AGE AND GROWTH OF RIBBONFISH *TRICHIURUS LEPTURUS* LINNAEUS

K. A. NARASIMHAM

Kakinada Research Centre of C.M.F.R. Institute, Kakinada-533002.

ABSTRACT

Age and growth of the ribbonfish *Trichiurus lepturus* Linnaeus is studied by length-frequency analysis of 20,562 fish measured during October 1965 to December 1970. The fish attains an average length of 41.6, 69.0 and 88.5 cm in 1st, 2nd and 3rd years, respectively. The growth rate is fairly faster than what hitherto believed was to be. The von Bertalanffy growth equation is fitted, which has the parameters L_∞ = 145.4 cm, K = 0.29 and t_0 = -0.20 years. The length-at-age data obtained in this study compare favourably well with similar data on the same species from the northern Gulf of Mexico, East China Sea and Yellow Sea-Pohai Bay.

INTRODUCTION

The ribbonfishes form an important group of food fish along the Andhra coast and among them *Trichiurus lepturus* Linnaeus is the dominant species. Except for the work of Prabhu (1955) and some comments by Tampi *et al* (1971), there is no other published information from Indian waters on age and growth of the species. This aspect has been dealt with in this article.

MATERIAL AND METHODS

Random samples, consisting of about 25 fish, were measured once or twice a week for total length, from the commercial catches at Uppada, Dummulapeta and Kakinada Fishing Harbour landing centres. The material was collected from catches by shoreseines, boatseines and otter trawls which operated in 5-40m depth off Kakinada (Lat. E. 82°-20' to 30'; Long. N. 16°-40' to 17°-10'). The mesh size of the cod end of all these nets varied from 1 to 2 cm. A total of 20,592 fish were measured during the period October 1965 to December 1970 and gearwise, the material comprised 73.5% from otter trawls, 18.2% from boatseines and the rest from shoreseines. The early juveniles reported by the author (Narasimham 1972) were also included in this study. The fish with tails suspected to be broken were rejected. Whenever the number of fish measured in a month was less than 50, the sample was rejected. In the absence of growth rings on the otoliths to be of use in age determination, the length-frequency method was followed. Only those modes which could be traced for over 6 months from first appearance were considered. It was observed that the fish, usually measuring over 50 cm, often moved in large shoals. These shoals remained in the fishing grounds for a few weeks to a few months before they moved away. Owing to this behaviour, modal progression of larger size groups could be studied only in a few cases. The von Bertalanffy growth equation (Beverton and Holt 1957) was fitted to the average of the modal values by the least-square method.

Age and Growth

In Figs 1-3 are shown the length-frequency distribution. The smallest mode, E was present at 4.5 cm in July 1966 (material collected in the last week of the month). It moved to 16.5 cm in October 66, 28.5 cm in January 67 and could be traced up to a modal length of 37.5 cm by June 67. The modal progresssion suggests fairly fast growth rate, particularly so in the first

