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Stock assessment of the ribbonfish, *Trichiurus lepturus* Linnaeus, from the Indian waters

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ABSTRACT

The fishery of the ribbonfishes and population of the species *Trichiurus lepturus* Linnaeus were studied from the all-India data collected during 1971-89. The last five years were the most productive with an annual average catch of 79 220 tonnes, contributing 4.5% of the total fish catch and exhibiting an increase of about 48% over the 1970-81 period. This increase in the landings was attributed to the increased exploitation by trawl nets in states like Gujarat and Maharashtra. Trawl net contributed about 50% of the total catch. About 75% of the catch came from the west coast and the rest from the east coast. In the west coast the peak fishing season was in the fourth quarter except in Kerala where it was in the third quarter. In the east coast also, peak season was in the fourth quarter in the northern states and in the third quarter in the southern states. The total instantaneous mortality (Z) rates were estimated as 3.15 and 3.71 for the east and west coasts respectively by length converted catch curve method. By Jones' cohort analysis they were estimated at 3.32 for the east and 3.77 for the west coasts.

Ribbonfishes form an important group among the marine fish resources of India with their annual contribution to the marine fish catch amounting to 79 220 tonnes, forming 4.5% of the total catch. It is exploited in all the maritime states with the bulk coming from Gujarat, Maharashtra, Kerala and Tamil Nadu. Till recently the fishery was confined to the coastal belt and was in the hands of traditional fishermen using artisanal gears operated from both motorized and non-motorized crafts. But this resource is now mainly exploited from the deeper areas by trawlers.

Ribbonfishes are represented in the seas around India by eight well recognized species (James *et al.* 1986). One of these, *Trichiurus lepturus*, appears to be the only dominant species occurring all along the west and east coasts of India. Hence an attempt was made to assess its stock position and level of exploitation.

Much work has been done on the biology of this species from Indian waters (Prabhu 1950, 1955; Vijayaraghavan 1951; Nair 1952; Basheeruddin and Nayar 1962; James 1967; Rao 1967; Thampi *et al.* 1968; George *et al.* 1968; Narasimham 1970, 1972, 1978; Pillai 1974; James and Baragi 1980 and James *et al.* 1983), and has also been reviewed by James (1973) and James *et al.* (1986). Besides, Rao *et al.* (1977), Narasimham (1983), James and Pillai (1989), Somavanshi and Antony Joseph (1989), Chakraborty (1990) and Lazarus and Sarma (1991) have also worked on different

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aspects of this species. As these works relate only to places of regional importance, an attempt is made here to estimate the stock of this species and the level of exploitation on all-India basis.

MATERIALS AND METHODS

The fishery data collected by the Fisheries Resources Assessment Division of CMFRI for 1971–89 were utilized for the study on the trend of fisheries. However, to describe the statewise fishery and gearwise contribution and also to study the population dynamics the data was limited to five years, from 1985 to 1989, and treated quarterwise. The catch per unit effort was calculated only for trawl net and was studied quarterwise for different states separately. The basic data on effort and catch were collected as per Sekharan (1965). The length measurements were grouped into 5 cm interval and number of fish in each size group was estimated separately for trawls and boat seines. The length frequency data collected from Visakhapatnam (1988), Kakinada (1986–88), Madras (1987–89), Tuticorin (1986–87) and Bombay (1988) from trawl net landings and from Vizhinjam (1986–88) and Tuticorin (1986–87) from boat seine landings were analysed for the study.

Growth parameters, L_∞ and K, were estimated using ELEFAN I programme (Gayanilo *et al.* 1988). Mortality estimates were made following Pauly's (1982) length converted catch curve. The estimates of stock size and fishing mortalities were obtained by cohort analysis (Jones 1984). Yield (catch in weight) and stock biomass were predicted for various levels of fishing effort using length converted Thompson and Bell analysis (Sparre 1985). The out put of Jones' length cohort analysis, namely, the recruitment and fishing mortalities, formed the inputs for length converted Thompson and Bell analysis.

RESULTS

Fishery

Trend of the fishery: The trend of the fishery is given in Fig. 1. The annual catch ranged between 36 225 tonnes (1972) and 92 047 tonnes (1986) with average at 60 620 tonnes. However, the landings were above average in ten years out of the 19 year study

