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FISHERY, AGE, GROWTH AND MORTALITY ESTIMATES OF *TRICHIURUS LEPTURUS* LINNAEUS FROM BOMBAY WATERS

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ABSTRACT

Fishery, age, growth and mortality estimates of *Trichiurus lepturus* Linnaeus is described in the present communication. During the sixteen year period from 1969 to 1984 the average contribution of ribbon fish to the total marine landings in India was 3.94%. At New Ferry Wharf and Sassoon Docks landing centres of Greater Bombay, ribbon fish contributed 6.44 and 5.92% respectively to the total marine catch during 1980-'86 period. The VBGF parameters in length estimated were $L\infty$ = 129.7cm, K = 0.50335 (annual) and t_o = +0.0011125 years. This species grows to 51.2, 82.5, 101.0 cm at the end of first, second and third year of its life respectively. The average total mortality 'Z' for the 1979 - '80 to 1981-'82 period was estimated as 1.96, natural mortality (M) as 1.05 and fishing mortality (F) as 0.91. The exploitation rate (U) and exploitation ratio (E) was estimated as 0.39 and 0.46 respectively.

INTRODUCTION

The ribbon fish (family Trichiuridae) forms an important group of food fish in the Indian waters. Though distributed on both the coasts, bulk of the catches comes from the states of Andhra Pradesh, Tamil Nadu, Kerala, Maharashtra and Gujarat. The annual average catch of ribbon fish in India during 1969-'84 period was 50,903 t contributing 3.94% to the total marine catch. Ribbon fish ranked seventh among the exploited fish group in order of predominance (James *et al.*, 1986).

The fishery is confined to the depth zone usually shallower than 50 metres. *T. lepturus* , the most widely distributed, forms the mainstay of ribbon fish fishery (James *et al.*, 1986).

From the Indian waters the study on the biology, age and growth of *T. lepturus* have been done by Prabhu (1955), Tampi *et al.* (1971), Narasimham (1970, 1972 and 1976) and James *et al*. (1978). The investigations on the mortality and yield parameters have been done by Narasimham (1983) from Kakinada waters and Somavanshi and Antony (1989) from the northwest coast of India.

MATERIAL AND METHODS

The catch and effort data of the commercial landings were collected by the field staff. Weekly observations were made at the landing centres for catch and length composition. Total length from the snout to the tip of the tail was taken from the length frequency study. The fish with tail suspected to be broken were rejected. The length data was placed in 20 mm group for the growth study. Scatter diagram technique of Devaraj (1982) was employed in the present study. The growth was expressed by employing von Bertalanffy's (1938) equation given as

$$L_t = L\infty\,(1 - e^{-K\,(t-t_o)})$$

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Where L∞ is the asymptotic length, 'K' is the growth coefficient, 't_0' is the theoretical age at length O. 'L∞ and 'K' were estimated by the Ford-Walford plot (Ford, 1933; Walford, 1946) of L_t against L_{t+1} on the basis of length attained at quarterly intervals. 't_0' was estimated by Gulland and Holt's (1959) plot.

The instantaneous rate of total mortality (Z) was estimated by employing Beverton and Holt's (1956) formula expressed as

$$Z = K \frac{(L\infty - \bar{L})}{\bar{L} - Lc}$$

Where L_c is the length at first capture and L is the mean length in the range of L_c to L.

The mortality coefficient (M) was estimated by Cushing's (1968) formula. Here in the unexploited state if the number of the one year olds is taken as 100 and the number surviving to maximum age (T_{max}) as1 then the formula could be written as

$$M = \frac{1}{T_{max-1}} \log e \frac{100}{1}$$

The largest fish recorded during the present study was 121.0 cm at which using VBGF the age was estimated as 5.36 years. This was taken as T_{max} for the present investigation.

$$\text{Thus } \frac{1}{5.36 - 1} . \log e \frac{100}{1} = \frac{4.6051}{4.36} = 1.05$$

The second method used for the estimation of 'M' was of Srinath (MS) given by the formula

$$N_L = R\ (L\infty - L) \ /\ (L\infty - Lr)^{M/k-l}$$

Where R is the number of recruits and Lr is the length at recruitment. If we assume that 95% of the fish population die before attaining 95% of the L∞ then we have

$$0.05 = (129.7 \times 0.05)^{M/k-l}\ (129.7—28.1)^{M/k-l}$$

[L∞ = 129.7cm, K = 0.50335, Lr = 28.1cm]

Using this formula M was estimated as 1.05128. The same formula was used assuming that 99% of the recruits die by the time they reach 99% of the L∞ and the 'M' was estimated as 1.0348.