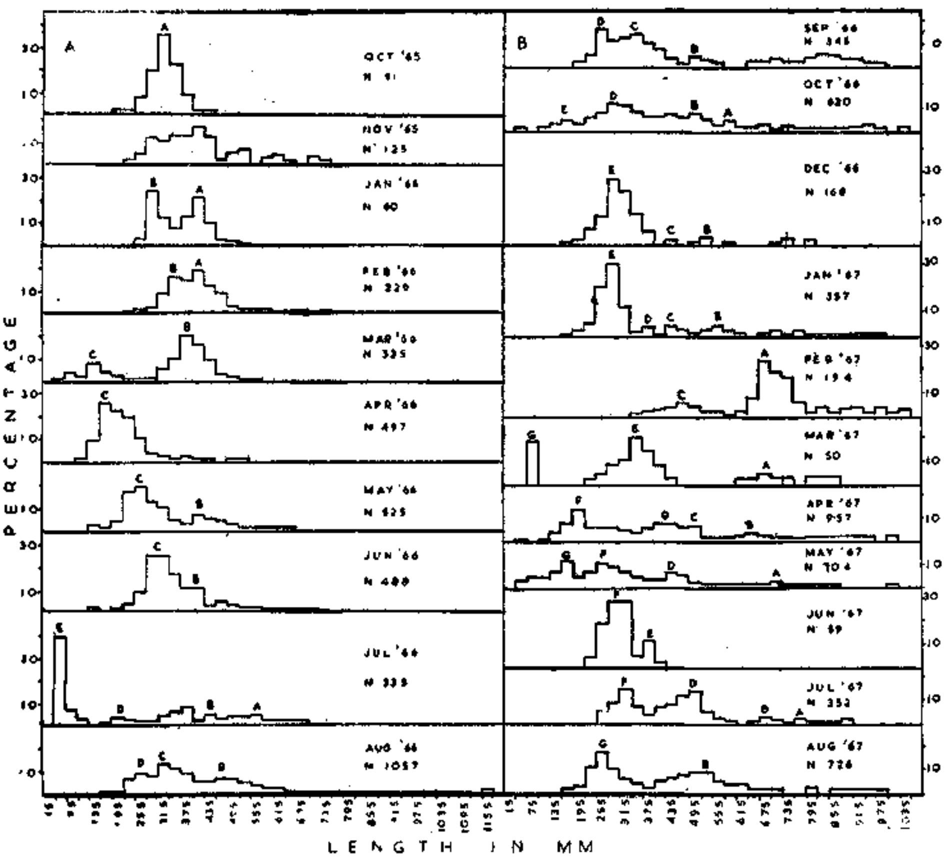

Fig. 1. Length-frequency distribution in *Trichiurus lepturus*. N indicates the number of fish measured.

6 months and it is reasonable to assume that the 4.5cm modal length in July 66 represented fish under one-month old. Prabhu (1955) stated that in one-and-half months after spawning the young ones of *T. haumela* (= *T. lepturus*) grow to a size of 7 to 9 cm, which agrees with the observation of Tang Wu (1936) on *T. japanicus* (= *T. lepturus*). The rapid modal progression seen in the present study lends support to Prabhu's (1955) observation. Consequently the fish represented by mode E attained a length of 28.5 cm in 6 months and 37.5 cm in 11 months. On the above basis it is reasonable to allot 1-month age to mode G which appeared at 7.5 cm in March 67. This mode progressed to 28.5 cm in September 67 which represented 7 months growth. Similarly mode C at 13.5 cm in March 66 was alloted 2-month age. This mode shifted to 31.5 cm in September 66 (7 months), 43.5 cm in January 67 (12 months). In April 67 (15 months) it reached 49.5 cm and after 5 months gap reappeared at 64.5 cm in October 67. It moved to 69.0 cm in January 68 (24 months),