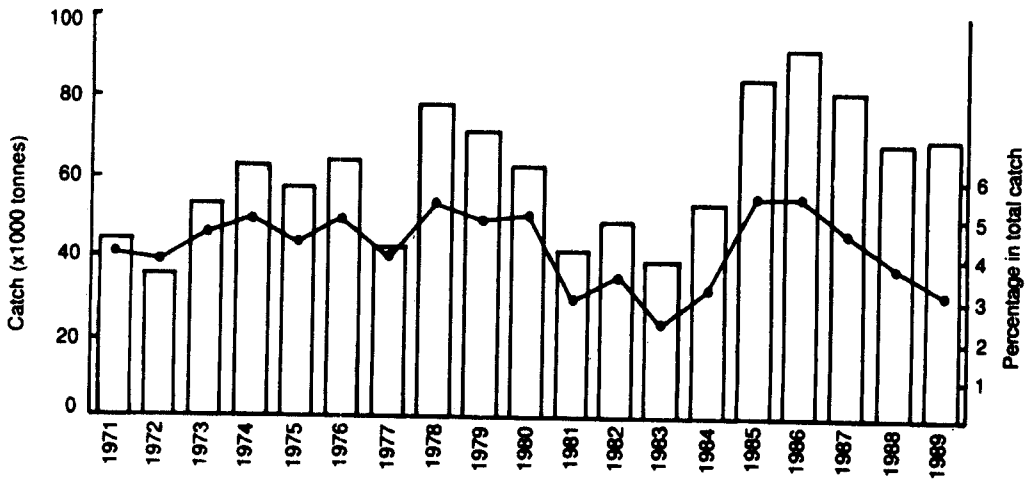
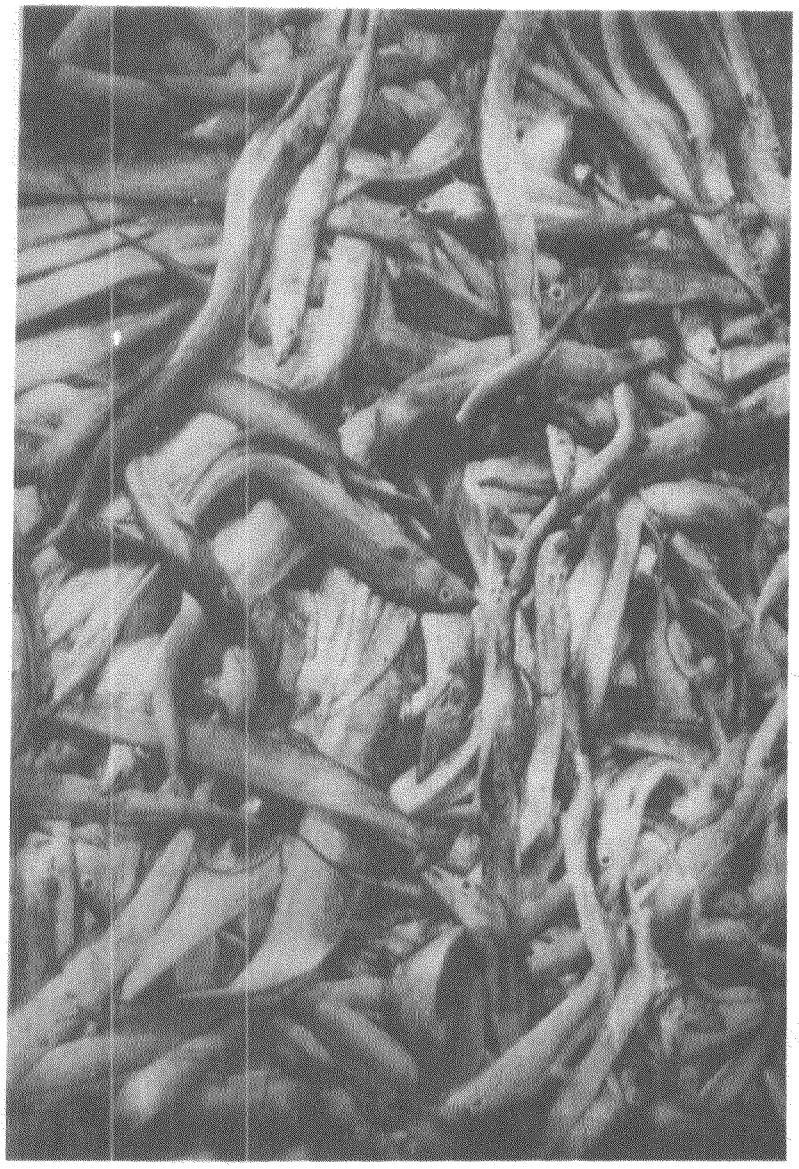


Fig. 1. Estimated ribbonfish landings in India (1971-89)



Trichiurus lepturus

period. The last five years (1985–89) witnessed good catches and this was the more productive period contributing 79 220 tonnes annualy, on an average.

Statewise production: Among the maritime states, Gujarat produced maximum ribbonfish in the country with an average yield of 21 358 tonnes forming 27% of the all-India catch (Fig. 2). The year 1986 witnessed the maximum catch and 1988 the minimum (Fig. 3). The peak ribbonfish season in this state appears to be in October–December.

Maharashtra with 22% of the total all-India catch stood second in the annual landings of ribbonfish (Fig. 2) which ranged between 12 446 and 23 501 tonnes with an average at 17 464 tonnes (Fig. 3). The year of glut in Gujarat (1986) was the year of scarce landings in Maharashtra. Similarly the year of poor landings (1988) in Gujarat was the productive year for Maharashtra. Although the over all production was more during the fourth quarter (Fig. 2), there used to be good fishery during the second quarter also.

Goa produced only 2 137 tonnes of ribbonfish and occupied the ninth place (2.7%) among the ribbonfish producing states (Fig. 2). The annual catch fluctuated between 1.4 and 3.7 thousand tonnes (Fig. 3) and the peak season was found during the first quarter in all the year except 1986 and 1989.

Karnataka's share of average annual ribbonfish catch was estimated as 4.8 thousand tonnes and it fluctuated between 1.4 (1985) and 8.5 thousand tonnes (1987) (Fig. 2). With 6% contribution to the overall resources, it occupied the sixth place. Normally the fishery was good during the fourth and second quarters as seen in the years 1986 and 1987.

Kerala occupied the third place (Fig. 2) with its 17% contribution to the ribbonfish fishery of India and average annual landings of 13 690 tonnes. The year 1985 witnessed the maximum (25 142 tonnes) and 1988 the minimum (8 952 tonnes) landings (Fig. 3). Unlike other states of west coast, here the peak fishery season was in the third quarter, coinciding almost with the southwest monsoon.

