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Length-Weight relationship and morphological studies of the big eye shad, *Ilisha filigera* (Valenciennes, 1847) in Mumbai waters

Rajesh Kumar Pradhan[1*], V. D. Deshmukh[2], S. K. Chakraborty[1], A. Chellapan[2], A. K. Jaiswar[1] & Subal Kumar Roul[1]

[1]Central Institute of Fisheries Education (Deemed University), Panch Marg, Off Yari Road, Andheri (West), Versova, Mumbai, 400-061, Maharashtra, India
[2]Mumbai Research Centre of Central Marine Fisheries Research Institute (CMFRI), Seven Bungalows, Versova, Mumbai - 400 061, Maharashtra, India

[*][E-mail: rajeshfrm220@gmail.com]

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Present study was conducted to investigate the length-weight relationship and morphological studies of *Ilisha filigera* based on 353 fish specimens of different size collected from Mumbai waters from October 2010 to April 2011. Length-weight relationship of 181 males and 136 females found a high degree of correlation for males, females and both the sexes combine. Pooled data for both the sexes gave the length-weight relationship of $W = 0.002336\ L^{3.345211}$ with a coefficient of determination (r^2) value of 0.954042. The 'b' value for both the cases of males (3.110674) and females (3.42701) revealed allometric growth. Analysis of covariance indicated significant differences ($P<0.01$) between males and females. The comparison of morphometric characters showed a very high degree of correlation between them. Total length of the species observed in the present study ranged from 13.9 to 37.5 cm with standard deviation 26.09±4.34 cm.

[**Key Words**: Length-Weight, Big eye shad, Morphometric, *Ilisha filigera*]

Introduction

Fishes of the genus *Ilisha* (Family-Pristigasteridae)[1] have a circumtropical distribution reported from estuaries and coastal waters, with one species in the tropical east Atlantic, two in South America (one fresh water and one coastal) and eleven in tropical Asia. In Mumbai this genus contributed as much as 23% of the catch of mechanized gillnet vessels[2], yet there is no comprehensive taxonomic and biological work on this genus in general and the dominant species *Ilisha filigera* (Valenciennes, 1847) in particular. Historically several species belong to genus *Ilisha* have been a significant part of the catch of the coastal and estuarine fisheries of Maharashtra[2]. Members of this genus mostly inhabit pelagic waters up to 100 m depth with round the year fishery along both the coasts of India. They occur in estuaries and exhibit wide range of salinity tolerance (5-38 ppt).[3]

The Big eye shad, *I. filigera* locally known as "Kati" has been gaining commercial importance in export as well as local market. It is distributed in India (Bombay to east coast), Bangladesh, New Guinea, South China, *etc*[1]. It is reported to attain up to 700 mm in Standard length and life span of 4 years in Sarwak (Malaysia) waters[4] making it the largest clupeid in the world. It has good market demand in fresh as well as dried form, mainly caught by the bag, trawl and gill nets operated in coastal bays and estuaries.

Owing to large size and longer life-span *I. filigera* is more vulnerable to the non-selective gears like trawl and bag nets operated in Maharashtra. Therefore, the present study was envisaged to understand the length-weight relationship and morphometric relationship of this commercially important species which would help in the future investigations pertaining to the stock assessment and management of this resource.

Materials and Methods

During October 2010 to April 2011 a total of 353 specimens of *I. filigera* ranging in size from 139 mm to 375 mm were collected randomly from the bag netters (dol netters) and small trawlers operated in near shore waters in Vasai creeks at Naigaon and Versova, New Ferry Wharf and Sasson Dock landing centres of Mumbai.

The fish specimens were transported to the laboratory facility of Mumbai research Centre of Central Marine Fisheries Research Institute (CMFRI), India in a well preserved condition using ice, washed thoroughly using tape water and wiped before mrphometric and meristic study. Fishes were measured to the nearest of millimeter and weighed to the nearest milligram accuracy in an electronic balance. The length and weight of males and females were taken separately after determining the sex of the fish by anatomical observation. Meristic and morphometric character were studied following standard procedure followed by Apparao (1966)[5] and Dwivedi and Menezes (1974)[6]. Various morphometric measurements like total length (TL), fork length (FL), standard length (SL), head length (HL), snout length (SnL), eye diameter (ED), pre dorsal length (PDL) and body depth (BD) were recorded. Meristic counts like the number of rays in dorsal fin, anal fin and pectoral fin as well as number of gill rakers and belly scutes (prepelvic and post pelvic) were recorded for the present study. To find out the relationships between various morphometric characters the data were analyzed using SAS stastical programme.

Since weight increases approximately by cube of length, the relationship between length (L) and weight (W) can expressed as:

$$W = a*L^b$$

Length-weight relationship was determined for both the sexes separately. One way analysis of co- variance was conducted to find out the differences in males and females. Linear regression was carried out by plotting lnW against lnL to find out the slope and intercept.

