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*Full Length Research Paper*

# External morphometric study of hatchery reared mahseer (*Tor putitora*) in relation to body size and condition factor

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**Different samples of Mahseer (*Tor putitora*) were examined for the study of external morphometric characters of the fish. Slopes of log transformed data were used for comparison with an isometric slopes (b=1, b= 0.33 or b= 3). Relationships between wet body weight and external body parts lengths showed that increasing trend was found in all the parameters with the increase in wet body weight. Length of all the external body parts was also found to be increase with the increase in total length of the fish. Highly significant correlation (r = 0.9436) was found with negative allometric growth in the length-weight relationship. Wet body weight showed positive correlation with external body parts length and their weights. The relationship between wet body weight and the condition factor was found linear with no significant correlation, but with total length, it showed inverse relationship with highly significant correlation. This study will help to recognize the morphometric of different variants and to improve body weight for fish breeding and commercial growth.**

**Key words**: External morphometery, body size, condition factor, *Tor putitora*.

## INTRODUCTION

In the family Cyprinidae (carps), the genera *Tor*, *Neolissochilus* and *Naziritor* are known with the common name “Mahseer”. However, Sen and Jayaram (1982) restricted the term 'Mahseer' to members of the genus *Tor.* Their distribution is known from Indonesia, Malaysia, India and Pakistan (Menon, 1992; Roberts, 1999; Mohindra et al., 2007). *Tor putitora* (Hamilton), as also known as Golden Mahasher, is a fish of the family Cyprinidae, found in Pakistan and southern Asia generally. It is considered as commercially important game fish by the anglers (Shrestha, 1990), as well as highly esteemed food fish.

It is frequently seen that in any group of animals large and small forms differ notably in the relative size of various organs or parts. Morphometrics is the quantitavie analysis of organism shape and integral component in evolutionary ecology and developmental studies in biology, while taxonomists and systematists use morphological information to describe and diagonse species (Shearer, 1994). Morphometric analysis also helps to understand the relation between body parts (Carpenter, 1996). The morphometric relationships between length and weight can be used to assess the well-being of individuals and to determine possible differences between separate unit stocks of the same species (King, 2007).

As mass verses length relationship, size of scales or other calcified tissue versus body length play an important role in determining the age and growth of fish. Therefore, the study of allometric growth has been largely based on the earlier mentioned parameters (LeCren, 1951; Weatherley, 1972)

The present topic has been neglected in Pakistan as only few workers have reported length-weight and condition factor relationship (Salam and Junjua, 1991; Javaid and Akram, 1972; Javed et al., 1992; Naeem et al., 1992; 2010a, b; Yousaf et al., 2009). This study dealt with the external morphometrics in relation to body size (length and weight) and condition factor and it is the first attempt from Pakistan providing detailed morphometric

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studies for an important omnivore game-fish, *Tor putitora*.

## MATERIALS AND METHODS

150 specimens of *Tor putitora* (immature) of variable body sizes were captured from Hatyan Nursery unit Attock, Pakistan for laboratory studies with the help of drag nets. Collected fish were transported alive to the laboratory in a plastic container. These were killed with a blow on the head, blotted dry on a paper towel, and weighed to 0.01 g on an electric balance (MP-3000, Chyo, Japan). Body length measurements were made by using wooden measuring tray fitted with a millimeter scale and vernier caliper to the nearest 0.01 cm.

The values of the compiled growth exponent were used for the calculation of the condition factor (K) by using the formula $K = 100 \times W/L^3$ following the method of Weatherly and Gill (1987) and Wootton (1990).

Statistical analysis including regression, calculation of correlation coefficients and comparison between the regression coefficents was carried out by using a computer package of statistical programmes (Lotus 1-2-3).

## RESULTS

### Relationships between wet body weight, total length and condition factor

The relationship between wet body weight and the condition factor was linear with no significant correlation, but the condition factor and total length showed inverse relationship with highly significant correlation. This showed that the condition factor did not increase with wet body weight but decreased with total length (Tables 1 and 2).

### Relationships between wet body weight and external body parts length

The relationships of wet body weight and external body parts lengths showed that all the parameters increased with total wet weight. These showed high positive correlations between the wet weight and all the external parts lengths (Table 1).

