar by accustic surveys and fishing experiments was made by Rao *et al* (1977) while the population dynamics of *T. lepturus* were studied by Narasimham (1983) from the Kakinada area.

The major part of the biomass of ribbon fish is made up o *Trichlurus lepturus*. The estimates of the resources of ribbon fish for each coverage from October 1972 to October/November 1975 are given in Table 3. The average standing stock of ribbon fish per coverage was estimated at 67,200 tonnes, whereas highest estimate in 1973 was during May/June (89-702 tonnes) in 1974 during June/July (1,09,841 tonnes) and in 1975 during May/June (3,09,311 tonnes). The highest average estimate is along the coast of Kerala (44,664 tonnes), followed by that of southern Maharastra (20,866 tonnes). The estimates for Karnataka and Goa together and Gulf of Mannar are in the order of ~~4,598 and 3,034 tonnes respectively~~. It is evident from Table 3 that the period of greatest abundance along Maharastra is during the second and third quarter of the year. Along the coasts of Karnataka and Goa the period of abundance is generally during the second and third quarter. Off the coast of Kerala greatest abundance was from May to September. In the Western part of the Gulf of Mannar the highest estimate was obtained during the third quarter of the year (Rao *et al.* 1977).

Table 3 Showing distribution of Biomass estimates of Ribbonfish by coverage and area (Source Rao et al 1977)

Area coverage		Southern Maharashtra	Karnataka & Goa	Kerala	Southern Tamil-Nadu (Gulf of Mannar & West coast.	Total
1972	Oct.	0	169	18200	—	18369
	Nov.	—	226	17530	—	17756
1973	Jan/Feb	16020	3626	33508	0	53154
	Mar/Apr	0	1815	49696	0	51511
	Apr	—	—	21479	—	21479
	May/Jun	2320	1819	85563	0	89702
	Jun/Jul	5384	259	52914	1031	59588
	Jul/Aug	17931	968	14112	406	33417
	Sep	—	901	62957	—	63858
	Sep/Oct	0	83	8252	—	8335
	Oct/Nov	0	174	19037	2696	21907
	Dec	—	126	6630	1082	7838
1974	Jan/Feb	13914	4166	30179	0	48249
	Mar/Apr	25000	7882	19240	3750	55872
	Apr/May	10575	3398	25269	5977	45219
	Jun/Jul	18918	13117	77906	—	109841
	Aug	0	408	53556	7327	61291
	Sep/Oct	—	60	28608	9056	37724
	Oct/Nov	0	89	26121	404	26614
	Nov/Dec	0	203	5024	253	5480
1975	Feb/Mar	60685	11587	56400	0	128672
	Apr/May	49839	11927	53889	9570	125225
	May/Jun	122010	25299	160179	1823	309311
	Jul Aug	53667	21775	169081	9642	254465
	Oct/Nov	—	293	21287	4639	26219
Total :		3,96,463	1,10,360	11,16,617	57,656	16,81,096
Average		20,866	4,598	44,664	3,034	67,243

The estimated average standing stock of ribbon fish in the region between Ratnagiri and Gulf of Mannary at 67,200 tonnes is about 4 times higher than the landings in this region and 1.25 times higher than the average annual all India landings for the period 1970-79. The average potentials off the coasts of southern Maharashtra, Karnataka and Goa, Kerala and southern Tamil Nadu are 11.8, 13.4, 3.3 and 1.3 times higher than the average landings in the respective regions.

indicating greater scope for the increased exploitation of this resource (Fig 17). It should be evident from the above that the ribbon fish catch could be at least doubled within the region from Ratnagiri to Gulf of Mannar without adversely affecting the stock (Rao *et al.* 1977). From Fig 17 it is also evident that there is tremendous scope for increased exploitation especially in the regions off southern Maharashtra, Goa and Karnataka.