A power curve, or any non-linear curve is a more difficult to fit than the straight line (Y=a+bx). In many cases, a more complex curve can be transformed into a linear form by the use of natural logarithms. So the data of total length and weight were statistically treated by the method of least square using the following equation[7].

$$\log W = \log a + b \log L$$

The slope "b" and intercept "a" was calculated and the correlation-coefficient (r) was obtained to see the interdependence of the variables.

Results

Total length was considered as independent variable and all the rest of the morphometric characters as dependent variable on the total length. The relationships between total length and other variables were calculated by the linear regression analysis. Total length of the species observed in the present study ranged from 13.9 cm to 37.5 cm with mean size of 26.09±4.34 cm which was sufficiently large enough to study variability in different morphometric characters. All the morphometric characters showed variations; but despite that, the coefficients of variation (c.v.) between the characters were sufficiently stable. Measurements of various morphometric characters of *I. filigera* are given (Table 1).

Each character was considered independent and all the rest as dependent variable and regression analysis was carried out for each other. Correlation coefficient (r) was used as the yard stick to determine the closeness of relationship. Array of correlation coefficients between various morphometric characters have been presented (Table 2). They ranged between 0.93 and 0.99 indicating high degree of correlation between the variables. It also indicated homogeneity within the samples and isometric growth of the body parts of *I. filigera*.

In the present investigation meristic characters such as dorsal fin rays, pectoral fin rays, pelvic rays, pre and post pelvic scutes and gill rakers were counted (Table 3). Dorsal rays, pectoral rays and anal rays showed a range of 16-18, 14-17 and 44-53 respectively. Pre-ventral scutes ranged from 21 to 24 and post-ventral between 10 and 11. Gill raker ranged from 27-32. All the meristic characters showed fair amount of constancy.

Generally, the weight of fish increases with size. However, such increase may not be always proportionate; the weight increases by cube of length since length is one dimensional while weight is related to volume which is three dimensional.

A total of 317 specimens comprising of 181 males and 136 females were taken for the length-weight study. Length of males ranged from 189 to 317mm and weight 45.5 to 250 g. Similarly, the length of females ranged from 165 to 375 mm and weight 27.2 to 440 g. Linearizing the two variables by taking their logarithmic values (natural logs) and by regressing them gave following linear expressions for the males and females.

Table 1- Morphometric characters of *I. filigera*, with minimum, maximum and mean size, standard deviation and coefficient of variation.

Variable	Minimum (mm)	Maximum (mm)	Mean	Std. Dev	Std. Error	Coefficient of Variation (c.v.)
TL	13.90	37.50	26.09	4.34	0.259	16.635
SL	11.40	31.20	21.31	3.71	0.221	17.407
FL	12.40	33.00	22.77	3.89	0.232	17.093
HL	2.900	8.20	5.35	0.89	0.053	16.774
SNL	0.600	1.90	1.19	0.21	0.012	17.957
ED	0.900	2.100	1.49	0.26	0.015	17.384
BD	3.800	10.40	7.01	1.28	0.076	18.258
PDL	5.900	16.40	11.05	1.93	0.115	17.515

Table 2- Morphometric characters of I. filigera and their correlation coefficients.

	TL	SL	FL	HL	SNL	ED	BD	PDL
TL	1	0.995	0.991	0.973	0.93	0.938	0.985	0.987
TL	__	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
SL	0.995	1	0.991	0.971	0.924	0.938	0.983	0.985
SL	<.0001	___	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
FL	0.991	0.991	1	0.968	0.92	0.936	0.978	0.983
FL	<.0001	<.0001	___	<.0001	<.0001	<.0001	<.0001	<.0001
HL	0.973	0.971	0.968	1	0.916	0.919	0.961	0.969
HL	<.0001	<.0001	<.0001	___	<.0001	<.0001	<.0001	<.0001
SNL	0.93	0.924	0.92	0.916	1	0.899	0.927	0.925
SNL	<.0001	<.0001	<.0001	<.0001	___	<.0001	<.0001	<.0001
ED	0.938	0.938	0.936	0.919	0.899	1	0.923	0.943
ED	<.0001	<.0001	<.0001	<.0001	<.0001	___	<.0001	<.0001
BD	0.985	0.983	0.978	0.961	0.927	0.923	1	0.975
BD	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	___	<.0001
PDL	0.987	0.985	0.983	0.969	0.92	0.943	0.975	1
PDL	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	___

Male: LnW= -5.31099742+3.110674 LnL (R^2=0.89)

Female: LnW= -6.326098474+3.42701 LnL (R^2= 0.97)

Analysis of covariance following the statistical programme suggested by Snedecor (1967) revealed a significant difference (p<0.01) between the length-weight relationship of males and females (F=10.816) (Table 4).