Although Tamil Nadu occupied the fourth place (11%) among the ribbonfish producing

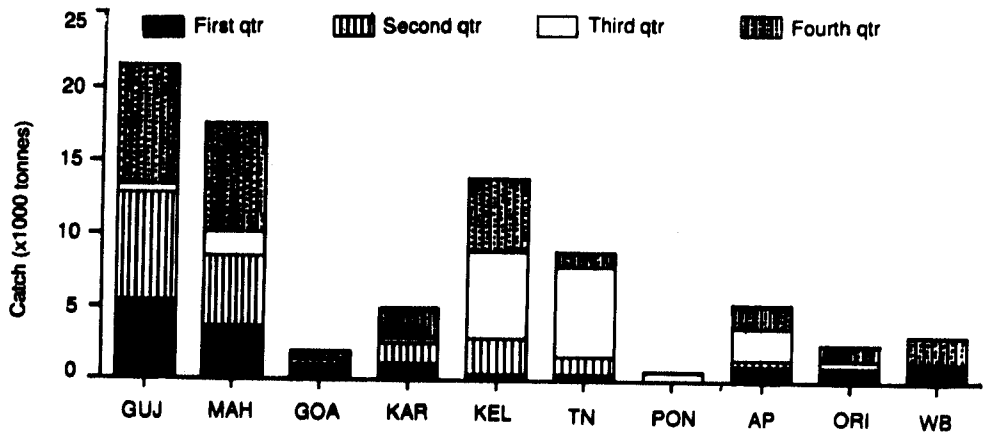


Fig. 2. Quarterwise average ribbonfish landings (tonnes) in various states (1985-89). GUJ, Gujarat; MAH, Maharashtra; KAR, Karnataka; KEL, Kerala; TN, Tamil Nadu, PON, Pondicherry, AP, Andhra Pradesh; ORI, Orissa; WB, West Bengal.

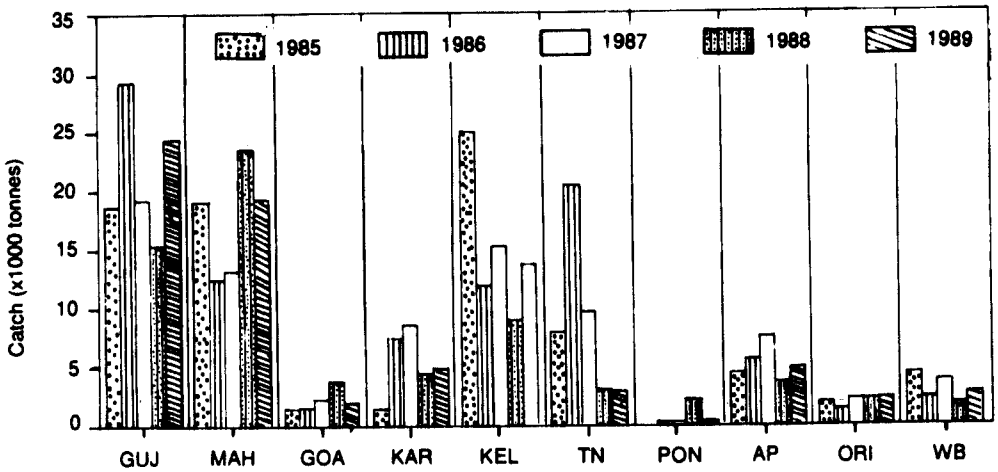


Fig. 3. Statewise, yearwise estimated ribbonfish landings (tonnes) in India (1985-89). For abbreviation *see* Fig. 2.

states (Fig. 2), in the east coast it contributed the maximum. Third quarter was the peak season for the fishery in this state.

Pondicherry has a small fishery for ribbonfish. It occupied the tenth place with an annual average landing of 570 tonnes, and less than 1% of the all-India catch (Fig. 2). The fishery was more during the third quarter.

Andhra Pradesh occupied the fifth place (Fig. 2) showing a steadiness in the catch of ribbonfishes (Fig.3). It contributed about 5 183 tonnes (7%) of ribbonfish annually.

By producing 2 322 tonnes (3%) of ribbonfish (Fig. 2) at an average, Orissa occupied the 8th place. The fishery was steady (Fig. 3) with a small lean season in the second quarter.

In West Bengal also the ribbonfish fishery was steady (Fig. 2), contributing 2 986 tonnes of fish annually forming 4% of the total catch. It occupied the seventh place and the peak fishery was in the fourth quarter (Fig. 3).

Thus, the five states of the west coast contributed 59 443 tonnes of ribbonfish annually forming 75% of the total catch. The remaining 25% of the catch was shared by the five states (including Pondicherry) of the east coast. In general, the peak fishery was observed during the fourth quarter in the northern states of both the coasts (Gujarat, Maharashtra, Karnataka, Orissa and West Bengal) and during the third quarter in the southern states of both the coasts (Kerala, Tamil Nadu, Pondicherry and Andhra Pradesh).

Gearwise contribution: Trawl net contributed 50% of the all-India catch of ribbonfish (Table 1). Gujarat and Maharashtra accounted for about 67% of the trawl catch, Karnataka and Kerala for about 21% and the other states for the rest. Trawl net was operated in all the states except West Bengal. This was the important gear for ribbonfish in the northwest coast region up to Karnataka. About 86% catch of Karnataka, 70% of Goa, 75% of Gujarat and 59% of Maharashtra were netted by this gear. In Kerala, trawl net contribution was about 31%. In the east coast, it accounted for 33% of the catch in Andhra Pradesh and Orissa but only 4% in Tamil Nadu and

Pondicherry.

Statewise and quarterwise average CPUE calculated for trawl net is given in Fig. 4. In Gujarat it varied from 25.3 kg in the third quarter to 276.2 kg in the second quarter, with an average at 176.9 kg. But in Maharashtra the average CPUE recorded was only 50.5 kg and the minimum and maximum were found respectively in the first and second quarter.

