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Growth and Mortality Parameters of Hairtail *Lepturacanthus savala* from Pakistan Waters

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ABSTRACT

The length-frequency data of *Lepturacanthus savala* (Cuvier 1829) were collected by the four demersal trawl surveys in the Pakistan waters in 2009-2010. A total of 4035 lengths and 1391 pairs of length-weight were measured. The length ranges from 5 to 127cm with an average length of 44.23±19.75cm while weight ranges from 1 to 1942g with an average weight of 110.81±229.57 g. The estimated values of length-weight relationship for *L. savala* were $W=0.0001^{*}L^{3.191}$ (R^2=0.960) n=1391.The calculated von Bertalanffy growth function parameters using ELEFAN method in FISAT computer package of *L. savala* were $L\infty$=133.35cm and k=0.130 year^{-1} and t_0=-0.877. The estimated rate of total mortality Z applying the length-converted catch curve analysis method for *L. savala* was Z=0.49 year^{-1}, natural mortality M were estimated as M=0.304 year^{-1} at an annual average sea surface temperature of 26°C while the rates of fishing mortality F was calculated as F=0.185 year^{-1}. Hence, exploitation ratio ($E=F/Z$) were calculated as 0.377 year^{-1}. Yield per recruit contour map reveals that when t_c was assumed to be 1, F_{max} was estimated at 0.6 and $F_{0.1}$ at 0.45. Current age at first capture was about 1 year and $F_{current}$ was 0.185, therefore, $F_{current}$ was smaller than $F_{0.1}$ and F_{max}. When biological reference point F_{opt} was equal to M (0.304), the current fishing mortality rate of 0.185 is smaller than the target biological reference point. The estimated values of growth performance index for the *L. savala* from Pakistan waters were ϕ' =3.364 year^{-1}. The estimated value of *MSY* was 26983t with the estimated biomass of 110135t. Again the obtained results of maximum sustainable yield (*MSY*) of 26983t for *L. savala* from Pakistan waters were larger than the recent catch of 20375t; therefore, we may indicate that the *L. savala* fishery in Pakistan waters may be in a sustainable state.

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QL supervised and designed the study. KHM executed the experimental work, analyzed the data and wrote the article with the help of other coauthors.

Key words:
***Lepturacanthus savala*, biological reference points, mortality parameters, growth parameters, length-weight relationship.**

INTRODUCTION

Lepturacanthus savala (Cuvier, 1829) (Sueo, 1976; Nakamura and Parin, 1993), a commercial marine fish are commonly known as ribbonfish, hairtail, talwar, tinji and chindi in Pakistan belongs to family Trichiuridae (Bianchi, 1985; Romero, 2002). It is a benthopelagic and amphidromous fish (Riede, 2004) found in tropical waters (Nakamura and Parin, 1993) along the coastal waters of Indo-west Pacific and Indian Ocean (Bianchi, 1985; Nakamura and Parin, 1993). Its length ranging from 30cm to 87cm with a maximum length of about 100cm, while its common length is about 70cm (Nakamura, 1984).

In Pakistan, China, India and Sri Lanka the shore seines, bagnets and coastal bottom trawls are used to catch this species and is being exported in frozen as well as dry salted form. The handbook of fisheries statistics of Pakistan reported that the annual catch of *L. savala* from Pakistani waters ranges from 31623t (1999) to 20375t (2009). Rizvi and Nautiyal (2002) stated that the peak breeding season of the species was in December and May. It reproduces in fresh waters and newly hatched larvae move to the sea. The larvae of the species feed and grow for few months in marine waters until juveniles stage which then move to freshwater for further feeding and growing until maturation and reproduction (Riede, 2004).

There is no published work available for the estimation of growth and mortality parameters using length-frequency data of the species from Pakistan waters. There is, however, some published work available in recent years for the stock assessment of some other species from Pakistani water such as brush tooth lizardfish, *Saurida undosquamis* (Kalhoro *et al*., 2014); barramundi, *Lates calcarifer* (Memon *et al*., 2014); Bombay duck, *Harpodon nehereus* (Kalhoro *et al*.,

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2013); greater lizardfish *Saurida tumbil* using CEDA and ASPIC packages by (Ali *et al*., 2015), and anadromous fish *Tenualosa ilisha* (Family Clupeidae) (Panhwar *et al*., 2011). Keeping this in view, we attempted to estimate the growth and mortality parameters of the *L. savala* using length-frequency data from the Pakistan waters. The obtained results could be beneficial for the fishery managers to manage the stocks of the commercially important species at a sustainable level in future.