The instantaneous rate of fishing mortality (F) was obtained by subtracting M from Z given as

$$F = Z\text{-}M$$

The exploitation ratio (E) and the exploitation rate (U) were calculated by the formula

$$E = \frac{F}{F+M} \text{ and } U = \frac{F}{Z}(l\text{-}e^{-Z})$$

respectively.

RESULTS

The annual catch rate and percentage contribution of *T. lepturus* to the total marine catch at New Ferry Wharf and Sassoon Docks for 1980-'86 period is given in Fig.1. The total catch of this species at New Ferry Wharf during this period was 15,758t whereas the same for Sassoon Docks was 9,474 t. Taking the catch of both the centres together, N.F. Wharf's share comes to 62.45% and that of S. Docks to 37.55%. Highest catch of 3,880 t with CPUE of 196.57 kg was recorded is at New Ferry Wharf in 1980 while the lowest catch of 881 t with CPUE of 38.52 kg was recorded in 1984.

The average monthwise catch during 1980-'86 period is presented in Fig. 2. Highest catch of 173 t with CPUE of 100.54 kg was recorded at S. Docks in April whereas the lowest catch of 62 t with CPUE of 39.49 kg was recorded in July. At N. F. Wharf, March recorded the highest catch of 304 t

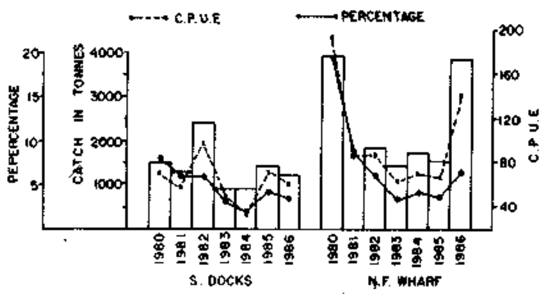

Fig. 1. Annual catch, catch rate and percentage of *T. lepturus* to the total marine catch.

with CPUE of 129.32 kg. At this centre too the lowest catch was in July (9t) with CPUE of 32.91kg.

A total 12,383 specimens of *T. lepturus* in the length range of 28.1 to 121.0 cm were measured during March, 1978 to March, 1982. By connecting maximum number of modes in the scatterogram it was possible to obtain 15 growth curves of almost identical shapes (Fig. 3). The average lengths attained at quarterly intervals were read and the same was used for the Ford-Walford plot. The growth coefficient 'K' was estimated as 0.50335 on annual basis and the asymptotic length as 129.7 cm. The 't_o' was estimated as +0.0011125 years. The estimated lengths in cm at the end of I to V year of its life was found to be 51.2, 82.5, 101.0, 112.3 and 119.2 cm respectively. The L∞ of 129.7cm is close to the largest fish of 121.0 cm observed in the catch. The von Bertalanffy's growth formula (VBGF) for this species could thus be written as

$$L_t = 129.7\ (1 - e^{-0.50335}\ (t - (+0.0011125))$$

The total mortality coefficient (Z) for the three year period from 1979-'80 to1981- '82

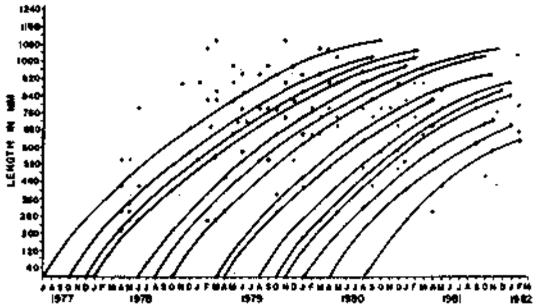

Fig. 3. Scatterogram of modal length for *T. lepturus*.

