International Journal of Fisheries and Aquatic Studies 2013; 1 (2): 25-30

ISSN: 2347-5129
IJFAS 2013; 1 (2): 25-30

Received: 14-11-2013
Accepted: 16-11-2013

Pallavi K. Pakhmode
Dept. of Fisheries Biology, College of Fisheries, Ratnagiri, Maharashtra, India

Swapnaja A. Mohite
Dept. of Aquaculture, College of Fisheries, Ratnagiri, Maharashtra, India

Suresh D. Naik
Dept. of Fisheries Biology, College of Fisheries, Ratnagiri, Maharashtra, India

Ashish S. Mohite
Dept. of Fisheries Engineering, College of Fisheries, Ratnagiri, Maharashtra, India

Correspondence:
Swapnaja A. Mohite
Dept. of Aquaculture, College of Fisheries, Ratnagiri, Maharashtra, India

Length frequency analysis and length-weight relationship of ribbonfish, *Lepturacanthus savala* (Cuvier, 1829) off Ratnagiri coast, Maharashtra

Pallavi K. Pakhmode, Swapnaja A. Mohite, Suresh D. Naik, Ashish S. Mohite

ABSTRACT
In the present study, length frequency and length weight relationship analysis of *Lepturacanthus savala* of Ratnagiri coast were done. The fishes ranged in total length from 10 to 70 cm. From the cumulative frequency calculations, it was observed that *L. savala* attained first maturity at the size of 38 cm. L_∞ calculated for *L. savala* was 68.25 cm, K was 0.55. The length of 43 cm was attained at the end of first year, 58 cm at second year and 65 cm at the end of third year. The analysis of covariance did not show significant difference in length-weight relationship between sexes. The relationship was described as Log W = -3.6049+3.2285 Log L.

Keywords: *Lepturacanthus savala,* length frequency, Ratnagiri, Maharashtra.

1. Introduction
Ribbonfish form a major and abundant fishery resource among the marine pelagic fin-fishes of the Indian seas. They are distributed in the Atlantic and Indo-Pacific regions as well as all along the Indian coast with abundance in the northwest and central east coasts[1]. The ribbon-fishes belong to the family Trichiuridae and are represented in Indian waters by four species namely, *Trichiurus lepturus, Lepturacanthus savala, Eupleurogrammus intermedius* and *E. muticus*, the first two species being the most dominant. These fishes are collected between Longitude 68º-70º E and Latitude 8º-22º N on the Gujarat coast, south Kerala and central Maharashtra coast and 15º N and 13º10´N - 92º37´E in Andaman and Nicobar Islands and mainly off Orissa and north Andhra coasts[2]. Occurrence of *L. savala* in high numbers is recorded during October – December in nearshore waters along Ratnagiri coast.
Estimated marine landing of ribbonfish in 2010 in east coast was 19,629 tonnes whereas in west coast estimated marine landing of ribbonfish[3] was 1,25,293. Estimated annual landing of ribbon fishes in Maharashtra state in 2011-2012 was 24094 tonnes, while the annual production of ribbonfish along Ratnagiri coast[4] in 2011-2012 was 4362 tonnes. Estimated annual production of ribbonfish in Mirkarwada landing centre in 2011-2012 was 1662 tonnes[4]. Present work was undertaken to study the biological aspects of L. *savala* as it contributes the major marine landings along the Ratnagiri coast. Most of the catch is used for surim production and some catch of this fish is utilized in dried form along this coast.

2. Materials and methods
From the length data, the frequencies of the length classes were tabulated. Total 1650 individuals were studied for length frequency analysis for a period of eleven months from February 2012. Sampling for June – July could not be collected due to ban on fishing during monsoon. From the size frequency analysis, dominant modes of size distribution of *L. savala* were noted. The shifting of the mode values in the graphs for different months was used as the base for interpretation of growth. The length frequencies are used for separating the polymodal length frequency distribution into modal lengths of different year classes.

The estimation of growth parameters were also supplemented by analyzing the data by using FISAT (FAO - ICLARM Stock Assessment Tools) computer software package[5], which includes direct fit of length frequency data by ELEFAN - II (Electronic Length Frequency Analysis) method[6] and developed into a computer software package[7].