The curvilinear relationships ($W= a*L^b$) for the males and females were as follows:

Males: $W= 0.004937L^{3.110674}$

Females: $W= 0.001789\ L^{3.42701}$

The parameters of length-weight relationships are presented (Table 5). It was seen that exponent 'b' is higher in females than in males while constant 'a' is higher in males than females.

The curvilinear relationships of length and weight of males, females are given (Figs 1) and (Fig 2).

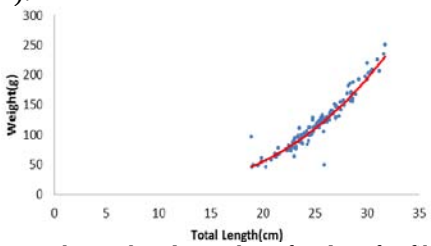

Fig. 1-Length-weight relationship of males of *I. filigera*

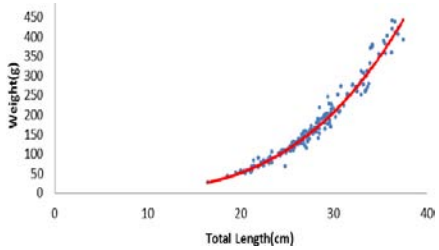

Fig. 2-Length-weight relationship of females of *I. filigera*

Discussion

During the present investigation high values of correlation (0.93 to 0.99) were obtained from various morphometric characters when compared with the total length. While comparing head length with other characters still better correlation was obtained, which ranged from 0.91-0.97. This indicates a higher degree of interdependence of these characters. However, in the present study maximum total length of *I. filigera* recorded was 37.5 cm, which is considerably lower than the total length (47 cm) reported[8] from Bangladesh waters. In another study highest length of 70 cm was recorded from Sarawak, Malaysia [4]. The lower total length in the present investigation might be due to heavy fishing pressure. The larger size of the species makes it more vulnerable to fishing gears deployed along northwest coast of India[10].

Table 3- The mean and standard deviation of meristic character counts of *I. filigera.*

Meristic counts (numbers)	Range	Mean	Standard deviation
Dorsal Rays	16-18	17	3
Pectoral rays	14-17	15	2
Pelvic rays	21-24	22	2
Pre-ventral scutes	21-24	22	2
Post-ventral scutes	10-11	11	4
Gill rakers	27-29	29	2

Meristic characters have been widely used in the studies of fish populations. Unlike morphometric body proportions, meristic characters develop at or before metamorphosis and remain constant throughout the life. In the present study, the meristic counts of *I. filigera* were also found to be almost constant with very little variation in the observed size range.

Table 4- Analysis of co-variance of length-weight relationships between male and females of *I. filigera*.

					Deviations from regression				
Source	d.f.	ssx	ssy	Spxy	Reg.coef	d.f.	S.S.	M.S	F	Prob
Within										
Males	135	1.793143	19.44607	5.577884	3.110674	134	2.095093	0.015635		
Females	180	4.247148	51.32167	14.55502	3.42701	179	1.441465	0.008053		
						313	3.536558	0.011299		
Pooled W	315	6.04029	70.76774	20.1329	3.333102	314	3.662727	0.011665		
						1	0.126169	0.126169	10.81626	P<0.01
Between B										
W+B	316	6.812157	79.90154	22.7881		315	3.670544			
			Between adjusted means			1	0.007816	0.007816	0.670093	

* F value obtained between males and females is significant so common formulae can't be given

The length-weight relationship of *I. filigera* revealed that the regression coefficient 'b' for males and females were 3.11 and 3.43, respectively. This indicates that with increasing size, the weight of female increases more rapidly than in male. ANACOVA also showed that the length-weight relationship between the sexes was also significantly different warranting use of sex-wise separate relationship. This differential increase may be attributed to significant increase in size and weight of ovaries in females than the testes of males with onset of maturity.

Table 5- Regression parameters of length-weight relationship of *I. filigera*.

SEX	A	b	R^2
Male	0.004937	3.110674	0.892261
Female	0.001789	3.42701	0.971913
Sexes pooled	0.002336	3.345211	0.954062

The coefficient 'b' of length-weight relationship for *I. filigera* reported from Bangladesh waters was 2.752[11] and 2.5803[9]. Both the values from Bangladesh are comparatively lower than the values of the present investigation (b=3.45) from Mumbai. This also shows that the weight gained by the fish with increasing size is much rapid in Mumbai than in Bangladesh.

Conclusion

The length-weight relationship plays vital role in finding the yield by converting one variable to other. It is also essential in population dynamics studies and for the bio-economic analysis of the resource. Morphological relationship studied in the present species shows high degree of correlation. Since, the 'b' values obtained for both males and females were more than the ideal value of 3, it can be concluded that the growth pattern of the species is allometric in nature.

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