### Relationships between total length and external body parts length

The relationships between total length and external body parts showed positive relationship; they all were found to be increased with the increase in total length. They all showed positive correlation with total length. In log total length and external body parts, all showed positive correlation (Table 2).

### Relationships between wet body weight and external body parts weights

The regression correlation between wet body weight and external body parts weight were highly significant with highly significant 't' value. When the values were transformed in log, the pectoral fin weight, dorsal fin weight and caudal fin weight showed significant correlation. Pelvic fin weight and anal fin weight showed no correlation with wet body weight (Table 3).

### Relationships between total length and external body parts weights

The relationships between total length and external body parts weights showed highly positive correlation except anal fin weight which showed significant correlation. The graph showed directly proportional relationship between all.

When the values were transformed into log, anal fin weight showed no correlation with total length but the other parts showed significant correlations with total length (Table 4).

## DISCUSSION

### Wet body weight, total length and condition factor

Weight is considered to be a function of length in fish. According to Ricker (1963), the form and specific gravity of the fish remains unchanged during its life time; the value of regression coefficient 'b' would be exactly 3.0 in the relation $W= aL^b$ (Bagenal and Tesch, 1978; Wootton, 1990). According to them, growth in many cases tends to be isometric, since b= 3.0 for isometric growth. Other investigators that worked with the same or different fish species reached similar conclusion (Javaid and Akram, 1972; Salam and Janjua, 1991; Salam and Davies, 1992; Salam and Khaliq, 1992; Salam et al., 1993). The values b of length-weight relationship of this study was found in usual range (2.5 to 3.5) as defined by Carlander (1969). The variation in the 'b' value of different species or the same species may be due to feeding (LeCren, 1951), state of maturity (Frost, 1945), sex (Hile and Jobes, 1940) and different population of species (Jhingran, 1968).

Condition factor (K) provides external measures of overall health. In other words when the value of b=3.0, then the K would remain constant without any change. If, however, the weight increases more rapidly than the cube of length, the condition factor would increase with the increase of length and when the weight increases less than the cube of length, then K would tend to decrease with the growth of fish.

The condition factor (K) showed a decreasing trend with increasing length and there was no influence with the increase in weight in this study. This result was found different from other studies such as by Salam et al. (1993) on freshwater Chinese Carp, Samat et al. (2008) on *Pterygoplichthys pardalis,* Shakir et al. (2008) on

**Table 1.** Morphometric relationships between body weight (W, g) and external morphology for hatchery reared immature *Tor putitora* from Pakistan.

