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Length-Weight Relationship and Condition Factor of *Ilisha melastoma* (Clupeiformes: Pristigasteridae) Off Pakistan

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Abstract.- The length-weight relationship and condition factor for *Ilisha melastoma* (Bloch and Schneider, 1801) is described from samples collected between March 2004 and March 2005. The maximum standard length registered for males and females was 19.7 cm and 19.8 cm, respectively. The length-length relationship between the total length (TL), fork length (FL) and standard length (SL) for *I. melastoma* was found to be highly significant (r^2> 0.96, P< 0.001). The value of "b" of the length-weight relationship was 2.68 which indicated a negative allometric growth trend of this species. The relative condition factor *(Kn)* varied from 0.90 ± 0.08 to 1.03 ± 0.08. The means of the *Kn* value were significantly different in April, July 2004 and March 2005. The two-way ANOVA indicated no significant differences in *Kn* value between three seasons, pre-monsoon (January-April), monsoon (May-September) and post-monsoon (October-December) and between different size-classes.

Key words: Length-weight relationship, condition factor, *Ilisha melastoma*, northern Arabian Sea.

INTRODUCTION

The clupeoid fishes of genus *Ilisha* (Osteichthyes: Pristigasteridae) comprise 13 known species, which are distributed in the Indo-Pacific region, *i.e.*, Japan, China, Singapore, Java, Borneo, Sumatra, Burma, India, Pakistan, Persian Gulf and Africa. This genus has a circumtropical distribution in estuaries and coastal waters, with one species in the tropical east Atlantic (*I. africana*), two in South America (*I. amazonica* and *I. furthii*) and eleven in tropical Asia (*I. elongata, I. filigera, I. kampeni, I. macrogaster, I. melastoma, I. novacula, I. obfuscate, I. pristigastroides, I. sirishai* and *I. striatula*) (Whitehead, 1985).

There is little knowledge on most of these fishes, with the exception of *Ilisha africana* (Whitehead, 1985). Two species of the genus *Ilisha*, *I. melastoma* and *I. megaloptera*, have been reported from Pakistan (Bianchi, 1985), but no information is available on the biology and life history of these species from Pakistani waters.

Indeed, the knowledge on quantitative aspects such as length-weight relationship, length-length relationship, condition factor, growth and recruitment are important tools for the adequate management of any fish species (King, 2007). The length-weight relationship of fish is an important fishery management tool. It is important is estimating the average weight at a given length group (Beyer, 1987) and is useful for converting length observations into weight estimates to provide some measure of biomass (Froese, 1998). The relative well being of a fish population (Bolger and Connoly, 1989) can be assessed on the length-weight relationship. Similarly, the length-length relationships are important for comparative growth studies (Froese and Pauly, 1998). The well-being state of the fish can be inferred with a condition factor (LeCren, 1951), which is used for comparing the condition, fatness or well-being of fish (Tesch, 1968), assuming that heavier fish of a given length are in better condition. Condition factor has been used as an index of growth and feeding intensity (Fagade, 1979). Condition factor also influences the reproductive cycle in fish (Welcome, 1979).

Keeping in view that the basic requirements for the sustainable management of the fisheries is the assessment of the fish populations, the present study was initiated. The study aims to calculate length-length and length-weight relationships and investigate the condition factor fluctuations among months, seasons and sizes of *Ilisha melastoma*

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(Bloch and Schneider, 1801), one of the two *Ilisha* species present in the shallow coastal waters of Pakistan.

MATERIALS AND METHODS

Samples of *Ilisha melastoma* were bought each month from Karachi Fish Harbour, during March 2004 to March 2005. These fishes were collected with gill-nets along the 241 km of the Sindh coastline (Mohammad Moazzam, personal communication) (Fig. 1). These fish landings do not occur regularly, therefore, the harbour was visited frequently and whenever, the fish was available a subsample was bought.