In Goa a gradual decrease in the CPUE from 25.7 kg in the first quarter to 6.2 kg in the fourth quarter, with an annual average of 18.2 kg was seen. In Karnataka, although the average was 19.3 kg a maximum CPUE of 42.0 kg was obtained during the fourth quarter and 28.3 kg in the second quarter. Next to Karnataka the CPUE was reasonable only in Andhra Pradesh with the annual average at 16.5 kg. In all the other states, trawl net brought only negligible quantities.

After trawl net, only boat seine contributed maximum (14%) to the catch.

Contribution from other gears is not significant. However, about 17% of the ribbonfish catch comes from other artisanal gears such as hooks and line. The details of statewise contribution of various gears is given in Table 1.

Biology

Feeding habits and food: *Trichiurus lepturus* is carnivorous in nature and piscivorous in habit. Very often it exhibits cannibalism also. Ribbonfish shoal following whitebait shoal has been reported by Luther (1981). Lazarus and Sarma (1991) have even suggested to consider *Stolephorus* spp. and *Acetes* sp. as indicator species of this fish in the Vizhinjam area since they found the coincidence of ribbonfish fishery with that of the other two groups. Rao *et al.* (1977) have also recorded the availability of *Stolephorous* with ribbonfish.

Maturity and spawning: The size at first maturity differs in male and female fish. It was reported as 41.2 cm for male and 43.1 cm S L for female (James *et al.* 1983). During present study size at first maturity was estimated as 60 cm T L for female and 58 cm T L for male. Prabhu (1955) observed 50% maturity for this species (male and female combined) at 51 cm length. Although a prolonged spawning was reported for this species from some parts of the west coast (Rao *et al.* 1977, James *et al.* 1983) the peak spawning of this species was observed during April–June in this coast (Bapat *et al.* 1982, Lazarus and

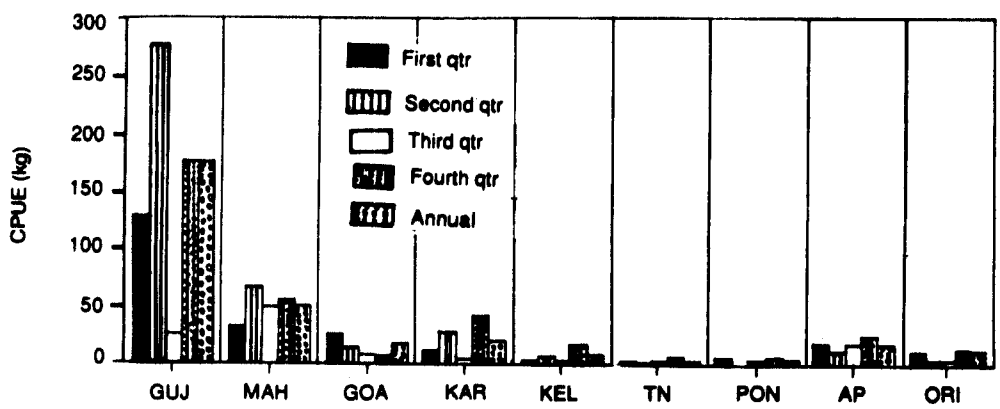


Fig. 4. Statewise, quarterwise average catch per unit effort (kg) in trawl net for ribbonfish.

Sarma 1991). In the east coast, Thampi *et al.* (1968) have reported two spawning seasons, one during May–June and another during November–December, for this species around Madras. But, off Kakinada, Narasimham (1972) observed prolonged spawning during February–June. The fecundity up to 134 000 was reported by James *et al.* (1983).

Population dynamics and stock assessment

Length-weight relationship: Length and weight data of 118 males in the size range of 22 to 75 cm and 194 females in the size range of 21 to 97 cm were used. The relationship was estimated separately for both the sexes (Table 2) which varied insignificantly and hence pooled to give the formula

$$W = 0.000546\ L^{3.05}$$

Where W, weight (g) and L, Length (cm).

Age and growth (east coast): The size range of the fish for the east coast was 5 to 115 cm. It was assumed that growth of *T. lepturus* follows von Bertalanffy growth formula (VBGF) which is expressed by the equation:-

$$Lt = L_\infty\ (1\text{-}e^{-k(t-t_0)})$$

The L_∞ and K were estimated by ELEFAN I from the length-frequency data collected from Madras, Kakinada and Visakhapatnam (Fig. 5). The L_∞ varied from 129 to 135 cm and K varied from 0.56 to 0.7 (annual). Keeping in view the largest specimen recorded, the estimates used for the studies were: $L_\infty = 129.0$ cm and K = 0.56 annual. The programme does not give estimate of t_0.

From the above, the length of the species was estimated at 55, 87, 105 and 115 cm respectively at the end of first, second, third and fourth year of its life.

Table 1. Gearwise average (1985-89) catch of ribbonfishes (tonnes) in various states

State	Trawl net	Gill net	Dol net	Purse seine	Boat seine	Shore seine	Other artisanal units	Total
Gujarat	15 932	1 080	3 218	-	-	-	1 128	21 358
	(75)	(5)	(15)	-	-	-	(5)	
Maharashtra	10 284	2 587	4 209	-	-	-	384	17 464
	(59)	(15)	(24)	-	-	-	(2)	
Goa	1 505	31	-	282	-	-	319	2 137
	(70)	(1)	-	(13)	-	-	(16)	
Karnataka	4 123	14	-	563	18	21	55	4 794
	(86)	(0.3)	-	(12)	(0.4)	(0.5)	(1)	
Kerala	4 266	510	-	3	6 558	29	2 324	13 690
	(31)	(4)	-	(0.0)	(48)	(0.0)	(17)	
Tamil Nadu and Pondicherry	851	51	-	-	171	-	8 133	9 286
	(9)	(1)	-	-	(2)	-	(88)	
Andhra Pradesh	1 702	1 024	-	-	2 044	285	128	5 183
	(33)	(20)	-	-	(39)	(5)	(3)	
Orissa	755	765	-	-	703	19	80	2 322
	(33)	(33)	-	-	(30)	(1)	(3)	
West Bengal	-	359	-	-	1 847	-	780	2 986
	-	(12)	-	-	(62)	-	(26)	
Total	39 418	6 421	7 427	848	11 341	354	1 341	79 220
	(50)	(8)	(9)	(1)	(14)	(1)	(17)	

% is given in parenthesis.