Total 680 individuals comprising of 233 males and 305 females and 142 indeterminates in the length range of 25 to 70 cm were studied for estimation of length-weight relationship by using linear regression analysis The data of total length and weight were statistically treated by the method of least square using the equation[8] given as: log W = log a+b log L, where 'a' and 'b' are constants estimated by linear regression of the log transformed varieties. Length-weight relationship was determined separately for males, females, indeterminates and total.

3. Results and discussion

3.1. Length frequency analysis

Random samples of fish collected from the commercial catches ranged in total length from 10 to 70 cm, mainly clustering between size groups 20-30, 30-40, 40-50 and 50-60 cm (Table 1, Fig. 1). It was observed that modal group of 40-50 cm size fish was caught during all the months along the Ratnagiri coast.

Table 1. Month wise length frequency distribution of *L. savala* of Ratnagiri coast during February 2012 to February 2013

Class Interval (cm)	Feb	Mar	Apr	May	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Total No.	Cumulative frequency	Relative frequency	Percentage frequency
1 – 10	1	0	0	0	4	0	0	0	0	0	11	16	16	0.0097	0.97
10 – 20	4	5	0	8	9	3	2	1	1	1	20	54	70	0.0327	3.27
20 – 30	5	17	5	15	19	45	12	18	12	17	41	206	276	0.1248	12.48
30 – 40	5	45	18	53	32	77	30	30	25	37	47	399	675	0.2418	24.18
40 – 50	29	52	45	70	34	71	65	45	48	22	61	542	1217	0.3285	32.85
50 – 60	6	23	66	48	2	4	85	42	51	18	20	365	1582	0.2212	22.12
60 – 70	0	8	16	6	0	0	6	14	13	5	0	68	1650	0.0412	4.12
	50	**150**	**150**	**200**	**100**	**200**	**200**	**150**	**150**	**100**	**200**	**1650**			

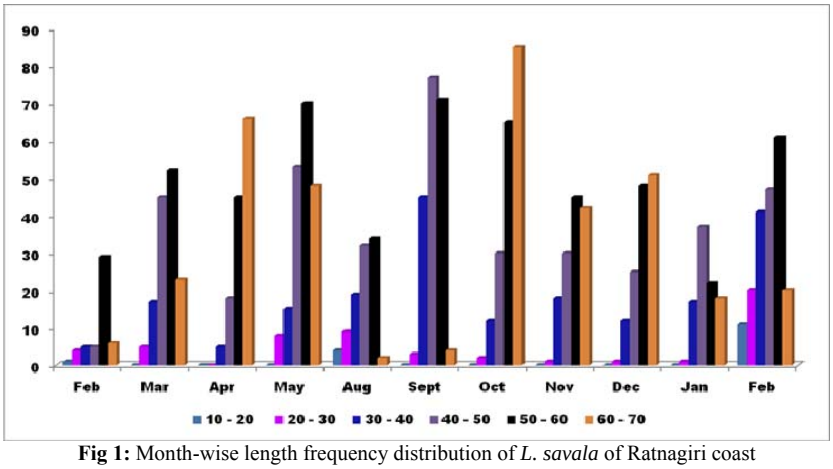

Fig 1: Month-wise length frequency distribution of *L. savala* of Ratnagiri coast

Shifting of the modes to next modal class was evident from the ELEFAN-II analysis. The analysis showed a curve indicating the broods or spawning periods. The first recruitment was observed in February - March and second recruitment was observed in November - December (Projected values) (Fig. 2). From the cumulative frequency calculations, it was observed that *L. savala* attained first maturity at the size of 38 cm. L_∞ calculated for *L. savala* was 68.25 cm, K was 0.55. The length of 43 cm was attained at the end of first year, 58 cm at second year and 65 cm at the end of third year.

Length of the specimens of *L. savala* collected from the Ratnagiri coast ranged from 100 to 700 mm. L_∞ was 68.25 cm, K was 0.55 year $^{-1}$, and the length at first maturity was estimated at 38 cm. It attained 43, 58 and 65 at the end of 1st, 2nd and 3rd years, respectively.