Since it is difficult to collect age-structured data in tropical fisheries, the length-frequency data are generally used for the stock assessment (Spare and Venema, 1998) and for the estimation of parameters such as growth and mortality rates of the species (Kohler *et al*., 1995). The main focus of this study was, therefore, to estimate the growth and mortality parameters using the length-frequency data of the *L. savala* from Pakistan waters.

MATERIALS AND METHODS

Data collection

The length-frequency data were collected by the four demersal trawl surveys from Pakistan waters in 2009-2010. Three vessels were used to conduct the demersal trawl surveys. During 2009 R/V 'Ferdows-1' Iranian research vessel were used. This vessel is a stern trawler (685 GRT, 45.4 m LOA) and well equipped with Global Position System (GPS), ITI net sounder system, two echo sounders and bottom trawl net (mesh size of cod end 80 mm and headline 72 m). During 2010 R/V Dr. Fridtjof Nansen was used which is originally Norwegian research vessel (1444, gross tonnage, (gt) 56x12 m) with bottom trawl having a headline of 31 m, footrope 47 m and 20 mm mesh size in the cod-end with an inner net of 10 mm mesh size. The trawl height was 4.5 m and distance between wings during towing about 21 m. The sweeps were 40 m long and well equipped with all scientific and modern research facilities. The third fishing vessel Mahboob-E-Madina a local fishing vessel was used to conduct the research survey (69 gt, 18.15 m length overall, 10.8 m beam bottom trawl with mesh size 50 mm and cod end 25 mm) with depth sensor and GPS.

Of 250 randomly selected stations, *L. savala* were caught from 70 stations during the month of October in 2009 and during the months of August, October and November in 2010. For each trawl, the date, time, trawl duration, bottom depth, GPS position, towing speed etc. were recorded. Each trawl was standard tow about 30 minutes with an average speed about at 3.5 knots. The fishes were identified using taxonomic identification sheets (Fischer and Bianchi, 1984) and field guide (Bianchi, 1985). The length-weight and length frequency data were recorded on board during those surveys.

A total of 4035 lengths and 1138 in October in 2009 and 1652 in August, 140 in October and 1105 in November 2010 and 1391 pairs of length-weight were estimated. The total length (TL) was measured to 1cm and weight was measured to 1g. The length ranges from 5 to 127cm with an average length of 44.23±19.75cm, while weight ranges from 1 to 1942g with an average weight of 110.81±229.57 g (Fig. 1).

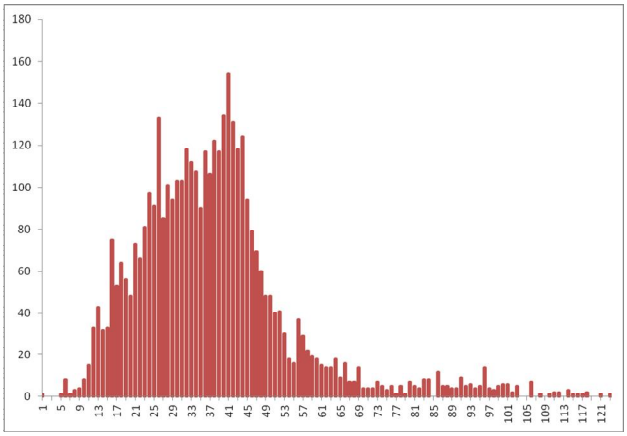

Fig. 1. Length frequency distribution of *L. savala* in Pakistan waters.

For the estimation of maximum sustainable yield (MSY) of the species, the data of most recent catch of 2009 were taken from the handbook of fisheries statistics of Pakistan published by Marine Fisheries Department, Government of Pakistan, Karachi.

Data analysis

Length-frequency data of *L. savala* were analyzed FISAT II (FAO-ICLARM stock assessment tool, Gayanilo *et al*., 2003) for the estimation of growth, mortality rate, biological reference points, growth performance index, and relative yield per recruit analysis.

Length-weight relationship

For estimation of the length-weight relationship the power function was used: $W = aL^b$

where W was the weight of fish in g, L was the length of fish in cm, a was constant condition factor and b was slope.