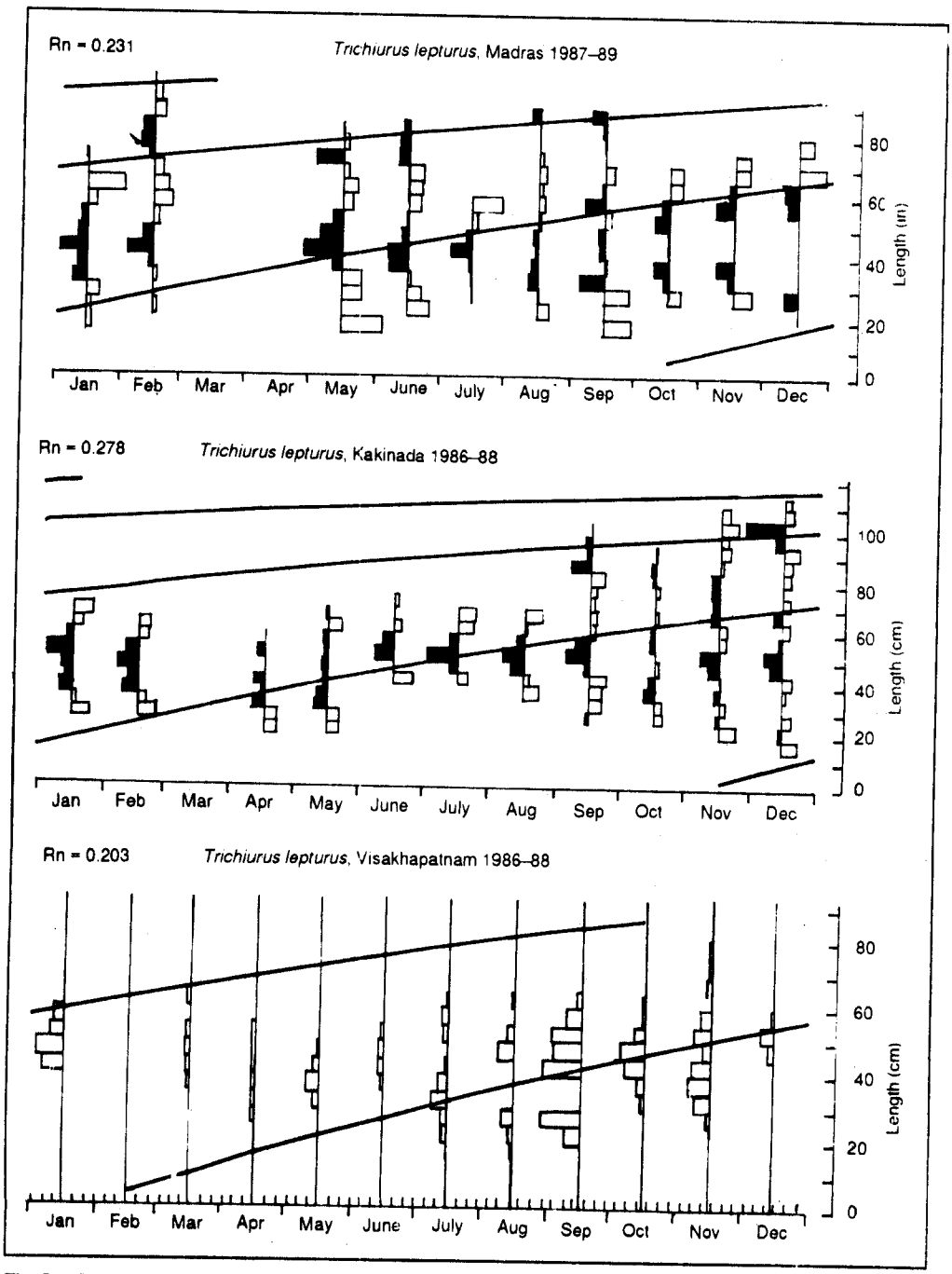


Fig. 5. ELEFAN I for the length frequency distribution of *Trichiurus lepturus* at Madras (pooled for 1987-89), Kakinada and Visakhapatnam (pooled for 1986-88).

Table 2. Analysis of covariance of length-weight data of *Trichiurus lepturus*

Source	DF	SS-X	SP	SS-Y	b	DF	SS	MS
Male	117	6.2817	18.0924	58.1232	2.880	116	6.014	0.05185
Female	193	15.2100	47.5019	155.9856	3.123	192	7.634	0.03976
Total						308	13.634	0.04431
Pld W	310	21.4917	65.5943	214.1088	3.052	309	13.910	0.04502
Difference between slopes						1	0.262	0.26229
Between		0.0586	0.1245	0.2646				
W+B	311	21.5503	65.7188	214.3733	3.050	310	13.961	0.04503
Difference between corrected means						1	0.050	0.05023

Estimation of mortality parameters and stock size (east coast): Total mortality coefficient (Z) estimated by length converted catch curve was 3.15 (Fig. 6). Jones' cohort analysis gave an estimated Z of 3.316 with M/K ratio of 2 and terminal F/Z as 0.6. The estimated F after fully recruited group of 50 cm was 2.1961. Thompson and Bell studies (Table 3) indicated the MSY at 20 456 tonnes at a relative fishing effort of 0.637. The biomass MSY was 19 758 tonnes.