It was pointed out that the two parameters of growth, asymptotic length ($L\infty$) and growth coefficient (K) are inversely related but natural mortality coefficient (M) is directly related to growth coefficient and indirectly related to life span[9]. In another study, the estimated growth parameter of *L. savala* from the east coast as $L\infty$ =1057.14 mm, K = 0.0887 year $^{-1}$ and t_0 = 0.03953 years by employing the Ford-Walford plot[10]. In the study of the age and growth parameters of *L. Savala,* $L\infty$ was estimated at 1057.14 mm, K as 0.0887 and t_0 as - 0.03957 years by fitting the von Bertalanffy growth equation[11]. 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.

In commercial fishery, *L. savala* specimens were recorded in the range of 200 -700 mm[12]. The size distribution of *L. savala* occurring off Bombay ranged in size group of *L. savala* in dolnet was found to vary from 15-19 to 115-119 cm[13]. The widely investigated ribbonfish *T. lepturus* is relatively a large sized species reaching more than 1200 mm while *L. savala* grows to approximately 650 mm[14].

The maximum size of *L. savala* was recorded as 688 mm and the size at 50% maturity was 517 mm[15]. The age of massive maturation was 1.57 years. The higher growth coefficient (K) was 0.87 per year and lower life span was only 3.3 years. It was reported that the highest number of fish frequency (∑f =

215) was observed in 70 cm to 75 cm length group and the lowest (∑f = 2) in 105 cm to 110 cm length group[16]. However, the distribution was found to be normal with minimum numbers in lowest and highest length groups and maximum in mid length groups. The preliminary values of L∞ = 683.3 mm; K = 0.86 year $^{-1}$ and r² = 0.707 were obtained by employing Gulland-Holt method[17]. The regression of mean length (L) and the growth increments (ΔL/Δt) formed basis of the plot of Lα, K and r² with the estimate of 688.02 mm, 0.87 year-1 and 0.508 respectively. *L. savala* grew to the size of 399 mm,
567.2 mm and 637.4 mm at the end of 1, 2 and 3 years respectively. Major recruitment pulse was evident from May-December with peak in October (19%) when 70% recruitment took place and a minor pulse from December-July with peak in March (8%), when remaining 30% fishes were recruited.

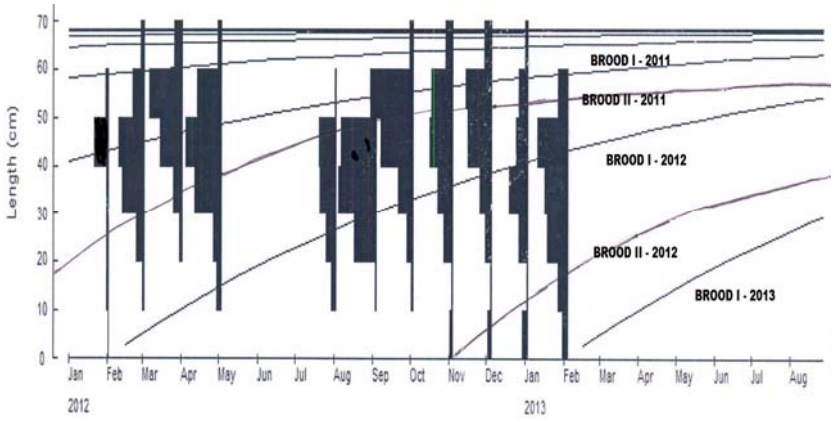

Fig 2: Modal progression analysis of length frequency observed in *L. savala* by using ELEFAN II