Growth

Von Bertalanffy's growth function (VGBF) was used to estimate the length with age of *L. savala* as:

$$L_t = L_\infty (1 - \exp(-k(t=t_0)))$$

where L_t was the length at age t, L_∞ was the asymptotic average maximum length, K was the growth coefficient and t_0 was the theoretical age with length at zero (Haddon, 2011) which can be calculated using the empirical equation of Pauly (1983) as

$$\log_{10}(-t_0) = -0.3922 - 0.275 \log_{10} L_\infty - 1.0381 \log_{10} k$$

Mortality

The annual total mortality rates (Z) were estimated using the length-converted catch curve analysis method (Pauly, 1983).

$$\ln(N_i / \Delta t_i) = a + b\, t_i$$

where N_i is the number of fish in length class i, Δt_i is the time needed for the fish to grow through length class i, t_i is the age (or the relative age, computed with $t_o = 0$) corresponding to the mid-length of class i, and where b, with sign changed, is an estimate of Z.

Following the Pauly's empirical formula the coefficient of natural mortality was estimated by:

$$\log_{10}(M) = 0.006 - 0.279 \log_{10}(L_\infty) + 0.654 \log_{10}(k) + 0.6434 \log_{10}(T)$$

where L_∞ was in cm and K was in per year. T was the annual average sea surface temperature which is 26°C in Pakistani waters. Fishing mortality (F) was estimated by subtracting (M) from (Z), the exploitation ratio E was calculated from F/Z.

Biological reference points

The biological reference points were estimated following the Gulland (1969) method $F_{opt} = M$.

Beverton-Holt Y/R analysis

The Beverton-Holt yield per recruit model was used, applying the following equation:

$$Y_w / R = F W_\infty e^{M(t_c - t_r)} \sum_{n=0}^{3} \frac{Q_n e^{-nk(t_c - t_0)}}{F + M + nk} (1 - e^{-(F+M+nk)(t_\lambda - t_c)})$$

where Y_2/R was yield per recruitment, t_c was mean age at first capture of fish, t_r was recruitment age, t_λ was asymptotic age, Q_n was constant value equal to 1, -3, 3 , -1 when n was 0, 1, 2, 3, respectively (Pitcher and Hart, 1982).

Growth performance index

The equation of Pauly and Munro (1984) was used to estimate the growth performance index, ϕ of *L. savala* from Pakistan waters.

$$\phi = \log_{10} k + 2 \log_{10} L_\infty$$

Maximum sustainable yield (MSY)

Maximum sustainable yield of the *L. savala* was calculated using the equation of Gulland (1979) as**:**

$$MSY = Z \times 0.5 \times B$$

where Z was the total mortality and B was the biomass. The biomass (B) was estimated from the ratio Y/F, where Y was the annual yield in tons of the species from Pakistani waters and F was the fishing mortality. The annual yield (Y) of the species was 20375t during the year 2009.

RESULTS

Length-weight relationship

The values of length-weight relationship for the *L. savala* from Pakistan waters were estimated as: a= 0.0001, b=3.191 and ($R^2 = 0.960$) $n = 1391$.

Figure 2 shows the length-weight relationship of *L. savals.*

Growth

The calculated von Bertalanffy growth function parameters of *L. savala* using ELEFAN method in FISAT were L_∞ = 133.35 cm and k = 0.130 year^{-1} (Fig. 3) and t_0 = -0.877, while the estimated values of goodness of fit of model estimation were R_n = 0.22**.**

Mortality

The estimated rate of total mortality Z applying the length-converted catch curve analysis method for *L. savala* were Z = 0.49 year^{-1} (Fig. 4) since the natural mortality M were estimated as M = 0304 year^{-1} at an annual average sea surface temperature of 26°C in Pakistan while the rates of fishing mortality F were calculated as F = 0.185 year^{-1}. Hence, exploitation Ratio (E=F/Z) were calculated as 0.377 year^{-1}.

Biological reference points

Yield per recruit contour map (Fig. 5) reveals that when t_c was assumed to be 2, F_{max} was estimated at 0.8 and $F_{0.1}$ at 0.6, when t_c was assumed to be 1, F_{max} was estimated at 0.6 and E_{10} at 0.45. Current age at first capture was about 1 year and $F_{current}$ was 0.185, therefore, $F_{current}$ was smaller than $F_{0.1}$ and E_{max}. When biological reference point F_{opt} was equal to M (0.304), the current fishing mortality rate of 0.185 is smaller than the target biological reference point. The optimum exploitation ratios were computed as E_{max} = 0.42, E_{10} = 0.355, E_{50} = 0.278.