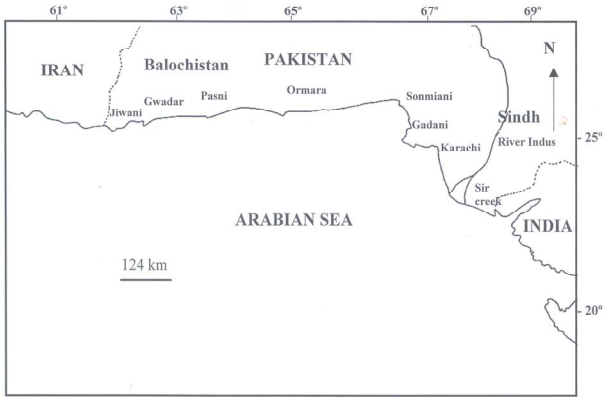

Fig. 1. Map showing the coastline of Pakistan, which extends from Sir creek at the Indian border in the southeast to Jiwani till the Iranian border in the northwest.

At the laboratory, specimens were identified according to Bianchi (1985). The total length (TL) standard length (SL) and fork length (FL) of fish were measured (±0.1 cm), weighted (± 1g) with an electronic balance, and the sex was assigned by examining the gonads (Chubb and Potter, 1984; Marcus and Kusemiju, 1984).

The relationships between different lengths were based on the formula of linear regression using equation 1:

$$(1) \quad Y = a+b*X$$

The Student's t-tests was used to confirm whether *b* values obtained in the linear regressions were significantly different from the isometric value (*b*= 1).

The length-weight relationship was estimated using the equation 2:

$$(2)\ W= aTL^b \text{ (Ricker, 1973),}$$

where *W* is the derived weight, *TL* is total length, *a* is the intercept of regression curve and *b* is the regression coefficient. The values of *a* and *b* were estimated from the $\log_{10}$ transformed values of length and weight (equation 3):

$$(3)\ \log_{10} W = a + b \log_{10} L$$

The length-weight relationship between males and females were calculated separately. The Student's t-tests was used to confirm whether *b* values obtained for the length-weight relationship were significantly different from the isometric value (*b*=3). To test the significance of difference of the regression coefficient 'b' between males and females, the ANOVA was performed.

The fish monthly relative condition factor (*Kn*) was calculated with equation 4:

$$(4)\ Kn= W/aTL^b \text{ (Le Cren, 1951)}$$

The data on relative condition factor (*Kn*) of *I. melastoma* in seasons [pre-monsoon (January-April), monsoon (May-September), post-monsoon (October-December)] and size-classes (14.0-16.0 cm, 16.0-18.0 cm, 18.0-20.0 cm, 20.0-22.0 cm, 22.0-24.0 cm and 24.0-26.0 cm total length) was subjected to two-way ANOVA to test for possible season and size interactions.

RESULTS AND DISCUSSION

Length-length relationship

A total of 708 specimens of *I. melastoma* were examined. The maximum SL and weight of *I. melastoma* recorded in this study was 19.8 cm and 193.0 g, which are substantially higher than those reported by other authors (Table I). The minimum and maximum total length, standard length and weight are shown in Table II. These length variations between sites may be correlated to the ecological conditions of the habitats and/or with animals physiology (Le Cren, 1951). Only one

Table I.- Maximum standard lengths (SL) of *Ilisha* sp. from various sources.

Sources	Bianchi (1985) Pakistan	Whitehead (1988) Indo-Pacific	Jhingran and Talwar (1992) India	Blaber *et al.* (1998) Malaysia	Fafioye and Oluja (2005) Nigeria	Present study Pakistan
			SL (cm)			
I. africana	-	30.0	-	-	21.1	-
I. elongata	-	40.5	-	37.5	-	-
I. filigera	-	22.0	-	72.4	-	-
I. kampeni	-	15.0	-	16.0	-	-
I. megaloptera	28.0	12.0	27.5	24.8	-	-
I. melastoma	13.0	17.0	17.0	13.2	-	19.8
I. novacula	-	32.0	32.0	-	-	-
I. pristigastroides	-	30.0	-	44.0	-	-

Ilisha species, *I. filigera*, reached a SL size bigger that 70.0 cm (Blaber *et al.*, 1998).