Though the L∞ value calculated in the current work is on par with the L∞ values calculated by other workers, *L. savala* occurring along the coast of Ratnagiri appears to attain maturity at length smaller than that reported by other workers. It also showed a slow rate of growth as compared to the length increment per year reported by other workers elsewhere.
Growth parameters of many Trichiurids species were studied by many workers. One of the relatively quick methods involves the study of the length measurements of fish[18]. Lengths of individuals of the same age group in a population of fish are approximately normally distributed. The length frequency distribution generally presents a multimodal curve which can be decomposed into its several normal components. Depending on whether the spawning is annual or biannual, the modes will represent the successive year or half-year classes respectively. This method is useful to find the average size of the few earlier year-classes and with advance in age, the growth slows down, resulting in overlapping of the modes, thereby making it difficult to separate them. The description of early stages was based on the smallest specimen of *L. savala* (61 mm)[19]. From the rate of growth arrived at from the length-frequency distribution these appear to be about two months old. He also reported that the maximum size of *L. savala* was 56.4 cm (S.L.).
The age and growth of *L. savala* was also studied by fitting the von Bertalanffy growth equation with the parameters L∞ = 1057.14 mm, K = 0.0887 and t_0 = - 0.03957 years[11]. The estimated length increments in mm (T. L.) at ages 1 to 6 were recorded as 93.10, 174.96, 249.82, 318.35, 381.06 and 438.44 mm respectively. Some workers have reported that the length range of *L. savala* in commercial fishery was 200-700 mm[12].The size distribution of *L. savala* occurring off Bombay ranged in size group of *L. savala* in Dolnet is from 15-19 to 115-119 cm[13]. The estimated growth parameters L∞, K and t_0 were 688 mm, 0.87 per year and 0.000251 respectively, for *L. savala*[15].
The growth parameters of *L. savala* such as L∞ and K were obtained by many workers[17, 20, 21]. The t_0 found by von Bertalanffy's plot is 0.000251 year $^{-1}$. The VBGF of growth for the species is expressed as: $Lt = 688 \{1\text{-}e^{(-0.87 (t - 0.000251)}\}$.
From the expression it was found that *L. savala* grew to the size of 399 mm, 567.2 mm and 637.4 mm at the end of 1, 2 and 3 years respectively. The largest specimen measured was 650 mm, the estimated age of which was 3.3 years. Also by pooling annual length-frequency, it was seen that there were two overlapping pulses of recruitment. Major recruitment pulse was evident from May-December with peak in October (19%) when 70% recruitment took place and a minor pulse from December-July with peak in March (8%), when remaining 30% fishes were recruited. The selection of probability of capture gave L∞ for *L. savala* as 463.3 mm in trawl, with input parameters of L∞ = 688 mm, K = 0.87, a = 0.00000108 g cm^{-1}, b = 3.6117, the terminal exploitation ratio of 0.55 was obtained by iteration for *L. savala*.

3.2. Length weight relationship

Data for all the four groups were analysed separately and following regression equations have been obtained; see in Table 2 and Fig. 3 to 6, 'x' variable as length and 'y' variable as weight. It was found that out of the total 680 specimens examined for the length-weight relationship 233 males (TL =26.7-65 cm, W= 10 to 198 gm), 305 were female (TL =31.4 - 70 cm, W= 14 to 280 g) and 142 were the indeterminates (TL = 25-58 cm, W= 8 to134 g). Independent statistical analysis of their length and weight relationship gave the following regression equations.

1. Male : Log W = -3.2801+3.0311 Log L
2. Female : Log W = -3.8222 +3.3608 Log L
3. Indeterminate : Log W = -3.4377+3.1173 Log L

4. Total : Log W = -3.6049+3.2285 Log L

The analysis of covariance indicated that there was no significant difference in the slopes of male, female and indeterminates samples (P >0.05). The t-test was employed to ensure isometric growth, within the groups. The asymptotic length (L∞) obtained using ELEFAN II software in the present study was 68.25 cm, K (yearly) was 0.86 and t_0 was calculated as 0.00029. Size at first maturity was recorded at 38 cm (Fig. 2).

In the present study, the scatter diagram of weight on total length in *L. savala* indicated that the relation to the general pattern of isometric growth. The length-weight regression equations reveal that the weight of fish increased at a rate lower than the cube of length. The difference in regression coefficients between male and female were not significant at 5% level. The 'a' and 'b' values of the length-weight relationship for males were -3.2801 and 3.0311 respectively, for females, -3.8222 and 3.3608 respectively and for indeterminates, -3.4377 and 3.1173 respectively.

The length-weight relationship of fishes was calculated primarily with a twofold aim[8]. First to determine the mathematical relationship between the two variables, length and weight, so that if one was known the other could be computed. Second aim was to measure the variations from the expected weight for length of individual fish or groups of fish as indications of fatness, general well-being or gonad development. It was stated that important departures from isometric growth (n = 3.0) were rare[9].

