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A Study on Length-weight Relationship and Condition Factor of Two Teraponid Fishes (Family Teraponidae) from Karachi Coast, Pakistan

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Abstract. The present work was carried out to find the length-weight relationship and condition factor of two Teraponid fishes (*Terapon jarbua* and *T. puta*) from Karachi coast, Pakistan. The value of coefficient *b* in LWR equation for *T. jarbua* indicates isometric growth pattern (*b*=3.014) in combined sexes, positive allometric growth in males (*b*=3.119) and negative allometric growth (*b*=2.933) in females. Whereas for *T. puta*, the values of coefficient *b* were examined higher than the ideal value (*b*=3.486 for combined sexes, *b*=3.324 for males and *b*=3.482 for females) shows the positive allometric growth pattern. The isometric pattern illustrates that the body shape of *T. jarbua* remains same with an increase in its length, while positive allometric growth shows that *T. puta* gets rounder with an increase in its length. The results of condition factor (K) were observed 1.43, 1.42 and 1.44 for combined, male and female sexes of *T. jarbua*. The condition factor (K) was obtained as 1.20, 1.18, 1.21 for combined, male and female sexes of *T. puta*. The higher K-values then the ideal value (K=1) shows that environmental conditions of Karachi coast, Pakistan which is supports the good health of *Teraponid* species.

Keywords: Fisheries assessment, growth pattern, ecological suitability, fitness, Pakistan

Introduction

The two studied *Teraponid* species (*Terapon jarbua* and *T. puta*) belongs to family Teraponidae. They are good food fishes and common in the commercial and artisanal catches from Pakistan coast (Musarrat-ul-Ain and Farooq, 2022a). The study on gonadosomatic index of *T. jarbua* shows one spawning season with peak during April and July (Musarrat-ul-Ain *et al*., 2015), while *T. puta* shows continuous spawning with peak during April and November from Pakistan (Musarrat-ul-Ain and Farooq, 2022b). These two *Teraponid* species have been reported all the year in different size classes from Pakistan coast, supports the suitability of environment for these species (Musarrat-ul-Ain and Farooq, 2020).

Length-weight relationship is extensively used in fisheries sciences because it provides mathematical estimation of the correlation between fish length and weight. It helps to calculate the weight when only length observations are available (Harrison, 2001). Length-weight relationship helps to compare the growth of fishes between different regions or habitat (Koutrakis and Tsikliras, 2003). Length-weight relationship is useful to assess the stock biomass from a small sample and helps to study the life history and morphological links between different regions (Petrakis and Stergiou, 1995). Length-weight relationship is a very important tool in fisheries science as it forecasts weight of fish at age by conversion of length into weight, in growth equations (Pauly, 1993). The age structure, growth rate and further component of the fish population can be estimated with the help of length-weight relationship (Kolher *et al*., 1995). Studies on length-weight relationships are useful in stock assessment models as it helps to change the length equations into the weight equation it helps to evaluate the biomass from length observations and to evaluate the fish condition and also allows comparing life history of fishes between different regions (Moutopoulos and Stergiou, 2002). It also helps to evaluate the relative wellbeing of the fish population (Thomas *et al*., 2003). Measurement of weight can be time-consuming process during field studies so, most scientists use length-weight relationship for the estimation of weight from the length (Sinovcic *et al*., 2004; Ecoutin and Albert, 2003). Length-weight relationship is not only helpful to estimate the fish weight but also helps to find the body condition and growth type of the fish (Yagi *et al*., 2015). Studies on

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length-weight relationships supports to calculate the fish weight and the standing crop biomass and the condition of fish and also helps to compare the morphometric characteristics of species and populations from different areas (Cicek *et al*., 2006; Ozaydin and Taskavak, 2006). Several scientists have proposed an estimate on the coefficient (*b*) of length-weight relationships (Gayanilo *et al*., 2005; Bernardes and Rossi-Wongtschowski; 2000; Haimovici and Velasco, 2000; Bagenal and Tesch, 1978). In most of the fishes, the coefficient of length-weight relationship (*b*) is closed to 3 shows the isometric growth. This *b*-value may vary 2 to 4, shows the allometric growth of fishes (Tesch, 1971). An isometric growth in fish shows that there is no change in the shape of the body with the increase in their length (Blackwell *et al*., 2000). When *b*=3 the fish shows the isometric growth and thought to be an ideal fish growth. When *b*<3, the fish illustrates the negative allometric growth which means that fish becomes slenderer as it increases in length. When *b*>3, the fish has a positive allometric growth and represents fish becomes rounder with the increase in length (Thomas *et al*., 2003). Variations in *b*-values can be endorsed to age differences, sex and maturity of fishes. The geographical area and ecological circumstances, for example, season, fullness of stomach, illness of fish and parasite loads, may be some of the factors which affect the value of *b* (Yankova, 2013; Bagenal and Tesch, 1978). The differences may be due to the quantity and size distribution of the sampled specimens, or due to gonad's maturity stage sex, diet composition, stomach fullness or due to the growth phase of the fish (Li *et al*., 2015). The previous studies on length-weight relationship supports the significance of work in fisheries science therefore, the present research was carried out to study the length-weight relationship (LWR) and Condition factor (K) for two *Teraponid* species from Pakistan.