Age and growth (west coast): The growth parameters from Bombay centres estimated by Chakraborty (1990) were: $L_\infty = 129.7$, K = 0.50335 (annual) and $t_0 = +0.0011125$

Length frequency data available at Vizhinjam and Bombay were also used for age and growth studies by using ELEFAN I (Fig. 7). The fishery at Vizhinjam is highly seasonal and confined to only few months. The growth parameters obtained for Vizhinjam were: $L_\infty = 126$ cm and K = 0.38 and for Bombay were: $L_\infty = 145$ cm and K = 0.62.

At Vizhinjam (Kerala), lower growth rates of 40,67,86 and 98 cm and at Bombay (Maharashtra) higher growth rates of 67,103,122 and 135 cm were noticed for the fish at the end of first, second, third and fourth year of its life respectively.

Since the data base for Bombay and Vizhinjam was for a limited period, for the purpose of studying the mortality and stock size the growth parameters ($L_\infty = 129.7$ and K = 0.5) estimated by Chakraborty (1990)

Table 3. Results of Thompson and Bell analysis for *Trichiurus lepturus* (east coast)

X	Yield	Mean biomass
0.0	0.00	73 194.31
0.2	14 828.57	43 444.98
0.4	19 355.35	28 857.46
0.6	20 432.07	20 786.64
0.8	20 279.98	15 904.33
1.0	19 697.19	12 742.77
1.2	18 988.69	10 583.77
1.4	18 273.84	9 045.39
1.6	17 597.85	7 910.22
1.8	16 975.33	7 047.46
2.0	16 408.09	6 374.77

MSY = 20 456.1, X = 0.6375, Biomass MSY = 19 758.32

Table 4. Results of Thompson and Bell analysis for *Trichiurus lepturus* (west cost)

X	Yield	Mean biomass
0.0	0.00	246 850.45
0.2	58 083.92	118 349.14
0.4	65 690.24	69 999.20
0.6	63 487.85	47 162.46
0.8	59 547.86	34 724.57
1.0	55 688.07	27 255.87
1.2	52 288.37	22 432.33
1.4	49 370.94	19 130.57
1.6	46 873.95	16 758.44
1.8	44 725.01	14 983.05
2.0	42 860.14	13 607.44

MSY = 65 666.1 X = 0.4125, Biomass MSY = 64 810.6

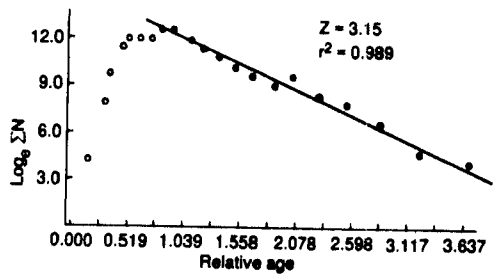


Fig. 6. Length converted catch curve of *Trichiurus lepturus* from east coast.

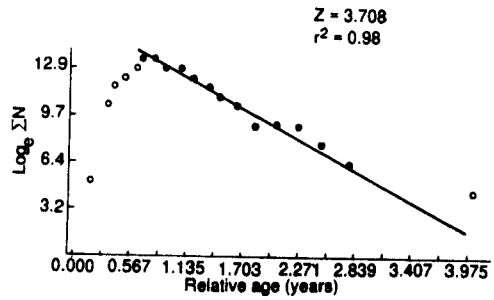


Fig. 8. Length converted catch curve of *Trichiurus lepturus* from west coast.