The length-weight relationship of *L. savala* for the two sexes together was calculated as Log W = -5.5396+3.30715 Log L in which the length was measured from snout to vent[22]. He found that the exponent 'b' was significantly different (p <0.05) from 3. The author also reported the length-weight relationship as Log W = 5.5396+3.30715 Log L, where W was weight in grams and L represented the snout-vent length in mm. The exponent was found to be significantly different from 3.

It was reported[11] that the changes in morphology with increasing age, however, often cause the coefficient of regression of logarithm of weight on logarithm of length to depart substantially from 3.0. The value of the exponent 'n' in the parabolic equation[23, 24] usually lies between 2.5 and 4.0 and for ideal fish which maintains constant shape[25], n = 3. The exponent b lies between 2.5 and 3.5, usually close to 3. Thus, the growth of *L. savala* was found to be isometric[6]. The length-weight relationship of 1119 specimens of *L. savala* (Cuvier, 1829) from the Bay of Bengal, Bangladesh was studied and it was found to be curvilinear (W = 0.0003612 TL3.18) and linear (Log W = -3.44+3.18 Log TL) for both the sexes combined in arithmetic and logarithmic scales, respectively[16]. The values of regression co-efficient (b) ranged from 3.002 to 3.337 at 95% confidence limit. The regression "b" value (3.18) followed the cube law and did not significantly (P >0.05) differ from the cube. The growth of the fish was found to be isometric.

The length-weight relationships[17] in *L. savala* males was reported as Log W = -6.7808+3.1671Log L (r = 0.83), in females Log W = -7.4918+3.4409 Log L (r=0.85), pooled equation was Log W = -7.9652+3.6117 Log L (r=0.96) and the combined equation was W = 0.00000001 L 3.6117. It was estimated that the length and weight measurements of males *L. savala* were 282 – 585 mm and 8.4 – 104.6 g and for females, 315–601 mm and 13.5–235.6 gm, respectively[26].

Estimated length weight relationships reported in the study of *L. savala,* for males was Log W = -6.7808+3.1671Log L and for females, Log W = -7.4918+3.4499 Log L. In the males the k values were higher in the length group of 321-340 mm and in 581-620 mm;

Table 2: Linear Regression equations of length-weight relationship of males, females and indeterminates of *L. Savala*

Parameters	Equation	a	b	r	n
Males	Log W = -3.2801+3.0311 Log L	-3.2801	3.0311	0.89	233
Females	Log W = -3.8222 +3.3608 Log L	-3.8222	3.3608	0.92	305
Indeterminates	Log W = -3.4377+3.1173 Log L	-3.4377	3.1173	0.89	142
Total	Log W = -3.6049+3.2285 Log L	-3.6049	3.2285	0.92	680

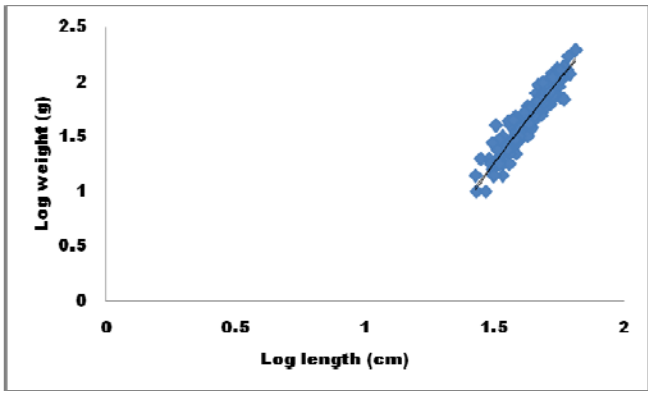

Fig 3: Logarithmic relationship between length and weight in the males of *L. savala.*

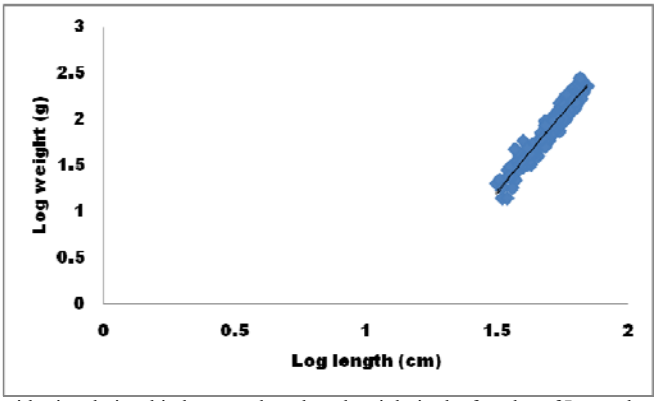

Fig 4: Logarithmic relationship between length and weight in the females of L. savala