Materials and Methods

The samples of two *Teraponid* species were collected from commercial catches of fish harbour, Pakistan from January 2013 to December 2014. Total 676 specimens of *T. jarbua* (325 male and 351 female) and 622 specimens of *T. puta* (213 male and 409 female) were observed from the samples. All the samples were transferred to the laboratory. Fresh samples were analyzed for this study. The length of the fish was measured from the snout to the tip of the caudal fin on a measuring board and fish was weighed on a digital balance. Fish was dissected from the abdomen to study the sex of fish. The sex of fish was determined after macroscopic examination of gonads (Musarrat-ul-Ain and Farooq, 2022a; 2022b; 2021, 2020; Musarrat-ul-Ain *et al*., 2015).

Length-weight relationship (LWR). The cubic law equation of Le Cren (1947, 1951) was used to estimate the relationship between length and weight of combined, male and female sexes of *Teraponid* species of this study.

$$W = aL^n \quad (1)$$

where:

W = fish weight in g; L = fish length in mm
a = intercept of regression equation; n = slope of the regression equation, also referred as *b*

According to Samat *et al*. (2008), the logarithmically transformed equation of linear relationship gives better results of the values *a* and *b*. The logarithmically transformed equation of model (1) is as follows:

$$\log W = \log a + b \log L \quad (2)$$

Outliers are an indication of errors due to the measurement, text or due to the presence of reproductively ripe females in the sample. Therefore, outliers were identified by quartiles and inter-quartile range (IQR) and removed from the final parameter estimation (Khatoon *et al.,* 2014; Hussain *et al.,* 2010). For this purpose, the lower limit and the upper limit of data was estimated (Weiss, 2012). The data points that lie below the lower limit or above the upper limit were determined as outliers.

In the equation (2), the value of coefficient *b* shows the growth pattern of fish. The ideal value for *b* is 3 which show the isometric growth in fishes. This value may fall between 2.5 to 4.0 hence, shows the allometric growth pattern of fishes. To confirm the significance of departure of *b*-value from its ideal value (*b*=3), the t-test was carried out at 5% significance level (P<0.05). For this purpose, null hypothesis H_o: *b*=3.0 against the alternative hypothesis H_a: $b \neq 3$ was tested as follows,

$$t = \frac{(b-3)}{S.E\,(b)} \quad (3)$$

where:

t = t-statistics; b = regression coefficient; $S.E\ (b)$ = standard error of regression coefficient b

Condition factor (K). Condition factor (K) explains the degree of fitness or health of a fish. In the present study, the following equation as proposed by Froese (2006) was used for the estimation of condition factor (K) for *Teraponid* species,

$$K = \frac{W}{L^3} \times 100 \quad (4)$$

where:

W = fish weight/mass in g: L = fish size/length in mm

Results and Discussion

Length-weight relationship (LWR). The estimated regression parameters for logarithmic transformed length-weight relationships of two *Teraponid* species (*Terapon jarbua* and *T. puta*) were shown in Table 1. Results for the logarithmic transformed analysis of length-weight relationship of *T. jarbua* indicated isometric growth (b=3.014) for combined sexes, while positive allometric growth (b=3.119) in males and negative allometric growth (b=2.933) in females. For *T. puta,* the value of b was estimated as 3.486 for combined sexes, 3.324 for males and 3.482 for females, which indicates a positive allometric growth pattern in combined, male, and female sexes. The values of r^2 shows significant correlation (r^2=0.80, $P<0.05$) between length-weight of combined, male, and female sexes of both *Teraponid* species of this study.

Condition factor (K). In general, the condition factor for *T. jarbua* and *T. puta* did not vary among combined sexes, male or female and were found to be similar between sexes. The mean condition factor of *T. jarbua* was calculated as 1.43 for combined sexes, 1.42 for males and 1.44 for females, respectively. Mean condition factor for *T. puta* was estimated at 1.20 for combined sexes, 1.18 for males and 1.21 for females, respectively (Table 2).

Length-weight relationship (LWR). Studies on *Terapon jarbua* have reported a wide range of length-

Table 1. Regression parameters of length-weight relationships (log W= a+ b log L) of two species of family *Teraponidae*.