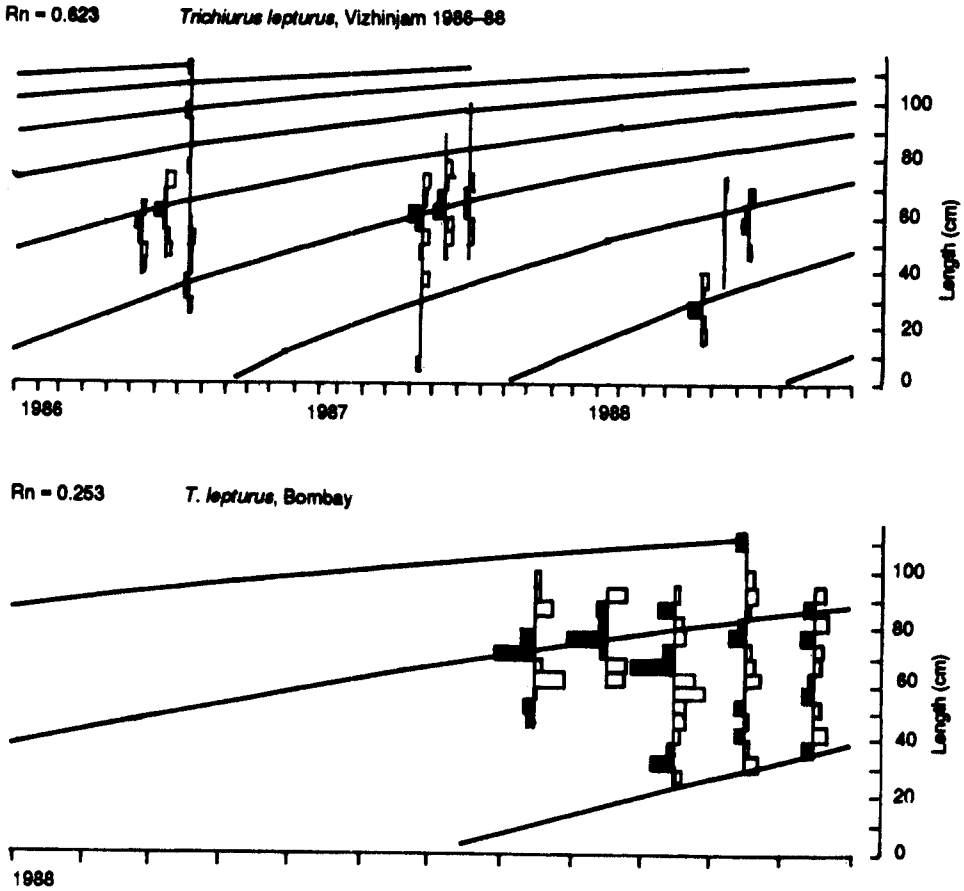


Fig. 7. ELEFAN I for the length frequency distribution of *Trichiurus lepturus* at Vizhinjam (1986-88) and Bombay (1986).

were used.

Estimation of mortality parameters and stock size (west coast): Total mortality coefficient (Z) estimated by catch curve was 3.708 (Fig. 8). Cohort analysis gave an estimate of Z =3.771 with M/K ratio of 2 and F/Z as 0.7 for larger size group as input. The estimated F was 2.7049. Thompson and Bell analysis (Table 4) indicated MSY of 65 666 tonnes at a relative fishing effort of 0.4. Biomass MSY was 64 811 tonnes.

DISCUSSION

James *et al.* (1986) have given the average annual catch of ribbonfish as 53 475 tonnes forming 4.25% of the total marine fish catch in India during 1970–81. The present study showed an increase of 48% in the annual landings during 1985-89 with an average landing of 79 220 tonnes forming 4.5 percent of the total catch. This can be attributed to the maximum contribution by trawl net especially in Gujarat, Maharashtra, Karnataka and Goa. Large concentration of ribbonfish (CPUE ranged 900–1900 kg/hr of trawling) along the northwest coast, mainly off Gujarat, has been reported by James and Pillai (1989). In the west coast, in all the states except Kerala, the trawl nets are contributing the maximum (Table 1). In the east coast, however, the traditional gears still play an important role. The lean fishery period appearing in the third quarter in Gujarat, Maharashtra and Karnataka may be attributed to the less fishing activity in the monsoon months in these states, because the main craft used here is mechanized boat. In the east coast (except Orissa and West Bengal) and in Kerala the peak season falls in the third quarter and it is exploited mainly by artisanal gears. The period of greatest abundance along the Maharashtra coast, according to Meenakshisundaram *et al.* (1986) was during the second and third quarters. Now it is seen in the fourth and second quarters. In the other states, however, there is no change in the season observed by the above authors.

Narasimham (1970) found no significant difference between male and female length-weight relationship and his exponent value 3.4637 was found to be significantly different from 3. In this study also no difference was found in the length-weight relationship between the sexes. However, the pooled relationships exponent value 3.05 is in confirmity with the cube law. Prabhu (1955) also got a similar exponent value (3.0819). There is a great deal of variation in the estimation of growth parameters (Chakraborty 1990). This study on stock assessment indicated that the exploitation rate on the east coast (E =0.662) should be reduced by about 33%. Narasimham (1983) estimated exploitation rate as 0.25 for the period 1967–71. This shows that the effort has increased tremendously during the subsequent period. Large numbers of industrial trawlers have been concentrating during eighties. However, there is no direct estimate of biomass from the east coast to confirm the same as in case of the west coast of India.

On the west coast also the exploitation rate is very high (E = 0.717). The biomass estimated for northwest coast of India was 156 530 tonnes (Somavanshi and Antony Joseph 1989) based on FORV Murena operation during the year 1977 and for southwest coast 67 243 tonnes (Rao *et al.* 1977) based on the data collected by research vessels Rastrelliger and Sardinella during 1972–75. The total biomass for both north and south regions works out 223 773 tonnes. The present yield is around 56'000 tonnes, against the mean biomass of 65 000 tonnes, which gives the higher exploitation value of 0.77. The vast disparity in biomass between these estimates were due to the fact that the above two were

based on experimental fishing areas including deeper waters, as against commercial fishing in shallow inshore areas. Although the exploitation rates are higher at present for commercial fishing, chances of increasing the yield are still potentially possible by extending the fishing areas, considering the large biomass obtained for experimental exploitations.

The present yield is only 56 000 tonnes whereas biomass estimated is 223 773 tonnes. Therefore, the high E obtained here may be attributed to migration of this pelagic resources to deeper waters.

This study thus indicates that there is overfishing on the east coast and the effort should be reduced by 33% whereas on the west coast there is a scope to increase the effort as the present yield is not even 50% of the biomass estimated. A similar recommendation was given by Meenakshisundaram *et al.* (1986) also.

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REFERENCES

Basheeruddin S and Nayar K N. 1962. A preliminary study of the juvenile fishes of coastal waters off Madras city. *Indian Journal of Fisheries* **8**(1): 167-88.

Bapat S V, Deshmukh V M, Krishnamoorthi B, Muthiah C, Kagwade P V, Ramamirtham C P, Mathew K J, Krishna Pillai S and Mukundan C. 1982. Fishery Resources of the Exclusive Economic Zone of the northwest coast of India. *CMFRI Bulletin* **33**: 1-81.

Chakraborty S K. 1990. Fishery, age, growth and mortality estimates of *Trichiurus lepturus* Linnaeus from Bombay waters. *Indian Journal of Fisheries* **37**(1): 1-7.