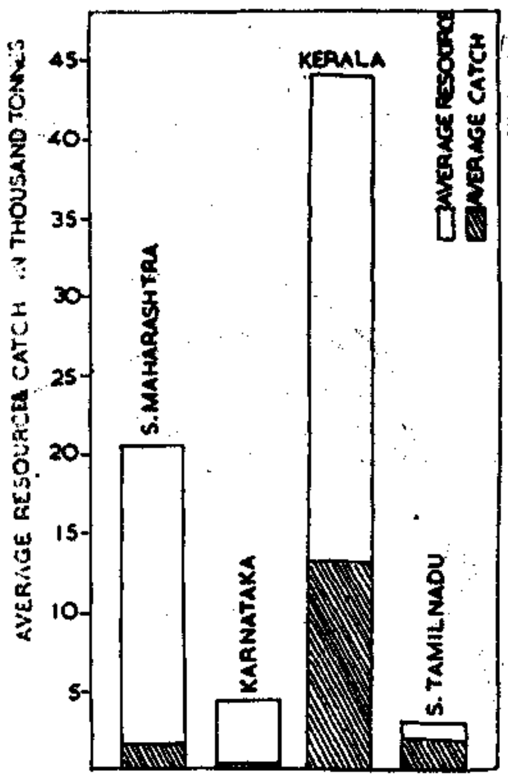


Fig. 17 Histograms showing the average annual landings and average resources of ribbon fish in the region from Ratnagiri to Gulf of Mannar (after Rao *et al.* 1977).

Along the east coast in the Kakinada region, based on the annual age composition of *T. lepturus* for 1967–71, the instantaneous total mortality coefficient Z was estimated at

1.2 from the average catch curve with boat-seine as standard gear. Instantaneous coefficient of natural mortality M was estimated as 0.9; then instantaneous coefficient of fishing mortality F becomes 0.3. The exploitation rate (U) is estimated as 0.17 using the equation $U = \frac{F}{Z}(1 - e^{-Z})$. The yield in wei-

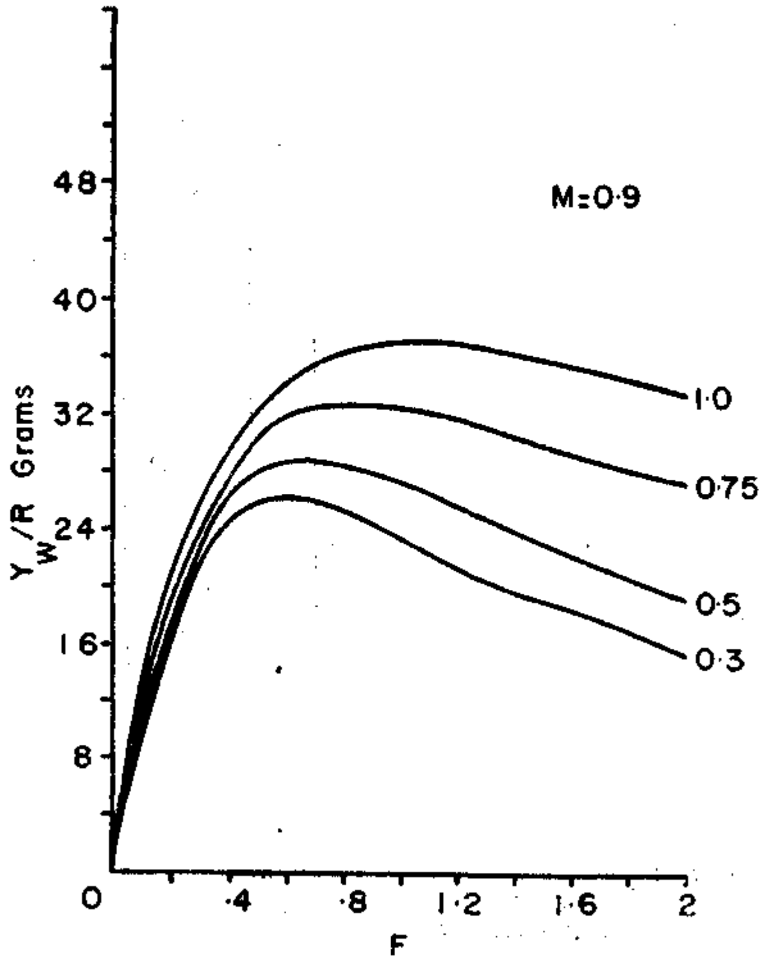


Fig. 18 Yield in grams per recruit of ribbon fish *Trichiurus lepturus*. F and M indicate fishing and natural mortality rates, 0.3, 0.5, 0.75 and 1 at the age when the fish becomes fully exploitable. (after Narasimham 1983).