Growth performance index

The parameters of $\phi = \log_{10} k + 21 \log_{10} L_\infty$ have been remarkably constant between different populations of the same species, as long as similar units and definitions are

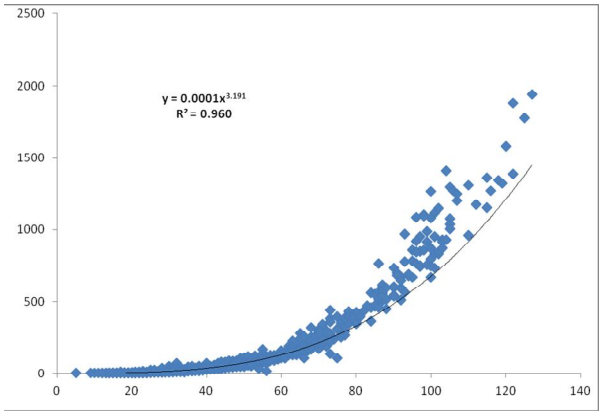

Fig. 2. Length-weight relationship of *L. savala* in Pakistan waters.

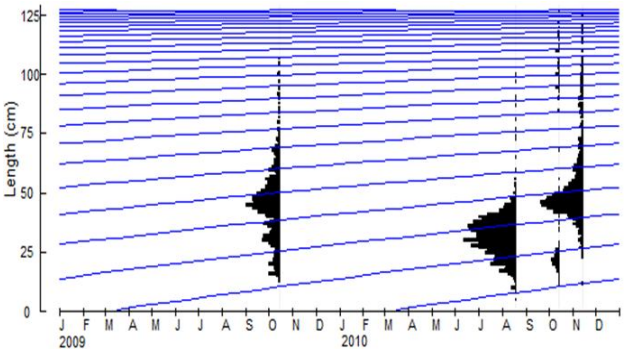

Fig. 3. Length Frequency distribution data and growth curves estimated using ELEFAN method for *L. savala* in Pakistan waters.

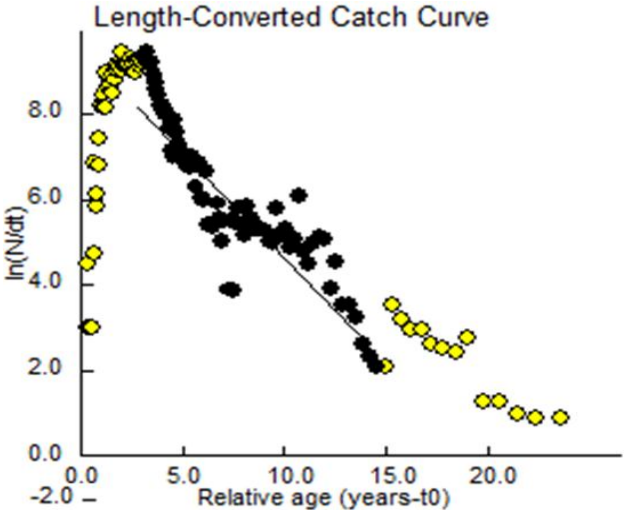

Fig. 4. Length converted catch curve analysis of *L. savala* in Pakistan waters.

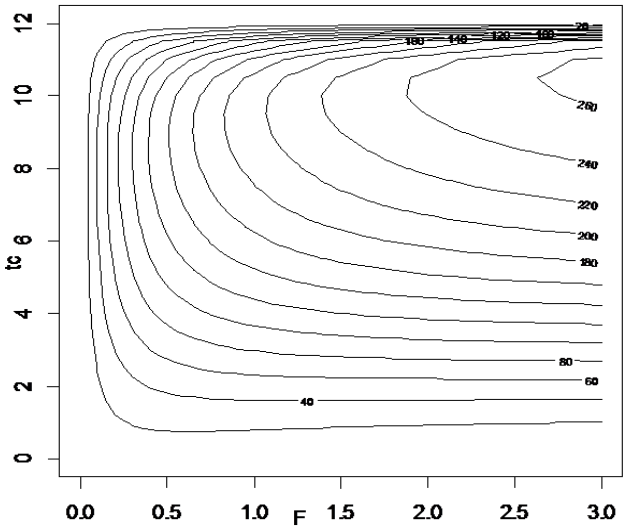

Fig. 5. Yield per recruit contour map of *L. savala* in Pakistan waters.

used *e.g.* cm and total length for asymptotic length L_∞ and year^{-1} for K and base 10 for the logarithms. The estimated value of growth performance index for the *L. savala* from Pakistan waters was $\phi = 3.364$ year^{-1}.