Gayanilo F C, Soriano J R M and Pauly D. 1988. A draft guide to the complete ELEFAN. *ICLARM Software Project.* 265 pp and 10 diskettes.

George K C, Dayanandan M G and Karunakaran Nayar P. 1968. Food of some demersal fishes from the trawl grounds off Cochin. *Indian Journal of Fisheries* **15** (1&2): 81-87.

James P S B R. 1967. The ribbonfishes of the family Trichiuridae of India. *Memoir 1. Marine Biological Association of India.* 226 pp.

James P S B R. 1973. The ribbonfish resources of India. *Proceedings of the Symposium on Living Resources of the Seas around India.* pp 34-38.

James P S B R and Baragi V M. 1980. Ovary as an indicator of frequency of spawning in fishes. *Proceedings of the Indian National Science Academy*, B **46**(4): 479-89.

James P S B R and Pillai Narayana V. 1989. Fishable concentration of fishes and crustaceans in the offshore and deep sea areas of the Indian Exclusive Economic Zone based on observations made on board FORV *Sagar Sampada. Proceedings of the First Workshop on Scientific Results of FORV Sagar Sampada*, 5-7 June, 1989. pp 201-13.

James P S B R, Chandrasekhara Gupta T R and Shanbhogue S L. 1983. Some aspects of the biology of the ribbonfish *Trichiurus lepturus* Linnaeus (1978). *Journal of the Marine Biological Association of India* **20**(1&2): 120-37.

James P S B R, Narasimham K A, Meenakshisundaram P T and Appanna Sastry Y. 1986. Present status of ribbonfish fishery in India. *CMFRI Special Publication* No. 24..

Jones R. 1984. Assessing the effect of changes in the exploitation pattern using length composition data (with a note on VPA and cohort analysis) *FAO Fisheries Technical Papers* No. 256. 118 pp.

Lazarus S and Sharma P S S. 1991. The resource characteristics of the ribbonfish *Trichiurus lepturus* Linnaeus, at Vizhinjam, southwest coast of India. *Journal of the Marine Biological Association of India* **33**(1&2): 89-88.

Luther G. 1981. Anchovy fishery of southwest coast of India with notes on characteristics of the resources. *Indian Journal of Fisheries* **26**(1&2): 23-39.

Meenakshisundaram P T, Narasimham K A and Appanna Sastry Y. 1986. The ribbonfish resources. *CMFRI Research and Development Series for Marine Fisheries Resources Management.* 3 pp.

Nair R V. 1952. Studies on some postlarval fishes of the Madras plankton. *Proceedings of the Indian Academy of Science* **35** B: 25-244.

Narasimham K A. 1970. On the length-weight relationship and relative condition in *Trichiurus lepturus* Linnaeus. *Indian Journal of Fisheries* **17**: 90-96.

Narasimham K A. 1972. Occurrence of early juveniles of the ribbonfish, *Trichiurus lepturus* Linnaeus in the Kakinada area with notes on their food. *Indian Journal of Fisheries* **19**: 210-14.

Narasimham K A. 1978. Age and growth of the ribbonfish

Trichiurus lepturus Linnaeus. *Indian Journal of Fisheries* **23**(1&2): 174-83.

Narasimham K A. 1983. On the fishery, mortality rates and yield per recruit of the ribbonfish, *Trichiurus lepturus* Linnaeus. *Indian Journal of Fisheries* **30**(1): 99-109.

Pauly D. 1982. Studying single species dynamics in a multispecies context. *Proceedings of the ICLARM CSIRO Workshop on the Theory and Management of Tropical Multispecies Stock, Cronulla, Australia*. pp 32-70.

Pillai P K M. 1974. A note on the food and feeding habits of the ribbonfish, *Trichiurus lepturus*. *Indian Journal of Fisheries* **21**(2): 597-600.

Prabhu M S. 1950. On the breeding habits of the ribbonfish, *Trichiurus haumela* (Forsk). *Current Science* **19**(7): 213-14.

Prabhu M S. 1955. Some aspects of the biology of the ribbonfish, *Trichiurus haumela* (Forskal). *Indian Journal of Fisheries* **2**(1): 132-63.

Rao K S. 1967. Food and feeding habits of fishes from trawl catches in the Bay of Bengal with observation on diurnal variation in the nature of the food. *Indian Journal of Fisheries* **11**(1): 277-14.

Rao K V N, Kumaran M and Sankarasubramanian J. 1977. Resources of ribbonfish and catfish off the south-west coast of India. *Seafood Export Journal* **9**(11): 9-25.

Somavanshi V S and Antony Joseph. 1989. Population dynamics and assessment of *Trichiurus lepturus* Linnaeus stock in northwest coast of India. Studies on Fish stock Assessment in Indian Waters. *Special Publication* No. 2. Fishery Survey of India, pp 1-32.

Sekharan K V. 1965. On the oil sardine fishery of the Calicut area during the years 1955-56. *Indian Journal of Fisheries* **9**(1): 679-700.

Sparre P. 1985. Introduction to tropical fish stock assessment. Rome, FAO Denmark Funds-in-Trust, FJ CCP/392/DEN, *Manual*, 333 pp.

Thampi P R S, Meenakshisundaram P T, Badheeruddin S and Ghanamuthu J C. 1968. Spawning periodicity of the ribbonfish *Trichiurus haumela* (F), with a note on iterate of growth. *Indian Journal of Fisheries* **15**: 53-60.

Vijayaraghavan P. 1951. Food of the ribbonfishes of Madras. *Journal of the Madras University* **21**: 81-95.