Species	sex	N	Length (mm)		Weight (g)		Log a	Log b	r^2	S.E(b)	t-test	P-value
			Max	Min	Max	Min						
Terapon jarbua	Combined	676	325	153	398	48	-1.864	3.014	0.971	0.02	151.01	0.000
	Male	325	285	153	333	48	-2.005	3.119	0.969	0.03	100.85	0.000
	Female	351	325	153	398	51	-1.755	2.933	0.974	0.02	115.38	0.000
Terapon puta	Combined	622	166	103	56	10	-2.458	3.486	0.899	0.047	74.23	0.000
	Male	213	151	104	41	11	-2.280	3.324	0.872	0.087	37.9	0.000
	Female	409	166	103	56	10	-2.454	3.482	0.907	0.055	62.49	0.000

Table 2. Condition factor (K) for combined, male and female sexes of two species of family *Teraponidae*. length (L) in mm; weight (W) in g; N= sample size.

Species name	Sex	N	Total length (L)		Weight (W)		Condition factor (K)		K-values
			Range		Range		Range		Mean
			Max	Min	Max	Min	Max	Min	
Terapon jarbua									
	Combined sexes	676	325	153	398	48	1.97	1.12	1.43
	Male	325	285	153	333	48	1.97	1.18	1.42
	Female	351	325	153	398	51	1.8	1.12	1.44
Terapon puta	Combined sexes	622	166	103	56	10	2.2	0.83	1.20
	Male	213	151	104	41	11	1.49	0.83	1.18
	Female	409	166	103	56	10	2.2	0.93	1.21

weight relationships (LWRs) from across the species range (Lavergne *et al*., 2013; Manoharan *et al*., 2013; Karna and Panda, 2012; Isa *et al*., 2012; Harrison, 2001; Yanagawa, 1994;). During this study, isometric growth (*b*=3.014) was observed in combined sexes, positive allometric growth (*b*=3.119) in males and negative allometric growth (*b*=2.933) in females of *T. jarbua,* which agrees with the findings of Hussain *et al*. (2010) from Pakistan. The positive allometric growth (*b*=3.131) of *T. jarbua* has reported from the New Caledonian lagoon (Kulbicki *et al*., 2005). An isometric growth (*b*=3.0914) in males and positive allometric growth (*b*=3.3776) in females of *T. jarbua* have been reported from India (Nandikeswari *et al*., 2014). The inconsistency in the growth pattern of fishes might be due to seasonal variations or by un-evenness in sampling sites and might be due to the habitat differences (Isa *et al*., 2012). The differences in comparisons could also be attributed to the alterations in sampling because the number of specimens and length range of the sampled specimens was dissimilar among localities (Morey *et al*., 2003). An alternate explanation for the difference in these results may be due to a large percentage of small-sized specimens in the studied sample (Franco *et al.,* 2014). The transformation of *b*-value among species can be attributed to the fish weight. In this study, it was found that the weight was dependent on the individual's health, which in turn, influenced the length-weight relationship (Yousuf and Khurshid, 2008).

During this study, positive allometric growth was observed in *T. puta,* while negative allometric growth has been reported from India and Pakistan (Ahmed and Benzer, 2015; Karna and Panda, 2012). Different results of LWRs in accordance with its counter parts in Pakistan might be due to the different number of specimens examined in the study or changes in the observed length groups of the sampled specimen (Karna and Panda, 2012). In addition, small sized specimens which have not reached to adult body size also cause differences in *b*-values (Cicek *et al*., 2006), on the other hand, polluted environment and deficiency of food may possibly affect the normal growth of the fish, thus alters the *b*-values (Nyanti *et al.*, 2012).

Condition factor (K). Condition factor is widely used to find out the state of health or fitness of a fish, as it is a significant feature for fish culture management (Gopalakrishnan *et al*., 2014). K-values give the insight to understand the well-being or robustness of fish. In this study, K-values were categorized as follows: >1.60 indicated a fish in excellent condition; 1.40 indicated a well-proportioned fish; 1.20 indicated a fish in fair health; 1.00 indicated a fish in poor health (long and thin body) and 0.80 indicated a fish in extremely poor condition (Gerami *et al*., 2013). Based on these categories, *Terapon jarbua* in the current study (combined sexes, male and female) all would be considered in good health, while *T. puta* (combined sexes, male and female) all would be considered in fair health. The higher K-values for *T. jarbua* showed that they were heavier than their length, while the lower K-values for *T. puta* showed that they were lighter than their length (Shakir *et al*., 2008). Examining the K-values, Lavergne *et al*. (2013) had reported the good health of *T. jarbua* during the post-monsoon season from the wider Gulf of Aden. Ahmed and Benzer (2015) had reported good health of *T. puta* during the pre-monsoon season from Pakistan. The higher K-values at the beginning of rainy season shows a most suitable period for fish growth (Abowei, 2009a). During the rainy season, the phytoplankton production also increased which supports the good health of fish (Utete and Chikova, 2013). The higher K-values signifies that the fish was making good use of its feeding source (Parida *et al.* 2013; Abowei, 2009b) and how well the fish was in this water body (Lawson *et al*., 2010).

Conclusion

From the results of present study, it can be concluded that the environment and coast of Pakistan is suitable for the two studied *Teraponid* species (*Terapon jarbua* and *T. puta*) of this study.

Conflict of Interest. The authors declare that they have no conflict of interest.

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