Maximum sustainable yield (*MSY*)

The estimated values of MSY were 26983t; the estimated biomass was 110135t.

DISCUSSION

Length-weight relationship

The length-weight relationship of the fish species provides the knowledge about the seasonal changes in their specific environment, the physical well-being of the fish. It also determines the growth of the fish whether it is isometric or allometric because the information about the growth of the fish is considered to be an important aspect of the study of the fish population dynamics. The statistical correlation between the length and weight has meaningful importance for the estimation of the weights of the fish of known lengths.

Bianchi (1985) reported that only two species of family *Trichiuridae* including *L. savala* and *Trichiurus lepturus* were observed in Pakistani waters. The estimated length-weight parameters for *L. savala* in the present study were compared to the length-weight parameters of *L. savala* and *T. lepturus* from different countries of the world (Table I).

The observed values of *a*, *b* and R^2 for the *L. savala* and *T. lepturus* from the other parts of the world were about the same to the estimated values of *L. savala* in this

Table I.- Length-weight parameters of *L. savala* in comparison with *L. savala* and *T. Lepturus* from different countries.

Location	Species		*a*	*b*	R^2	Source
Bangladesh	*Lepturacanthus savala*	Both Sex	0.0003	3.18	0.996	Azadi *et al*. (2008)
Visakhapatnam	*Lepturacanthus savala*	♂	0.00001	2.894	0.857	Myla *et al*. (2012)
		♀	0.000014	2.517	0.825	
Visakhapatnam	*Trichiurus lepturus*	♂	0.000012	2.9925	0.698	Myla *et al*. (2012)
		♀	0.000013	2.9329	0.878	
India	*Lepturacanthus savala*	Both sex	0.00025	3.229	0.92	Pakhmode *et al*. (2013)
Yemen	*Lepturacanthus savala*	♂	0.01300	2.776	0.97	Al-Sakaff and Esseen (1999)
		♀	0.01100	2.814	0.966	
Mumbai coast	*Lepturacanthus savala*	Both sex	0.00000001	3.611	0.962	Rizvi *et al*. (2010)
Ratnagiri	*Lepturacanthus savala*	Both sex	0.0006049	3.2285	0.92	Pakhmode *et al*. (2013)
Mumbai coast	*Lepturacanthus savala*	♂	0.0000007	3.167		Rizvi *et al*. (2012)
		♀	0.0000000.5	3.44	-	
Karnataka	*Lepturacanthus savala*	♂	0.00000063	3.963	0.686	Kudale / Jadhav and Rathod (2014)
		♀	0.00000046	3.578	0.969	
Kakinada	*Trichiurus lepturus*	Both sex	0.000095	3.6437	0.885	Narasimham (1970)
Karachi Coast	*Trichiurus lepturus*	Both sex	0.0677	2.65	-	Tabassum *et al*. (2013)
	Lepturacanthus savala	Both sex	0.087	2.821	-	
Visakhapatnam	*Trichiurus lepturus*	♂	0.00273	3.2458		Reuben *et al*. (1997)
		♀	0.000223	3.9862	0.96	
India	*Trichiurus lepturus*	♂	0.000042	3.587	0.98	Ghosh *et al*. (2009)
		♀	0.0009	3.438	0.95	
Saurastara	*Trichiurus lepturus*	Both sex	0.000032	3.6163	0.87	Fofandi (2012)
Visakhapatnam	*Trichiurus lepturus*	♂	0.0003	3.12	0.96	Satria *et al*. (2007)
		♀	0.0001	3.36	-	
Pakistan	*Lepturacanthus savala*	Both sex	0.0001	3.191	0.960	Present Study

Table II.- Growth parameters of *L. savala* in comparison with *L. savala* and T. Lepturus from different countries.