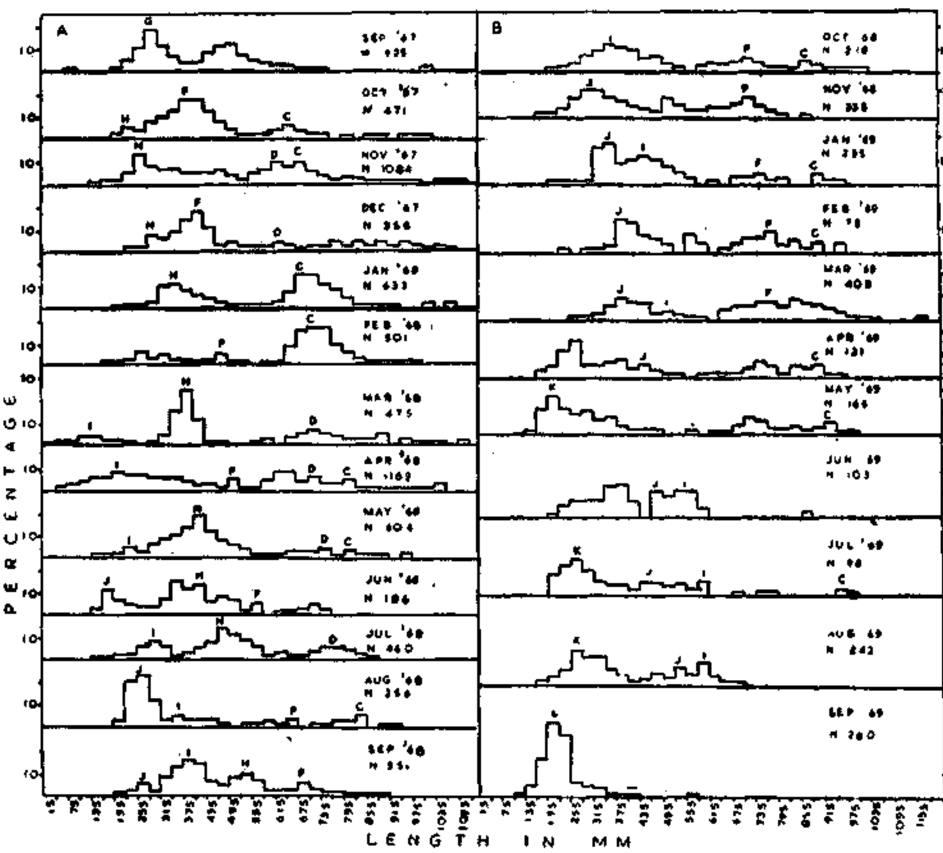

FIG. 2. Length-frequency distribution in *Trichiurus lepturus*. N indicates the number of fish measured.

82.5 cm in August 68 (31 months), 88.5 cm in January 69 (36 months) and 94.5 cm in July 69 (42 months). Mode A appeared in October 1965 at 31.5 cm and this was alloted to 7-month age (C reached this length in 7 months). This mode moved to 40.5 cm in February 66 (11 months), 58.5 cm in October 66 (19 months), 67.5 cm in March 67 (24 months) and 76.5 cm in July 67 (28 months). Mode B which appeared at 28.5 cm in January 66 was considered as 6 months old (E reached this length in 6 months) and it progressed to 43.5 cm in July 66 (12 months), 55.5 cm in January 67 (18 months) and 67.5 cm in July 67 (24 months). Mode D at 19.5 cm in July 66 was assigned to 4-month age. It reached 25.5 cm in September 66 (6 months), 43.5 cm in April 67 (13 months), 52.5 cm in August 67 (17 months), 70.5 cm in March 68 (24 months) and 76.5 cm in July 68 (28 months). In April 67, mode F stood at 19.5 cm and was alloted to 4-month age. It was traced to 28.5 cm in June 67 (6 months), 40.5 cm in December 67 (12 months), 64.5 cm in August 68 (20 months), 73.5 cm in January 69 (25 months) and 76.5 cm in March 69 (27 months). Mode H, considered as represented by 4-month old fish at 22.5 cm in October 67, progressed to 28.5 cm in December 67 (6 months), 40.5 cm in June 68 (12 months) and 52.5 cm in September 68 (15 months). In March 68 mode I at 13.5 cm was assigned to 2-month

