LENGTH-WEIGHT RELATIONSHIP OF *EPINEPHELUS DIACANTHUS* (FAMILY SERRANIDAE; SUB-FAMILY EPINEPHELINAE) COLLECTED FROM KARACHI FISH HARBOUR, PAKISTAN

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Abstract

An investigation was conducted to find the length-weight relationship in *Epinephelus diacanthus* belonging to the family Serranidae along Pakistan coast. For this purpose, 201 fish samples of various lengths were collected bimonthly during the research period of October 2012 to April 2014 from Karachi fish harbour. The results revealed the positive allometric growth pattern for combined sexes, females and males of *E. diacanthus* because the values of regression coefficient were found to be greater than the ideal value of regression coefficient (i.e., b=3.0). The coefficient of correlation (r) was observed to be >0.90 which illustrates the strong correlation. The overall results for length-weight relationships of *E. diacanthus* for the combined sexes, females and males were found highly significant ($p<0.05$). Thus, present results proved that environmental conditions of Pakistan coast are appropriate for the growth of *E. diacanthus*.

Introduction

Epinephelus diacanthus is a marine, demersal, predatory fish. According to Chen *et al.,* (1980) *E. diacanthus* attained maturity at the size of 125mm in Taiwan. *E. diacanthus* is abundant on muddy trawling grounds in Pakistan where it forms large schools at 20-50m depths (De Bruin *et al*., 1995). According to them it is rare in Sri Lanka and its population is declining in India.

According to Le Cren (1951) and Pauly (1983) length-weight relationship can be studied by parabolic equation of the form $W=a.L^b$. In this equation, 'a' is the constant/coefficient of body shape. a value will be around 0.1 for small sized and rounded shaped fishes. Streamlined fishes will have a values around 0.01 and 0.001 for eel shaped fishes. In contrast, '*b*' is the growth parameter/exponent/coefficient balancing the dimensions of the equation and its values can be smaller, larger or equal to 3 (Froese, 2006). If $b<3$ or $b>3$ then the fish growth is allometric. When *b*-value is less than 3 then the fish grows faster in length than in weight i.e. fish becomes lighter (negative allometric). When *b*-value is greater than 3 the fish grows faster in weight than in length i.e. fish becomes heavier (positive allometric). Whereas, when the *b*-value is exactly 3, growth is isometric (Wootton, 1998). Length-weight relationships are very important tools in fisheries science and can be used to estimate biomass from length information, condition factor of a species and to compare the life history and morphological differences within same species inhabiting different localities (Binohlan and Pauly, 2000). Length–weight relationship plays significant role in fish stocks estimation (Demirhan and Can 2007). Le Cren (1951) discussed length-weight relationship via cube law which is now applied for many fishes. Many notable researchers have published their work on length-weight relationship of *Epinephelus* species including Premalatha, (1989); Tessy (1994); Rangaswamy *et al*., (1999); Al-Dhahi (2000); Shanmugam *et al*., (2000); Ashraj (2005); Manojkumar (2005); Sivakami and Seetha (2006); Jaya-Sankar *et al*., (2007) and Sujatha *et al*., (2010). According to McIlwain *et al*., (2003) regression slope of length-weight relationships differ significantly between the sexes of *Epinephelus.* According to Man and Chuen (2006) *E. lanceolatus* attained size of 2.7m in length and weight about 400kg.

Sadovy and Erisman (2012) reported that *E. diacanthus* found all over the oceans of the world are facing some of the danger and are considered as near threatened. Therefore, efforts should be taken for the conservation and protection of this economically important fish. As length-weight relationship play a significant role in fishery biology studies, therefore, present study was conducted to observe the length-weight relationship of *E. diacanthus* landed at Karachi fish harbour, Pakistan. Such study will provide useful information in fisheries conservation and managements.

Materials and Methods

Fish Sampling and Laboratory Processing: A total of 201 samples of *Epinephelus diacanthus* were collected from the landing site of Karachi fish harbour (October 2012 to April 2014). Specimens of various sizes of *E. diacanthus* were collected bimonthly. All specimens were thoroughly identified up to the species level during field survey, as well as in laboratory using FAO species catalogue for groupers (Heemstra and Randall, 1993). Identified specimens were measured accurately in millimeters (mm) on a measuring board. Weight of fish was recorded in grams (g) on digital balance.

Data analysis: Calculations for combined sexes, female and male fish specimens were done after Le Cren (1951);

$$W = a L^b \quad \text{(Equation 1)}$$

Where,
W = fish body weight (g)
L = fish body length (mm)
a = initial growth coefficient/ intercept
b = the slope/ exponent/ growth coefficient
In order to linear the data, log transformed equation was used (Jaiswar *et al*., 2004);

$$\text{Log } W = \text{Log } a + b \log L \quad \text{(Equation 2)}$$

All results for statistical analysis of data were obtained by using Minitab statistical software Version 17.0.