Locality	Species	L_∞	*K*	T_0	Method	Source
Ratnagiri Coast	*Lepturacanthus savala*	68.25	0.55	-0.0396	LF	Pakhmode *et al*. (2013)
Mumbai Coast	*Lepturacanthus savala*	68.8	0.87	-0.0003	LF	Rizvi *et al*. (2010)
Oman	*Trichiurus lepturus*	127	0.39	-0.9	LF	Ben Meriem *et al*. (2004)
Bay of Bangel	*Lepturacanthus savala*	108	0.75	-	-	Ashraful (1998)
Saurastara Coast	*Trichiurus lepturus*	131.3	0.13	-0.0777	LF	Fofandi (2012)
India	*Trichiurus lepturus*	134.1	0.29	-0.0527	LF	Ghosh *et al*. (2009)
Bangladesh	*Lepturacanthus savala*	105.4	0.68	-	LF	Khan *et al*. (2003)
Mauritania	*Trichiurus lepturus*	147	0.29	-0.46	OT	Pauly (1978)
South Africa	*Trichiurus lepturus*	146	0.29	-	-	Torres (1991)
Taiwan E. Coast	*Trichiurus lepturus*	129	0.27	-0.22	OT	Chen and Lee (1982)
Taiwan S. W. Coast	*Trichiurus lepturus*	131	0.34	-0.39	OT	Chen and Lee (1982)
Taiwan S. W. Coast	*Trichiurus lepturus*	133	0.29	-0.76	OT	Chen and Lee (1982)
Kakinada India	*Trichiurus lepturus*	145.4	0.29	-0.2	FW	Narasimham (1976)
N. Persian Gulf	*Trichiurus lepturus*	124	0.91	-0.011	-	Raeisi *et al*. (2012)
Bombay waters	*Trichiurus lepturus*	129.7	0.5	-	LF	Chakraborty (1990)
Philippines	*Trichiurus lepturus*	78	0.7	-	LF	Ingles and Pauly (1984)
Philippines	*Trichiurus lepturus*	66	0.4	-	LF	Ingles and Pauly (1984)
Philippines	*Trichiurus lepturus*	64.5	0.410	-	LF	Ingles and Pauly (1984)
Japan	*Trichiurus lepturus*	43.4	0.298	-	FW	Pauly (1978)
Japan	*Trichiurus lepturus*	45.4	0.411	-	OT	Pauly (1978)
Japan	*Trichiurus lepturus*	50	0.29	-	OT	Pauly (1978)
Vishakhapatnam	*Trichiurus lepturus*	106.8	0.61	-0.1399	LF	Reuben *et al*. (1997)
India	*Trichiurus lepturus*	109	0.640	-	-	Somvanshi and Joseph (1989)
Pakistan	*Lepturacanthus savala*	133.4	0.13	-0.877	LF	Present Study

LF, Length-frequency; OT, otoliths; FW, Ford / Walford plot.

Table III.- Mortality parameters of *L. savala* in comparison with *L. savala* and *T. Lepturus* from different countries.

Locality	Species	*Z*	*M*	*F*	Source
Bangladesh	*Lepturacanthus savala*	2.06	1.33	0.73	Khan and Latif (1997)
Bay of Bengal	*Lepturacanthus savala*	2.58	1.54	1.04	Ashraful (1998)
Bay of Bengal	*Lepturacanthus savala*	1.89	1.08	0.81	Ashraful (1998)
Bay of Bengal	*Lepturacanthus savala*	2.06	1.33	0.73	Mustafa and Khan (1993)
Mumbai Coast	*Lepturacanthus savala*	4.15	1.3	2.85	Rizvi *et al*. (2010)
Saurastara	*Trichiurus lepturus*	0.44	0.13	0.31	Fofandi (2012)
Bangladesh	*Lepturacanthus savala*	2.03	0.98	1.05	Khan *et al*. (2003)
Bangladesh	*Lepturacanthus savala*	1.89	1.08	0.81	Ashraful (1998)
Bombay waters	*Trichiurus lepturus*	-	1.09	-	Chakraborty (1990)
Persian Gulf	*Trichiurus lepturus*	3.66	1.16	2.5	Kamali *et al*. (1998)
N.Persian Gulf	*Trichiurus lepturus*	3.73	1.06	2.67	Raeisi *et al*. (2012)
Vishakhapatnam	*Trichiurus lepturus*	2.417	0.893	1.523	Reuben *et al*. (1997)
N. Arabian Sea	*Trichiurus lepturus*	0.52	0.34	0.18	Ghosh *et al*. (2009)
Pakistan	*Lepturacanthus savala*	0.49	0.304	0.185	Present Study

study. The estimated b value in the present study of 3.191 was near to 3 which show the ideal condition of the fish in the Pakistan waters (Allen, 1938). However, Pauly *et al*. (1987) describe the values of *b* ranged between 2.5 to 3.5 since the observed values of 3.191 in our study are in the range of those values and indicate the growth of the species is positive allometric in the Pakistan waters.