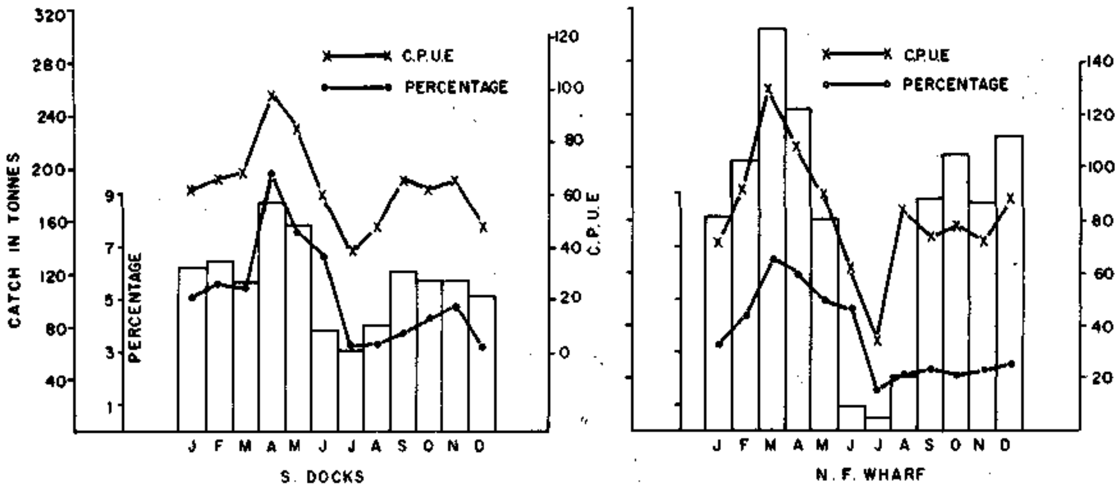

Fig. 2. Average monthwise catch, catch rate, and percentage of *T. lepturus*.

TABLE 1. *Mortality exploitation rate and exploitation ratio of* T. lepturus(*based on combined catch of S. Docks and N. F. Wharf)*

Year	Z	M	F	U	E
1979-'80	1.98	1.05	0.93	0.40	0.46
1980-'81	1.93	1.05	0.88	0.38	0.45
1981-'82	1.99	1.05	0.94	0.40	0.47
Average	1.96	1.05	0.91	0.39	0.46

ranged from 1.93 to 1.99, the average being 1.96 (Table 1). The natural mortality coefficient (M) was taken as 1.05. The average fishing mortality coefficient thus obtained by subtracting M from Z was 0.91.

DISCUSSION

The catches of ribbon fish show fluctuating trends at both the centres. At S. Docks there was a marked decline in the catch in 1983 and 1984 but it improved in 1985 and 1986. At N. F. Wharf the lowest catch was recorded in 1983. Seasonwise it appears that September - November and January-April recorded good catches of ribbon fish at S. Docks while at N. F. Wharf, October and December-April were the better seasons.

Age and growth studies of *T. haumela* (*T. lepturus*) from the seas around India was studied by Prabhu (1955) and he gave the length attained at 1-4 years of its life as 18, 30, 46 and 54 cm respectively. His data does not include fishes of more than 56 cm. So his data does not represent the true picture of the population and consequently the rate of growth and the life span obtained by him are open to doubt (James, 1967). Prabhu's (1955) study was based on length frequency data of five months only and he assumed that each mode represents an year class for he believed that spawning of the fish is restricted to a short definite period, probably by the end of June. Narasimham, (1976) and Tampi *et al*. (1971) observed that the fish spawns twice in a year in May-June and November- December and revised Prabhu's data. On that basis they assumed that the time interval between successive modes to be six months and thus the two year old fish of Prabhu become one year old. This was one of the first significant observations indicating the faster rate of growth of *T. lepturus* (Narasimham, 1976). James *et al*. (1978) reported that this species at Mangalore water attains 39.1, 58.7, 70.8 and 82.8 cm at the end of I-IV year of its life. Narasimham (1976) while working on *T. lepturus* from Kakinada waters reported still faster growth rate for this species. The estimated lengths in cm at one to five years are 42.7, 68.6, 87.9, 102.4 and 113.2 in total length respectively. The VBGF parameters estimated by him were L∞145.4 cm, K = 0.29 (annual) and t_0 = —0.20 years. Somavanshi and Antony (1989) reported that *T. lepturus* in the north west coast of India has a growth coefficient and asymptotic length of 0.64 (annual) and 109 cm respectively.

Using length frequency data, Dawson (1967) reported that *T. lepturus* in the northern Gulf of Mexico grows to 40 and 70 cm at the end of I and II year of its life. Ingles and Pauly (1984) reported that the asymptotic length and annual K of *T. lepturus* from Philippines waters to be 78 cm and 0.70 respectively.