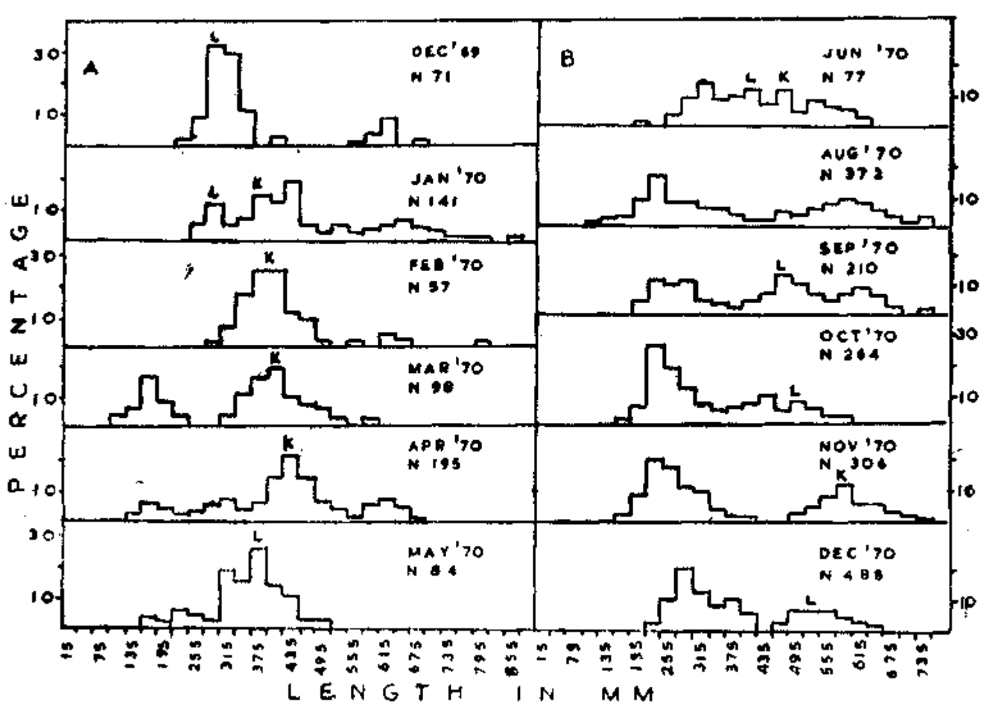

FIG. 3. Length-frequency distribution in *Trichiurus lepturus*. N indicates the number of fish measured.

age and it reached to 28.5 cm in July 68 (6 months), 43.5 cm in January 69 (12 months) and 55.5 cm in July 69 (18 months). Modes J, K and L which had modal lengths at 16.5 or 19.5 cm when first appeared, were assigned to 3-month age. They all shifted to 25.5 or 28.5 cm when 6 months old, 40.5 cm when one-year old and mode L moved 52.5 cm when one-and-half years old.

In Table 1 are shown the observed modal lengths for different modes at 6 months time interval. It may be seen from this Table that *T. lepturus* attains an average length of 27.3, 41.6, 55.0, 69.0, 79.8, 88.5 and 94.5 cm in 6, 12, 18, 24, 30, 36 and 42 months respectively.

In Fig. 4, the Ford-Walford line (Ford 1933, Walford 1946) is fitted to the observed average modal lengths at 6 months time interval (Table 1) which shows that the points are well represented by the regression. The various parameters of the von Bertalanffy growth equation are estimated as under:

L_∞ (asymptotic length) = 145.4 cm

K (a constant equivalent to 1|3 of catabolic coefficient) = 0.29 on annual basis and

t_0 (arbitrary origin of growth curve) = -0.20 years.

Therefore the equation for length in cm at age t (= L_t) is:

$$L_t = 145.4\,(1-e^{-0.29\,(t+0.20)})$$

TABLE 1. *Modal lengths in cm at 6 months time interval of* T. lepturus.

Modes	Months							Remarks
	6	12	18	24	30	36	42	
A	—	*44.2	55.4	67.5	—	—	—	* Indicates the calculated length based on the position of the immediately preceding or succeeding modal length
B	28.5	43.5	55.5	67.5	—	—	—	
C	*27.0	43.5	—	69.0	*79.8	88.5	94.5	
D	25.5	*40.1	*55.6	70.5	—	—	—	
E	28.5	*40.9	—	—	—	—	—	
F	28.5	40.5	—	*70.6	—	—	—	
G	25.5	—	—	—	—	—	—	
H	28.5	40.5	—	—	—	—	—	
I	28.5	43.5	55.5	—	—	—	—	
J	25.5	40.5	*55.6	—	—	—	—	
K	25.5	40.5	—	—	—	—	—	
L	28.5	40.5	52.5	—	—	—	—	
Average Length	27.3	41.6	55.0	69.0	79.8	88.5	94.5	

The average modal length (Table 1) and the estimated length by the growth equation (Table 2) at different ages show close agreement.

Discussion

Prabhu (1955) determined the lengths at ages 1 to 4 of *T. lepturus* (Table 2) which show considerably slow growth rate for this species. He did not establish the time interval between successive modes by tracing them over a period of time. In fact his study is based on only 5 months length-frequency data and he assumed that each mode represented an year class for he believed that spawning in the fish is restricted to a short and definite period, probably