The small differences may be due to the sample collection time, area of sampling, vessels, and fullness of stomach, gonads maturity, and health differences and also some other factors related to fish ecology such as sex, age of fish, season, habitat, temperature, availability of food, and conditions for spawning (Ricker, 1973; Baganel and Tesch, 1978).

Growth parameters

The estimation of growth parameters can help to estimate the parameters of production, stock size, recruitment and mortality of the fish population (Isaac, 1990). These parameters may be estimated from the absolute or relative age of the fish species or may be estimated by the length-frequency analysis.

In the present study, the length-frequency data were applied using VBGF for the estimation of asymptotic length L_∞ and growth coefficient (K). VBGF is usually used for the estimation of growth parameters of fish and was built keeping in view the growth as balance among the anabolic and catabolic process in a species (von Bertalanffy, 1957; Pauly and David, 1980). The estimated results for *L. savala* were shown in Table II. In our study the asymptotic length L_∞ 133.35 cm and growth coefficient K 0.13 year^{-1} were much higher than the previously estimated values except those of the estimated values by Chen and Lee (1982) and Fofandi (2012) of *Trichiurus lepterus* from Southwest coast of Taiwan and Saurashtra coast India of L_∞ 133.0, K 0.289 and L_∞ 131.25, K 0.13 respectively ,which were about same as our observed values, while the estimated values by Narasimham (1976), Torres (1991) and Pauly (1978) of *Trichiurus lepterus* from Kakinada India, South Africa and Mauritania of L_∞ 145.2 and K 0.29, L_∞ 146.8 and K 0.292, and L_∞ 147.0 and K 0.296 respectively, which were higher than our observed values. This may be because of the stomach fullness, maturity of gonads, health differences, availability of food, and spawning conditions, as well as the estimation methods (Ricker, 1973; Baganel and Tesch, 1978).

In this study, the calculated values of K (0.13 year^{-1}) show that the species has a low growth rate. Generally speaking, there is a high correlation between growth rate (K) and $L\infty$. Beverton and Holt (1956) stated that natural mortality coefficient (M) is directly proportional to the growth coefficient (K) of a fish and inversely proportional to the asymptotic length (L_∞) and the life span. In simple words, fishes with higher growth coefficient have higher natural mortality and shorter life span. Hence in this study the larger L_∞ and lower growth coefficient indicate lower natural mortality and longer life span.

Mortality

The estimated rates of total mortality Z, natural mortality M and fishing mortality F for *L. savala* from Pakistan waters were shown in Table III. The obtained results in present study for *L. savala* from Pakistan waters were compared to the previously estimated results for the *L. savala* and *Trichiurus lepturus* from the different countries of the world Table III which indicated that our

estimations were generally smaller than the previously estimated values except that of the estimated values by Fofandi, 2012 of *Trichiurus lepturus* from Saurashtara coast of $Z = 0.44$, $M = 013$ and $F = 0.31$ were about same as our observed values from Pakistan waters of $Z = 0.49$, $M = 0.304$ and $F = 0.185$.

The estimated exploitation ratio E for *L. savala* from Pakistan waters was 0.377 year^{-1} which is lower than the optimum exploitation ratio (E) of roughly 0.5 (Gulland, 1971). Therefore, the stock of this species in the region may be in a sustainable condition.

Biological reference points

The yield per recruit contour map (Fig. 5) reveals that when t_c was assumed to be 1, F_{max} was estimated at 0.6 and $F_{0.1}$ at 0.45. Current age at first capture was about 1 year and $F_{current}$ was 0.185, which shows that the estimated current fishing mortality for *L. savala* from Pakistan waters is smaller than estimated biological reference point $F_{0.1}$ at 0.45 year^{-1}.This indicates that the current status of the species in the Pakistan waters may be in a sustainable condition.

Maximum sustainable yield

The estimated MSY values of 26983t for *L. savala* from Pakistan waters were larger than the recent catch of 20375t which indicates that the *L. savala* fishery in Pakistan waters may be in a sustainable state.

The obtained results of fishing mortality *F* and maximum sustainable yield MSY both indicate that the fishery of *L. savala* may be in a sustainable state in the region. Therefore, the obtained results showed the authenticity of our study.

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Conflict of interest statement

Authors have no conflict of interest to declare.

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