ght per recruit was computed (Narasimham 1983) by taking 0.3, 0.5, 0.75 and 1.0 years as the age(T_{p1}) at which *T lepturus* become fully exploitable (Fig 18). At present, as stated earlier, M= 0 9, F =0.3 T_{p1}= 0.3 years and the yield per recruit is about 23g. The maximum Y_w/R value of 26 g is obtainable at F= 0.6. This suggests that, even at the very young age of exploitation, there is considerable scope to step up the production of *T lepturus* until F reaches a level of 0.6, under the steady state conditions. However, at the present level of M and F there is only a marginal increase in the Y_w/R values at different age of exploitation (upto 1 year); consequenty it is not remunerative to increase the age at exploitation without increasing the rate of fishing. A maximum of about 37 g per recruit can be obtained if F is increased to 1, concurrent with an increase in age at exploitation to one year (Narasimham 1983).

The available data (unpublished) on ribbon fish fishery during the period 1967-71 from Madras region show that the fishing craft and gear operated, species break-up and the size composition of *T. lepturus* in commercial catches are similar to those observed at Kakinada for the corresponding period. The average annual ribbon fish catch from Andhra Pradesh and Tamil Nadu (Pondicherry included) together during 1967-71 was 16,000 t and (at 90% of ribbon fish catch) *T. lepturus* catch worked out to 14,400 t. On the basis of the exploitation rate (U) obtained at Kakinada for the same period the average annual stock and average standing stock were estimated as 85,000 and 48.000 t, respectively, for *T.lepturus* indicating that the catch can be easily doubled without any adverse effect on the stock. During 1972-81 period the average catch of *T. lepturus* from these two states increased to 20,275 t with a maximum of 30,877 t in 1978 and a minimum of 12,438 t in 1973. Though estimates of mortality rates for this period are not available, it can be reasonably stated, on the basis of the above, that the stock of *T. lepturus* is still under-exploited.

Exploitation and Utilisation

The above studies by Rao *et al.* (1977) and Narasimham (1983) indicate that the ribbon fish is underexploited. The reasons for the present low level exploitation are due to the inaccessibility of the resources to the indigenous non-mechanised craft and gear and the small mechanised boats operating bottom trawls which cannot venture far out from the coast. Also the traditional fishries exploit mainly younger fish available on the inshore grounds, whereas the fully grown larger fish in good concentrations available in deeper waters are out of reach to the fishery.

Purse seining might prove very efficient for capturing surface school concentrations of ribbon fish. In view of the diurnal behaviour, bottom trawling during the day and pelagic trawling during night with medium sized vessels is very effective (Rao *et al* 1977). In the area between 9° and 14°N, *T. lepturus*, larger than 50cm in length occur in great school aggregations on the middle shelf after July, when most of them are in spent and recovering stages and these concentrations can be harvested with advantage by bottom trawl and midwater trawl.

One of the effective ways to increase the harvesting of ribbon fish resources is to intensify the fishing pressure during the monsoon months since the highest standing stock is found at that time on the shelf and to extend the fishing operations as well to deeper waters. Along the south-west coast the present fishery is unable to take advantage of the situation because of rough weather conditions prevailing during the monsoon. However, it should be emphasised that only larger vessels could be operated during the south-west monsoon (Rao *et al.* 1977).

Similar studies regrding the spatial and seasonal variations in abundance and the shoaling behaviour of the dominant species, *T. lepturus*, are needed from the shelf area for the rest of the Indian coast, particularly from the east coast. With the Exclusive Economic Zone extending upto 320 km from the shore, concerted efforts are required to tap the ribbon fish resource.

Increased exploitation of the ribbon fish resources calls for the proper utilisation of the catches involving handling, processing and distribution of fresh or iced fish on landing. A good portion of the catch could be filleted and forzen for subsequent marketing. The remaining portion of the filleted fish can be converted into fish meal. Some portion of the catches could be mixed with salt and sun dried under hygenic conditions or dried in larger artificial driers. As there is good demand for dried fish products in South-East Asian Countries it should be possible to export dried ribbon fish of good quality and earn foreign exchange.

As judged by the magnitude of the fishery they support, ribbon fishes occupy an important place among marine fishes of India. Although not considered as a quality fish, they are consumed by many people and, being abundant and cheap, thay are especially preferred by the common man. Large fish are generally preferred for fresh consumption (plate 1 F and G) while the smaller ones are sundried (plate 1 H). Being thin and ribbon-like, they are best suited for sundrying which is also economic. During seasons of abundance these fishes are salt cured.