In the present investigation the growth rate of *T. lepturus* was found to be relatively faster. The estimated length, length at the end of I to V years in cm were 51.2, 82.5, 101.0, 112.3 and 119.2 respectively. The growth coefficient was also found to be high (0.50 annual) as compared to 0.29 by Narasimham (1976). The age and growth parameters estimated by various authors is given in Table 2.

The inverse relationship between K and L∞ is well documented. Higher K of *T. lepturus* in the present study is justified in view of L∞ of 129.7 cm and life span of about 5 years as against K of 0.29 reported by Narasimham (1976) with an L ∞ of 145.2 cm. Moreover, if the growth coefficient is higher, it is obvious that the fish would move towards the asympototic length at a faster pace. Perhaps, that may be one of the reasons for relatively faster growth rate of *T. lepturus* from Bombay waters. It should also be noted that the average modal length given by Narasimham (1976) at six monthly intervals from 6-24 months does not indicate any relative decline in length with the increase in age. The method employed in the growth study by Narasimham (1976) also differs from the one employed in the present study. Thus, it may be that the relatively faster rate of growth of *T. lepturus* at Bombay, may, perhaps, be due to significant differences in the growth rate between the two populations and it may as well reflect the differences in

TABLE : 2 *Age and Growth estimation of* T. lepturus *by different authors based on length - frequency studies*

Author	Area	Total Length in cm at ages in years					L∞ in cm	K	t_o	Remarks
		I	II	III	IV	V				
Prabhu (1955)	Madras coast	18.0	30.0	46.0	54.0	—	—	—	—	—
Tampi *et al.*, (1971)	Madras coast	30.0	—	—	—	—	—	—	—	Based on Prabhu's data
Narasimham (1976)	Off Kakinada	42.7	68.6	87.9	102.4	113.2	145.2	0.29	-0.20	Calculated by von Bertalanffy's growth equation
James *et al.*, (1978)	Mangalore waters	39.1	58.7	70.8	82.8	—	—	—	—	—
Dawson (1967)	Northern Gulf of Mexico	40.0	70.0	—	—	—	—	—	—	—
Ingles and Pauly (1984)	Philippines waters	—	—	—	—	—	78.0	0.70	—	—
Somavanshi and Antony (1989)	Northwest coast of India	—	—	—	—	—	109.0	0.64	—	—
Present	Bombay	51.2	82.5	101.3	112.3	119.2	129.7	0.50335	+0.0011125	Calculated by VBGF

the methods employed for the estimation of growth. The L ∞ of 109 cm obtained by Somavanshi and Antony (1989) appears to be on the lower side considering the fact that in the present investigation the largest fish observed was 121.0 cm. The chief reason for the low L ∞may, perhaps, be due to limited number of samples collected from survey vessel M. T. *Muraena*.

The 'Z', 'M' and 'F' estimated by Narasimham (1983) based on the annual age composition of *T. lepturus* from Kakinada waters for the year 1967-'71 were 1.2, 0.9 and 0.3 respectively. The exploitation rate 'U' obtained by him was 0.17. Somavanshi and Antony (1989) reported Z, M and F of 1.79, 0.80 and 0.99 respectively for *T. lepturus* from the north west coast of India. In the present study the total, natural and fishing mortality was estimated as 1.96, 1.05 and 0.91 respectively. The higher estimates of 'Z' in the present study (E = 0.46) as compared to Kakinada waters is perhaps due to higher exploitation rate in Bombay waters.

Estimation of 'M' presents a good deal of problem in tropical multispecies fisheries where time series data of 'Z' and efforts (f) are generally not available. It is for this reason that 'M' cannot be estimated most often by any conventional method (Pauly, 1980). In the present investigation 'M' has been estimated by two methods and the results are almost identical. 'M' of 1.05 by Cushing's model was taken for further studies. It is close to 'M' of 1.08 estimated by Ingles and Pauly (1984) and 0.9 by Narasimham (1983) but higher than 0.8 estimated by Somavanshi and Antony (1989).

According to Gulland (1971) the exploitation ratio (E) gives a rough idea about the fishing pressure if the species subjected to E is upto 0.5 which he terms Eopt. The fish stock does not show any noticeable effects of fishing pressure. In the present investigation the exploitation ratio for *T. lepturus* was found to be 0.46 which indicates that the stock is not under pressure or threat of depletion.

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