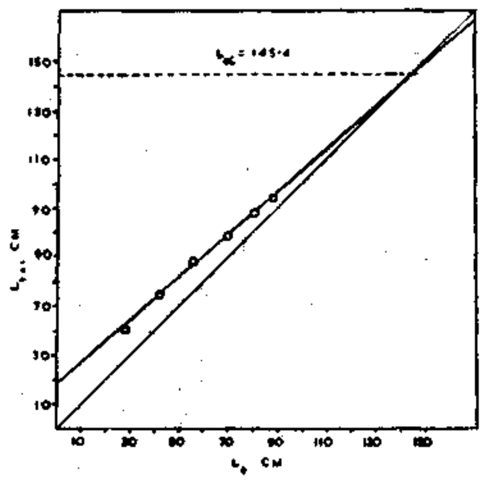

Fig. 4. Ford-Walford plot of length in cm at time L_t +1 against L_t

at the end of June. Tampi *et al* (1971) observed that the fish spawns more than once in a year and the two seasons given are roughly around May-June and November-December. On this basis they assumed that the time interval between successive modes to be 6 months and revised the age of Prabhu's 2-year old fish measuring 30 cm as 1-year old. Although Tampi *et al* (1971) did not present their data, their observations are significant in that they recognised that the fish grows at a faster rate. I observed (Narasimham 1972) that off Kakinada the spawning period in *T. lepturus* is prolonged with peak activity in February-June. In this study it may be seen that an year class may be represented by more than one mode (ex: modes I, C, D and E in 1966). For *Trichiurus pantului,* Gupta (1968) has given a still slower growth rate than Prabhu. While James (1969) considered this species as a synonym of *T. lepturus* by denying the existence of some characters even in the holotype, more information is desirable both on taxonomy and biology of this species.

TABLE 2. *Age estimation in* T. lepturus *by different authors.*

Author	Method	Area	Total length in cm at ages					$L\alpha$	Remarks
			1	2	3	4	5		
Prabhu (1955)	Length-frequency	Madras coast	18.0	30.0	46.0	54.0			
Tampi *et al* (1971)	Do	Do	30.0						Based on Prabhu's data
Narasimham (present study)	Do	Off Kakinada	42.7	68.6	87.9	102.4	113.2	145.4	Calculated by von Bertalanffy growth equation
Dawson (1967)	Do	Northern Gulf of Mexico	40.0	70.0					
Tsukahara (1964)	Otolith study	Japanese waters	24.0	56.8	82.4				
Misu (1964)	Do	East China Sea and Yellow Sea	24.9	69.6	90.8	103.4	110.7	123.5	Calculated by von Bertalanffy growth equation
Hamada (1971)	Do	Do	40.1	67.6	86.6	102.0	113.2	162.6	Do

The age data of the species given by Dawson (1967) agree closely with my observations (Table 2) while Tsukahara's data are on the lower side. Misu (1964) gave the von Bertalanffy equation for the species as under:

$$L_t = 455.7 \quad (1-e^{-0.4083-0.44})$$

where L_{∞} = body length (snout-vent length) in mm at time *t*. For the males of Yellow Sea-Pohai Bay, Misu (1964) gave the following regression equations for the conversion of the body length (B.L) into total length (T.L).

Up to 250 mm body length
Log B.L. = 0.0008109 T.L + 1.7612
Beyond 250-mm body length
Log B.L. = 0.0005762 T.L. + 1.9472.

Misu found significant differences between the two equations and noted that both in the females of Yellow Sea-Pohai Bay and either sex of East China Sea population similar break existed at 250mm body length. By these equations the body lengths derived from the von Bertalanffy growth equation were converted into total length and given in Table 2. Except for the one-year-old fish there is much similarity between Misu's age data and the results of the present study. It may be of interest to note that in actual practice Misu observed the first ring in the otolith at an average of 172mm body length (= 57.7 T.L.) when the fish is 1^+-year old (see Hamada 1971). James (1967, p 189) while citing Misu's work remarked that the rate of growth of *T. lepturus* from second year onwards in the East China Sea and Yellow Sea appears to be much slower in comparison with the growth rate of the same species in Indian waters (obviously referring to Prabhu's work). This is not correct, for James (1967) compared the snout-vent-length-at-age data of Misu with the total-length-at-age data of Prabhu and arrived at this conclusion.