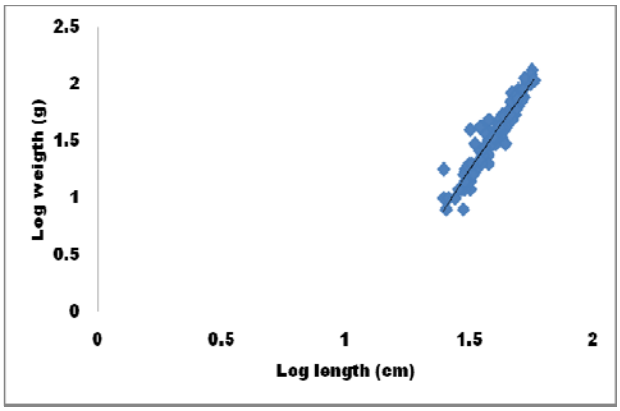

Fig 5: Logarithmic relationship between length and weight in the indeterminates of *L. savala*

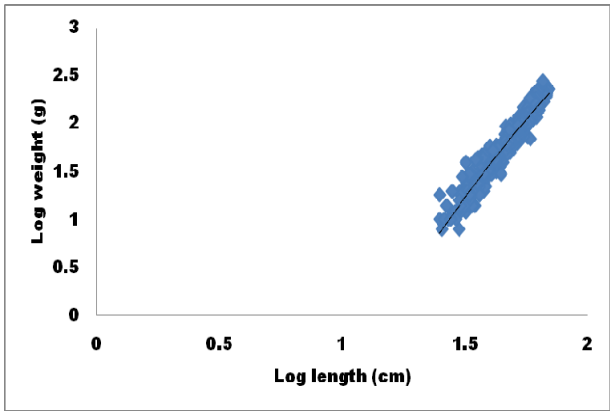

Fig 6: Logarithmic relationship between length and weight in the total of *L. savala*

the values were minimum in 261-300 mm group. For the females, a sharp increase in k value was noticed only after 541-580 mm. Another study of this fish reported that the total length and weight of *L. savala* ranged from 15 cm to 40 cm and 80 gm to 950 gm respectively[27]. The parabolic equations and the logarithmic regression equations obtained were represented as for males, W = 0.000011 L 2.8948 (r = 0.857) and Log W = - 4.715+2.8948 log L (r = 0.858), for females, W = 0.000014 L 2.5170 (r = 0.825) and Log W = -3.7508+2.5170 log L (r = 0.76). The pooled equations were W = 0.000013 L 2.7146 (r = 0.815) and Log W = -4.3183+2.7146 log L (r = 0.763). The study postulated negative allometric growth in *L. savala.*

Some workers expressed the length-weight relationship of *L. savala* for the two sexes together as Log W = -5.5396+3.30715 Log L in which the length was measured from snout to vent[10]. He found that the exponent 'b' was significantly different ($p < 0.05$) from 3. In the present study also 'b' was significantly different for *L. savala* thus exhibiting allometric growth. Similarly, the length-weight relationship was studied in 102 fish measuring 22.5 to 46.5 cm in length[28]. The following regression equation describes the logarithmic relationship between the length and weight in *E. glossodon*: Log W = -29398+2.8202 Log L.

The length-weight relationship based on study of 1,021 specimens ranging from 46.5 to 124.4 cm and weighing 50 to 1500 gm was expressed as Log W = Log –3.8448 +3.352 Log L ($r^2 = 0.924$)[29].