Results and Discussion

In the present study, the length-weight relationships (LWRs) was calculated by using Cubic law as suggested by Le Cren (1951) for the analysis of values of b. If $b<3$ then fish growth is negatively allometric and if $b>3$ then growth is positively allometric. Present results indicate strong correlation exists between the two variables (when $r \geq 0.70$) for male, female and combined sexes of *E. diacanthus* as shown in Table 1**.** Present study also clearly shows that length-weight relationships for male, female and combined sexes of *E. diacanthus* were found to be statistically highly significant at 5% level ($p<0.05$). According to Demirhan and Can (2007), length-weight relationship measurements are essential for stock assessment of fishes. Due to ecological changes '*b*' values of fish species deviate from normal range (Pauly and Gayanilo, 1997). They suggested that if '*b*' value range from 2.5 to 3.5 than it shows that results of present study are valid. In this study, the values of '*b'* showed positive allometry in the growth of male, female and combined sexes of *E. diacanthus* (Table 2). The departure of *b*-value from ideal were observed to be highly significant ($p<0.01$) at 1% significant level in *E. diacanthus* following cubic law as shown in Table 2. Sujatha *et al*., (2015) observed deviation in *b*-value in species of genus *Epinepheus*. Accordingly, *E. longispinis* showed negative allometric type of growth, whereas, *E. undulosus* showed positive allometric growth pattern. Özvarol and Gökoğlu (2015) also observed positive allometric growth pattern ($b>3$) in *E. aeneus, E. marginatus* and *E. costae* collected from Southern Turkey.

Gonçalves *et al*., (1997) reported that length-weight relationships are important for determination of fish biomass, life history as well as it is used for morphological comparison of dissimilar fish species and different populations. Previous literature shows following results regarding length-weight relationship of *Epinephelus* species. Sujatha *et al*., (2010) examined length-weight relationship in *E. epistictus, E. magniscuttis, E. latifasciatus* and *E. radiates* collected from East coast of India. In this case *b*-value for *E. epistictus* showed negative allometric growth. *b*-values for *E. magniscuttis* and *E. radiates* showed positive allometric growth and isometric growth type in case of *E. latifasciatus.* According to Brouard and Grandperrin (1984) regression coefficient (*b*) values for *E. magniscuttis* and *E. radiates* showed negative allometry. Bal and Rao (1984) explained that variations in *b*-values may be due to changes in the body shape of fish during different stages of life. Such deviation in results may also be due to environmental conditions. According to Sani *et al*., (2010) and Teixeira de Mello *et al*., (2006) length-weight parameters can be used for find out weight of fish from its length, for computing condition indices, for comparing morphological characters of different populations and to study variation in ontogenic allometry. Deviation in *b*-values from ideal may be due to number of factors like: number of fish samples observed, habitat, season, gonad maturity, stomach fullness, sex, preservation methods and physical health of fish (Ozaydin *et al*., 2007).

Several scientists have studied the length-weight relationship of various fish species from Pakistan and reported the positive and negative allometric growth in fishes. Mahmood *et al*., (2012) reported negative allometric growth in *Ilisha melastoma* from Pakistan. Ahmed *et al*., (2013) have investigated allometric growth in *Magalaspis cordyla* collected from Karachi fish harbour which was highly influenced by pre-monsoon, monsoon and post-monsoon seasons. However, Ahmed *et al*., (2014) had observed negative allometric growth in *Rastrelliger kanagurta* and *Scomberomorus guttatus.* Whereas, *Scomberomorus commerson* showed positive

allometric growth. Zubia *et al*., (2014) found that *Liza melinoptera* and *Valamugil speigleri* showed negative allometric growth while, *Mugil cephalus* and *Liza macrolepis* showed positive allometric growth from Pakistan coast. While, Elahi *et al*., (2015) observed positive allometric growth in *Sardinella sindensis* collected from Balochistan coast. These changes in length-weight relationship of fishes may be due to total number of specimens, season, locality and size of sampled specimens (Karna and Panda, 2012).

Table 1. Regression analysis of length-weight relationship ($W = a. L^b$) of *Epinephelus diacanthus* from Karachi coast, Pakistan.

Sex		Length range (mm)		Mean	Weight range (g)		Mean						
	N	Max.	Min.		Max.	Min.		a	B	S.E. (b)	r	t-test	p-value
Combined sexes	201	380	137	22.51	586.1	21.6	212.00	-483.2	30.873	0.859	0.931***	35.94	0.000*
Female	138	380	137	22.82	586.1	21.6	229.60	-483.1	31.221	0.984	0.939***	31.74	0.000*
Male	63	320	143	21.83	470.3	30.5	173.40	-450.3	28.56	1.71	0.906***	16.73	0.000*

N= sample size; S.E. (b) = standard error of regression coefficient. *** shows the strong correlation ($r \geq 0.70$), *Significant at 5% level.

Table 2. Regression analysis of length-weight relationship (logW = log a + log b L) of *Epinephelu*

Sex	N	log a	log b	r	t-test when b=3	p-value	G.T
Combined sexes	201	-3.0081	3.8557	0.969***	12.206	0.000*	A^+
Female	138	-2.96	3.8274	0.971***	10.291	0.000*	A^+
Male	63	-3.115	3.925	0.961***	6.335	0.000*	A^+

N= sample size; G.T= Growth type. A^+= positive allometric pattern, *=Significant at 5% level. *** =strong correlation.

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