Table II.- Minimum and maximum total length (TL), fork length (FL), standard length (SL) and weight (W) of *Ilisha melastoma.*

	Males		Females	
	Minimum	Maximum	Minimum	Maximum
TL (cm)	14.0	26.5	14.9	27.0
FL (cm)	12.6	22.5	12.4	21.7
SL (cm)	10.9	19.7	11.1	19.8
W (g)	26.0	193.0	29.0	179.0

Length-length relationships and the coefficient of determination r^2 are given in Table III. In this study the length-length relationships in *I. melastoma* was found to be highly correlated (in all cases: $r^2 > 0.96$, $P < 0.001$). The value of *b* is significantly different from the theoretical slope of 1.0 ($P < 0.001$, t-test values given in Table III) in the relationships between TL-FL, FL-SL and TL-SL. The length-length relationships have been reported to be significantly correlated in other studies such as the relationships between total, fork and standard length were all linear (for all cases: $r^2 > 0.93$) for 37 fish species including the clupeid fish *Sardinella aurita*, in the Aegean Sea, Greece (Moutopoulos and Stergiou, 2002). The length-length linear regressions were highly significant ($P<0.001$) with all *r2* values being > 0.90 in 42 fish species including the fishes belonging to family Clupeidae, from Turkish waters (Gaygusuz *et al*., 2006).

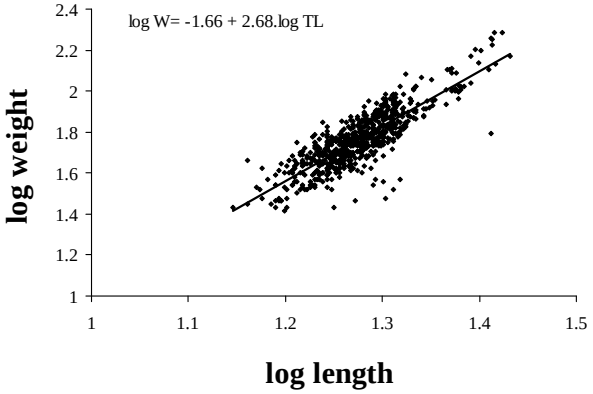

Fig. 2. Relationship between total length and weight in *Ilisha melastoma* from March 2004 to March 2005.

Length-weight relationship

The length-weight relationship of females and males of *I. melastoma* is shown in Table IV). As no significant difference was found between the value of *b* ($F= 1.77$; $df= 1$; $P> 0.10$) (Table V) in females and males of the fish, the data was pooled for the sexes to describe the length-weight relationship. The combined sex length-weight relationship corresponding to the logarithmic form $W= -1.66 + 2.68$ TL ($r= 0.84$) (Fig. 2). The value of *b* 2.68 indicates a negative allometric growth trend in *I. melastoma*. This slope is significantly different from the theoretical slope of 3.0 (t-test= -4.90, $P< 0.001$). The *b* value estimated for *I melastoma* in this study is almost the same as reported for *I. africana* (Marcus, 1982; Fafioye and Oluja, 2005; Abowei,

Table III.- Length-length relationships between total length (TL), fork length (FL) and standard length (SL) of *Ilisha melastoma.*

Equation	N	a	S. E. (a)	b	S. E. (b)	r^2	t-test
TL = a + b FL	708	- 0.61	0.15	1.23	0.01	0.96	25.29*
TL = a + b SL	708	- 0.66	0.14	1.38	0.01	0.97	39.87*
FL = a + b SL	708	0.21	0.09	1.10	0.01	0.97	14.98*

N, number of fish; a, intercept; b, slope; S.E., standard error; r^2, determination coefficient; *, P< 0.001.

Table IV.- Total length-weight relationships (log_{10} transformed) for *Ilisha melastoma.*

Sex	Number	Log a	S. E. (a)	b	S. E (b)	r^2
Males	275	-1.76	0.14	2.77	0.11	0.71
Females	433	-1.55	0.11	2.59	0.08	0.69

Log a, intercept; b, slope; S.E., standard error; r^2, determination coefficient

Table V.- Results of statistical analysis performed for comparison of regression lines for total length-weight relationship for the males and females of *Ilisha melastoma.*

Sources	Sum of Squares	Df	Mean Square	F-ratio	P-value
Log total length	9.4856	1	9.4856	1724.43	0.0000
Intercepts	0.0048	1	0.0048	0.87	0.3523
Slopes	0.0097	1	0.0097	1.77	0.1834

Df, degree of freedom.