The von Bertalanffy growth curve was fitted to the TL and age (in years) for *L. savala* and it was found out to be $Lt = 115.90 \{1\text{-}e^{-0.3021(t+1.0254)}\}$ ($n = 64$, $r^2 = 0.76$) for males, $Lt = 128.37 \{1\text{-}e^{-0.3918(t+1.1021)}\}$ ($n = 296$, $r^2 = 0.81$) for females, and $Lt = 127.40 \{1\text{-}e^{-0.3994(t+0.9815)}\}$ ($n = 378$, $r^2 = 0.89$) for all fish combined[30].

A total of 7,352 specimens of *L. savala* in the length range of 75 to 650 mm were measured during the two-year period[17]. Weight asymptote (W∞) was calculated as 194 gm. For length-weight relationship of *L. savala,* a total of 608 specimens ranging from 80 to 623 mm in total length and 0.2 to 235 gm in total weight were measured. The specimens comprised of 220 females ranging from 315 to 623 mm in length and 13.5 to 235.6 gm in weight, 123 males ranging from 282 to 585 mm in length and 8.4 to 104.6 gm in weight. The remaining 265 specimens were indeterminate juveniles ranging in size from 80 to 281 mm in length. The length-weight relationships of *L. savala* in logarithmic form were shown as:

Males: Log W = - 6.7808+3.1671Log L (r = 0.83)
Females: Log W = -7.4918+3.4409 Log L (r = 0.85)
Pooled: Log W = -7.9652+3.6117 Log L (r = 0.96)
For sexes combined: W= 0.00000001 L 3.6117

Similarly, a total of 608 specimens of *L. savala* ranging from 80-623 mm in total length and 0.2-235 g in weight including 265 indeterminate specimens ranging in length from 80-281 mm were studied. In the males of *L. savala*, the k values were higher in the length group of 321-340 mm and in 581-620 mm; the values were minimum in 261-300 mm group. For the females, a sharp increase in k value was noticed only after 541-580 mm[26].

4. Conclusion

In the present study also 'b' was significantly different for *L. savala* thus exhibiting allometric growth. The regression coefficient 'b' indicated that the weight of fish increased more or less in proportion to the cube of its length, but the females grew faster by weight than the males, as their exponential values are more. L_∞ calculated for *L. savala* was 68.25 cm, K was 0.55. *L. savala* attained 43 cm in first year, 58 cm in second year and 65 cm in third year. The length frequency analysis showed that the first recruitment occurred in February - March and second recruitment was observed in November – December.