Hamada (1971) gave the following growth equation for *T. lepturus*:

$$L_t = 766\ (1-e^{-0.139\ (t + 0.266)})$$

where L = body length (snout-vent length) in mm at time *t*. In Table 2 are given the calculated total lengths at different ages for the above equation which indicates striking similarity with my data. The largest specimen in the present study measured 115 cm. Tampi *et al* (1971) recorded a maximum length of 112 cm, Misu (1959) 134.9 cm (= 53 cm B.L. read from his figure 4) and Hamada (1971) 130.5 cm (= 50 cm B.L. read from his figure 7). In Indian waters the ribbonfish fishery is essentially coastal in nature, confined up to 40-metre depth line from the shore, whereas the Japanese exploit the ribbonfish far away from their coast, in the major part of the East China and Yellow Seas. This may possibly explain for the larger sizes of *T. lepturus* recorded by the Japanese workers.

ACKNOWLEDGEMENTS

The author is thankful to Dr S. Z. Qasim for encouragement and to late Dr K. V. Sekharan for going through the manuscript and suggesting improvements.

REFERENCES

BEVERTON, R. J. H. AND S. J. HOLT. 1957. On the dynamics of exploited fish populations. *Fishery Invest., London,* Series 2, 19. 533 pp.

DAWSON, C. E. 1967. Contributions to the biology of the cutlassfish (*Trichiurus lepturus*) in the northern Gulf of Mexico. *Trans. Amer. Fish. Soc.,* **26**. 117-121.

FORD, E. 1933. An account of herring investigations conducted at Plymouth during the years 1924-1933. *J. mar. biol. Ass. U.K.,* **19**: 305-384.

GUPTA, M. V. 1968. Studies on the taxonomy, biology and fishery of ribbon fishes (Trichiuridae) of the Hooghly estuarine system 3. Biology of *Trichiurus pantului* Gupta. *Proc. Zool. Soc. Calcutta,* **21**: 35-50.

HAMADA, R. 1971. Age and growth of the ribbon fish, *Trichiurus lepturus* Linne based on the transverse section of the otolith. *Bull. Seikai Reg. Fish. Lab.,* **41**: 53-62.

JAMES, P. S. B. R. 1967. *The ribbon-fishes of the family Trichiuridae of India.* Memoir I. Marine Biological Association of India: 226 pp.

JAMES, P. S. B. R. 1969. Comments on the four new species of ribbon-fishes (family Trichiuridae) recently reported from India. *J. Mar. biol. Ass. India,* 1967, 9: 327-338.

MISU, H. 1958. Studies on the fisheries biology of the ribbon fish (*Trichiurus lepturus* Linne) in the East China and Yellow Seas. I. On the age and growth. *Bull. Seikai Reg. Fish. Res. Lab.,* **15**: 1-13.

MISU, H. 1964. Fisheries biology on the ribbon fish (*Trichiurus lepturus* Linne) in the East China and Yellow Seas. *Bull. Seikai. Reg. Fish. Lab.,* **32**: 1-58.

NARASIMHAM, K. A. 1972. Occurrence of early juveniles of the ribbonfish *Trichiurus lepturus* Linn., in the Kakinada area with notes on their food. *Indian J. Fish.,* **19**: 210-214.

PRABHU, M. S. 1955. Some aspects of the biology of the ribbonfish *Trichiurus haumela* (Forskal). *Indian J. Fish.,* **2**: 132-163.

TAMPI, P. R. S., P. T. MEENAKSHISUNDARAM, S. BASHEERUDDIN AND J. C. GNANAMUTHU. 1971. Spawning periodicity of the ribbon fish, *Trichiurus lepturus* (F), with a note on its rate of growth. *Indian J. Fish.,* 1968, **15**.. 53-60.

*TANG, F. F. AND WU, H. W. 1936. A preliminary note on the spawning ground of *Trichiurus japanicus* (Schlegel) in Po-hai. *Ling. Sci. Jour.,* **15**: (4): 651.

*TSUKAHARA, H. 1962. Biology of the cutlass fish, *Trichiurus lepturus* Linnaeus. Part 2. Age and Growth. *Rec. Oceanogr. Wks Jap. Spec.,* No. 6: 57-64.

WALFORD, L. A. 1946. A new graphic method of describing the growth of animals. *Biol. Bull.,* **90**: 141-147.

* Not referred to the original.