2010) (Table VI), however, it is comparatively smaller than the *b* values reported for other clupeid fishes (Table VI). However, Fulton (1904) reported that even within species the length-weight ratio varies somewhat at different places and at certain times of the year, mostly due to the reproductive cycle. Recently, while studying the length-weight relationships of 41 fish species from the Korangi-Phitti Creek system of the northern Arabian Sea, Hussain *et al*. (2010) reported that 17 species showed negative allometric growth, including the fishes *Ilisha megaloptera* (b=2.7), *Hilsa kelee* (b= 2.4) with the *b* value was estimated to be as low as 1.5 in *Thryssa dussumieri*. From tropical and temperate waters, in most of the fishes the *b* values have been reported to range from 2.7 to 3.3 (*e.g.* Gonzales *et al.,* 2000; Santos *et al*., 2002; Morey *et al*., 2003).

Relative condition factor

The index of relative condition factor (*Kn*) was calculated for *I. melastoma* for both sex combined and varied from 0.90 ± 0.08 to 1.03 ± 0.08 (Table VII). The *Kn* obtained in this study varied slightly from the results of Abowei (2010) who showed the monthly condition factor to vary from 0.40 to 1.61 in *I. africana* from Nkoro River Niger Delta, Nigeria. The *Kn* value for *I. melastoma* throughout the study period was almost one, which showed that the fishes were above average condition within their waters (Wade, 1992). Similarly Abowei (2010) while studying condition factor in *I. africana* considered it to e in good condition. Ayoade and Ikulala (2007) while studying condition factor in three cichlid species reported that the mean K*n* value was greater than one indicating that the fish species were above average condition within the lake.

The highest *Kn* value were found in October 2004 (1.03±0.08) followed by June 2004 and January 2005. Analysis of variance showed that there was a statistically significant difference between the means of the *Kn* value along this study (F= 6.53; df= 12; P< 0.05). Multiple range tests showed that means of *Kn* value were significantly

Table VI.- Parameter *b* of length-weight relationships in some fish species.

Species	Family	Area	b	Source
Ilisha africana	Pristigasteridae	Nigeria	2.79	Marcus (1982)
Tenualosa ilisha	Clupeidae	Pakistan	3.00	Jafri *et al.* (1999)
Chirocentrodon bleekerianus	Chirocentridae	Brazil	3.25	Muto *et al*. (2000)
Harengula clupeola	Clupeidae	Brazil	3.18	Muto *et al*. (2000)
Pellona harroweri	Pristigasteridae	Brazil	2.98	Muto *et al*. (2000)
Gilchristella aestuaria	Clupeidae	South Africa	3.18	Harrison (2001)
Hilsa kelee	Clupeidae	South Africa	3.25	Harrison (2001)
Sardinops sagax	Clupeidae	South Africa	3.23	Harrison (2001)
Sardina pilchardus	Clupeidae	Greece	3.46	Koutrakis and Tsikliras (2003)
Sardinella aurita	Clupeidae	Greece	2.95	Koutrakis and Tsikliras (2003)
Ethmalosa fibriata	Clupeidae	Nigeria	3.21	Fafioye and Oluja (2005)
Ilisha africana	Pristigasteridae	Nigeria	2.79	Fafioye and Oluja (2005)
Ilisha africana	Pristigasteridae	Nigeria	2.72	Abowei (2010)

Table VII.- Result of regression analysis and Student's t-test for the length-weight relationship and relative condition factor of *Ilisha melastoma* from March 2004 to March 2005.