5. References

1. Nair RPN, Prakasan D. Status of exploited marine fishery resources of India. Joseph MM, Jayaprakash AA, (Eds.), CMFRI, Cochin, 2003, 76-87.
2. Nair PNR, Alexander K, Muthiah C, Lazarus S, Thiagarajan R, Khan MZ *et al.* Occurrence of ribbonfish in the Indian EEZ Council of Scientific & Industrial Research Pusa Campus New Delhi. Proc Second Workshop Scien Resul FORV Sagar Sampada 1996; 429-436.
3. Anon. FAO FISHSTAT PLUS, www.fao.org/fi/statist/FISHPLUS. 2010.
4. Anon. Maharashtra fish production report. Dept of Fishery, Govt of India, 2012, 131.
5. Gayanilo FCJr, Sparre P, Pauly D. The FAO-ICLARM Stock Assessment Tools (FiSAT) User's Guide. FAO Computerized Information Series (Fisheries) 1996; 8:126.
6. Pauly D, David N. ELEFAN-I a basic programme for the objective extraction of growth parameters from length-frequency data. Meeresforschung 1981; 28:205-211.
7. Gayanilo FCJr, Sparre P, Pauly D. FAO – ICLARM Stock assessment tool (FiSAT). Revised version. User's Guide 2005; 8:168.
8. LeCren CD. The length-weight relationship and seasonal cycle in gonad weights and condition in the perch (*Perca fluviatilis*). J Anim Ecol 1951; 20:201-219.
9. Beverton RJH, Holt SJ. A review of the life-spans and mortality rates of fish in nature, and their relationship to growth and other physiological characteristics. CIBA Foundation Colloquia on Ageing 1959; 54:142–180
10. Gupta MV. Studies on the taxonomy biology and fishery of ribbonfishes of the Hooghly estuarine system. 1. Taxonomy of ribbon fishes. Proc Zool Soc Calcutta 1967; 20:1-23.
11. James PSBR, Narasimham KA, Meenakrhisunderam PT, Sastry YA. Present status of ribbonfish fishery in India. CMFRI Special Publication 1986; 24:1-49.
12. Murty VS, Beadyopadhyay MK, Ramalingam P, Marine fish calendar, CMFRI, V. Kakinada, (Eds), CMFRI Cochin India 1988; 83:18.
13. Lazarus S, Scariah KS, Khan MZ, Veleyudhan AK. Present status of exploitation of fish and shellfish resources. Ribbonfishes Bull Cent Mar Fish Res Inst 1992; 45:121-132.
14. Thiagarajan RS, Lazarus Y, Appanasastry MZ, Khan M, Kasim H, Scariah KS. Stock assessment of the ribbonfish, *Trichiurus lepturus* Linnaeus, from the Indian waters. Ind J Fish 1992; 39:182-194.
15. Rizvi AS, Biradar RS, Chakraborty SK, Deshmukh VD. Estimation of mortality rates, exploitation rates and ratios of *Lepturacanthus savala* (Cuvier) and *Eupleurogrammus muticus* (Gray). Ind J fish 2005; 52:93-98.
16. Azadi MA, Ullah M. Lenght-weight relationship and relative condition factor of the ribbon fish *Lepturacanthus savala* (Cuvier, 1829) from the Bay of Bengal, Bangladesh. The Chittagong Univ J B Sci 2008; 3(1&2):119-126.
17. Razvi AF, Deshmukh VD, Chakraborty SK. Stock assessment of *L. savala* (Cuvier1829) along north-west sector of Mumbai coast in Arabian Sea. Ind J fish 2010; 57(2):1-6.
18. James PSBR. The ribbonfishes of the family *Trichuridae* of India- Life history, Memoir of *Mar*. Bio Ass of India 1967; 226.
19. Bal DV, Rao KV. Marine fisheries, (Ed.) Tata McGraw Hill Publishing Company Ltd., New Delhi 1984, 455.
20. Bhattacharya CG. A simple method of resolution of a distribution into Gaussian components. Biometrics 1967; 23:115-135.
21. Gulland JA, Holt SJ. Estimation of growth parameters for data at unequal time intervals. J Cons CIEM 1959; 25(1):47-49.
22. Gupta MV. Studies on the taxonomy biology of ribbonfishes (Trichiuridae) of the Hooghly estuarine system 2. Biology of *Trichiurus savala* Cuvier Proc Zool Soc Calcutta 1967; 20:153-170.
23. Hile R. Age and growth, of the cisco, *Leucichthys artedi* (Le Sueur) in the laks of-the north-eastern highlands Wisconsin. Bull U S Bur Fish 1936; 48:211-317.
24. Martin WR. The mechanics of environmental control of body form in fishes. Univ Toronto Stud Biol 58. Publ Ont Fish Res Lab 1949; 70:1-91.

25. Allen KR. Some observations on the biology of the trout *(Salmo trutta)* in Windermere. Ibid 1938; 7:333-349.
26. Chakravarty MS, Pavani B, Ganesh PRC. Length-weight relationship of ribbon fishes: *Trichiurus lepturus* (Linnaeus, 1758) and *Lepturacanthus savala* (Cuvier, 1829) from Visakhapatnam coast. J Mar Biol Ass India 2012; 54:99-101.
27. Rizvi AF, Deshmukh VD, Chakraborty SK. Comparison of condition factor of the ribbonfish *Lepturacanthus savala* (Cuvier, 1829) and *Eupleurogrammus muticus* (Gray, 1831) from Mumbai coast. J Mar Biol Ass India 2012; 54:26-29.
28. Narasimham KA. Some observation on the biology of the ribbon fishes, *Eupleurammlus muticus* (Gray). Indian J Fish 1976; 21:497-494.
29. Khan MZ. Fishery resource characteristics and stock assessment of ribbonfish, *Trichiurus lepturus* (Linnaeus). Indian J fish 2006; 53:1-12.
30. Nahdi AA, Marzouqi AA, Rasadi A, Groeneveld JC. The size composition, reproductive biology age and growth of largehead cutlassfish *Trichiurus lepturus* Linnaeus from the Arabian Sea coast of Oman. Indian J Fish 2009; 56:73 -79.