Apart from local consumption both in the fresh and cured states, considerable quantites of cured products are exported to countries like Sri Lanka and Malaysia.

The ribbon fishes are also used as effective bait for bigger fishes along the Andhra, Tamil Nadu and Maharastra coasts. Seer, tuna, carangids, eels, cat fishes and sciaenids are occasionally caught on hook and line with ribbon fish as bait.

SUGGESTIONS ON THE FUTURE LINES OF RESEARCH

From the foregoing study it is obivous that while our knowledge on the biology of *T. lepturus*, *L. savala*, *E. muticus* and *E. glossodon* is considerable, little is known about the other four species and it would be of interest, for comparative studies, to have information on the biology of these species. Among the ribbon fish species *T. lepturus* is widely distributed and is the mainstay of the ribbon fish fishery, accounting for the bulk of the ribbon fish landings almost all along the coast line. A critical examination of the available data on its biology shows that although this species was studied more extensively, when compared to others, many lacunae still exist and it is necessary to fill up these gaps in our knowledge to evolve suitable management policy.

The near absence of spawing fish in the commercial catches, the scarcity of eggs and larvae in the routine plankton collections and the frequent occurrence of early juveniles in the coastal waters led several investigators to believe that *T. lepturus* spawns in the offshore waters beyond the present fishing grounds. Rao *et al.* (1977) recorded small juveniles of modal sizes 2.5 to 12.5 mm in appreciable numbers from the northern and central shelf areas along the west coast. There is need to locate and delimit the exact spawning grounds. While it is generally recognised that an individual fish spawns more than once it is not clear about the number of times the fish spwans during the spawning season. Maturation and spawning of *T. lepturus* with particular reference to partial spawning should be investigated. Also if partial spawning exists, the number of eggs spawned for spawning in the same season could also be investigated. As regards the spawning season it is generally held that in *T. lepturus* there are either two spawning seasons or a single protracted season. Once the spawning grounds are located, apart from determining the spawning season it would be Worthwhile to study whether the spawning is synchronous in various age groups or not. It may be of interest to note that in the east China sea the spawning season for *T. lepturus* was protracted from April to August, older fish spawn earlier than younger fish and the spawning grounds are not far from the coast of mainland China (Yamada 1971). In the east China and Yellow seas, during the spawning season, *T. lepturus* moves in many schools; either of the sex may be predominant in these schools and after spawning sex ratio becomes normal (Misu 1959). Our knowledge on the sex ratio in *T. lepturus* is meargo and this should be investigated with particular emphasis during the spawning season in the spawning grounds.

In *E. glossodon* it was observed by James (1976) that the size groups above 42cm are represented by females only and that the females attain slightly larger size than males at corresponding age. Examination of large samples of *T. lepturus* by one of us (K.A.N) showed that the largest male and female measured 96 cm and 115 cm respectively (unpublished). Yamada (1971) stated that in *T. lepturus*, measuring below 250mm snout-vent length males are dominant; beyond 250 mm snout-vent length females outnumbered males and at age five all are females. This suggests a possible difference in the size at first maturity as well as in the growth rate of the two sexes in *T. lepturus* which needs to be studied. While it was observed that large schools of *T. lepturus* which contribute to the commerical fishery during peak months at different centres generally comprised spent fish measuring above 50 cm in length, neither the schooling behaviour nor the migratory pattern are understood to any appreciable extent. A general trend in the southward shift of ribbon fish concentrations begining from April to July-August in the western shelf region was suggested (Rao *et al* 1977). James (1967) indicated that *T. lepturus* moves in large shoals during August to October from east to west around Cape. It is imperative that a proper understanding of the schooling behaviour and the migratory pattern of *T. lepturus* in relation to environmental parameters is needed for forecasting the fishery.

Regular mointoring of the characterstics of the ribbon fish fishery along the coasts of Kerala, Tamil Nadu, Maharastra and Andhra Pradesh where it occupies an important position should be undertaken. Quick methods of stock assessment such as by acoustic survey and exploratory fishing by suitable gear should receive top priority in the research programme on ribbon fish.

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