Months	Number	r	A	a	*Kn*	b	t-test
Mar. 04	23	0.95	-1.64	0.02	0.99 ±0.07	2.74	-1.320
Apr. 04	54	0.96	-1.94	0.01	0.97 ±0.07	2.96	-0.344
May 04	102	0.85	-1.29	0.05	1.01 ±0.08	2.44	-3.617**
Jun. 04	39	0.94	-1.74	0.02	1.03 ±0.09	2.79	-1.194
Jul. 04	68	0.94	-2.35	0.01	0.90 ±0.08	3.29	1.890
Aug. 04	75	0.97	-1.85	0.01	1.01 ±0.08	2.79	-2.303*
Sep. 04	59	0.54	-1.09	0.08	1.02 ±0.19	2.17	-1.856
Oct. 04	69	0.94	-1.87	0.01	1.03 ±0.08	2.80	-1.606
Nov. 04	50	0.88	-1.96	0.01	1.00 ±0.08	2.88	-0.541
Dec. 04	61	0.75	-0.16	0.69	1.00 ±0.09	1.49	-8.767**
Jan. 05	45	0.88	-1.71	0.02	1.03 ±0.08	2.71	-1.317
Feb. 05	36	0.88	-1.74	0.02	1.01 ±0.08	2.74	-1.035
Mar. 05	27	0.85	-2.06	0.01	0.97 ±0.07	2.96	-0.018

A, regression constant; r, coefficient correlation, *a* and *b*, parameters of length and weight equation; *Kn*, relative condition factor; *, P< 0.05; **, P< 0.001.

different between April, July 2004 and March 2005. The significantly different *Kn* value (lower than 1.00) in these three months may be related to the gonad maturation in the fish *I. melastoma*. As Vazzoler (1996) stated that lowest *K* values during the mature gonad stages showed that the resource has been transferred to the gonads during the reproduction cycle.

The *Kn* in different seasons varied between 0.99 ± 0.08 (pre-monsoon) and 1.01±0.09 (post-monsoon) (Fig. 3). Among the various size-classes, the *Kn* value of *I. melastoma* varied from 0.76±0.18 to 1.35±0.17 (Fig. 4). The two-way ANOVA indicated no significant differences in *Kn* value between three seasons (F= 1.68; df= 2; P> 0.10) and different size-classes (F= 0.75; df= 6; P> 0.10). The condition factor calculated for *I. melastoma* did not vary significantly between the three seasons, suggesting that their food requirements are satisfied or follow the changes that occur during the pre-monsoon, monsoon and post-monsoon seasons. This is contradictory to the expected results, since higher condition factors were expected during the monsoon, due to NE monsoon winds in winter and spring the nutrients exported from the estuaries and mangroves to the coastal waters resulting in increased primary productivity in Pakistani coastal waters (Twilley, 1988; Harrison *et al*., 1997).

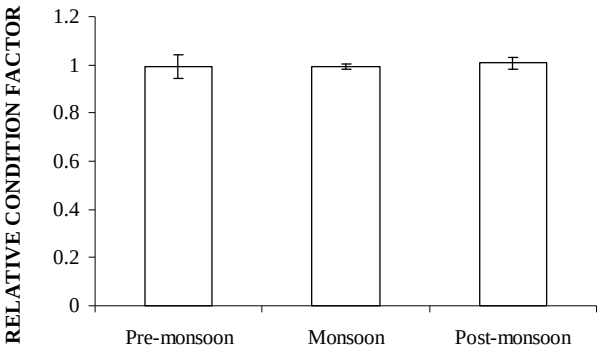

Fig. 3. Relative condition factor (Kn) of *Ilisha melastoma* in different seasons from March 2004 to March 2005.

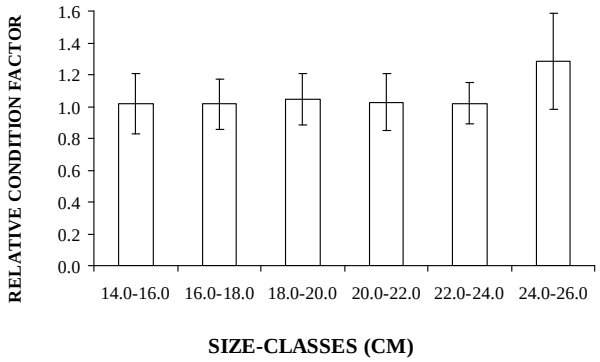

Fig. 4. Relative condition factor (Kn) of *Ilisha melastoma* in various size-classes from March 2004 to March 2005.

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