| Relationship | r | a | b | S. E. (b) | t value when b= 0.33 |
|---|---|---|---|---|---|
| Log body weight (x)<br>Log condition factor(y) | 0.1339 $^{ns}$ | -0.1469 | -0.0488 | 0.0300 | -11.048*** |
| Log body weight (x)<br>Log fork length (y) | 0.9395*** | 0.6435 | 0.3577 | 0.0108 | -30.198*** |
| Log body weight (x)<br>Log standard length (y) | 0.8824*** | 0.6111 | 0.3466 | 0.0154 | -21.082*** |
| Log body weight (x)<br>Log head length (y) | 0.8808*** | 0.0799 | 0.3161 | 0.0141 | -23.088*** |
| Log body weight (x)<br>Log body girth (y) | 0.2564** | 0.4889 | 0.2196 | 0.0687 | -4.584*** |
| Log body weight (x)<br>Log eye diameter (y) | 0.4881*** | -0.3920 | 0.2413 | 0.0358 | -8.977*** |
| Log body weight (x)<br>Log inter orbital width (y) | 0.7568*** | -0.3487 | 0.2428 | 0.0174 | -18.723*** |
| Log body weight (x)<br>Log gap of mouth (y) | 0.7852*** | -0.5173 | 0.3178 | 0.0208 | -15.548*** |
| Log body weight (x)<br>Log pre orbital length (y) | 0.7039*** | -0.5595 | 0.3735 | 0.0313 | -10.170*** |
| Log body weight (x)<br>Log post orbital length(y) | 0.8064*** | -0.2204 | 0.3079 | 0.0188 | -17.245*** |
| Log body weight (x)<br>Log pre-dorsal length (y) | 0.9073*** | 0.3368 | 0.3161 | 0.0122 | -26.733*** |
| Log body weight (x)<br>Log post dorsal length (y) | 0.8541*** | 0.0769 | 0.4055 | 0.0205 | -15.692*** |
| Log body weight (x)<br>Log pre-pelvic distance (y) | 0.9121*** | 0.3317 | 0.3241 | 0.0121 | -26.949*** |
| Log body weight (x)<br>Log caudal Peduncle length (y) | 0.7831*** | -0.2185 | 0.3806 | 0.0251 | -12.767*** |
| Log body weight (x)<br>Log caudal peduncle height (y) | 0.7655*** | -0.3852 | 0.3338 | 0.0233 | -13.829*** |
| Log body weight (x)<br>Log dorsal fin length (y) | 0.8733*** | 0.0111 | 0.3398 | 0.0157 | -20.679*** |
| Log body weight (x)<br>Log dorsal fin base (y) | 0.6064*** | -0.4586 | 0.4878 | 0.0531 | -5.727*** |
| Log body weight (x)<br>Log pectoral fin base (y) | 0.6918*** | -0.8829 | 0.3921 | 0.0340 | -9.314*** |
| Log body weight (x)<br>Log pelvic fin length (y) | 0.8419*** | -0.1264 | 0.3208 | 0.0171 | -18.977*** |
| Log body weight (x)<br>Log pelvic fin base (y) | 0.6947*** | -0.9434 | 0.4026 | 0.0346 | -9.135*** |
| Log body weight (x)<br>Log anal fin length (y) | 0.8247*** | -0.1176 | 0.3359 | 0.0191 | -16.942*** |
| Log body weight (x)<br>Log anal fin base (y) | 0.7317*** | -0.8105 | 0.4377 | 0.0339 | -9.297*** |
| Log body weight, (x)<br>Log caudal fin length (y) | 0.7792*** | 0.1700 | 0.2858 | 0.0191 | -16.992*** |
| Log body weight (x)<br>Log caudal fin base (y) | 0.8576*** | -0.4048 | 0.3571 | 0.0178 | -18.182*** |
| Log body weight (x)<br>Log maxillary barbles (y) | 0.5641*** | -0.502 | 0.3764 | 0.0458 | -6.829*** |

**Table 1**. continues.

| | | | | | |
|---|---|---|---|---|---|
| Log body weight (x)<br>Log mandibular barbles (y) | 0.7047*** | -0.4585 | 0.3438 | 0.0287 | -11.154*** |

r = Correlation coefficient; a = intercept; b = slope; S.E= standard error; ***=P < 0.001; **=P < 0.01; n.s. = P > 0.05.

**Table 2.** Morphometric relationships between total length (TL, cm) and external morphology for hatchery reared immature *T. putitora* from Pakistan.

| Relationship | r | a | b | S. E. (b) | t value when b= 3, b= 1 |
|---|---|---|---|---|---|
| Log total length (x)<br>Log wet weight (y) | 0.9436*** | -1.6998 | 2.5258 | 0.0736 | -38.236*** |
| Log total length (x)<br>Log condition factor (y) | 0.4517*** | 0.2646 | -0.4407 | 0.0723 | -41.948*** |
| Log total length (x)<br>Log fork length (y) | 0.9883*** | -0.0719 | 1.0073 | 0.0129 | -76.512*** |
| Log total length (x)<br>Log standard length (y) | 0.9217*** | -0.0750 | 0.9692 | 0.0339 | -28.529*** |
| Log total length (x)<br>Log head length (y) | 0.9101*** | -0.5360 | 0.8743 | 0.0331 | -29.337*** |
| Log total length (x)<br>Log body girth (y) | 0.2623** | 0.0673 | 0.6014 | 0.1837 | -4.842*** |
| Log total length (x)<br>Log eye diameter (y) | 0.5173*** | -0.8799 | 0.6845 | 0.0940 | -9.954*** |
| Log total length (x)<br>Log inter orbital width (y) | 0.7651*** | -0.8067 | 0.6571 | 0.0459 | -21.129*** |
| Log total length (x)<br>Log gap of mouth (y) | 0.7935*** | -1.1165 | 0.8597 | 0.0548 | -17.388*** |
| Log total length (x)<br>Log pre orbital length (y) | 0.7171*** | -1.272 | 1.0184 | 0.0822 | -11.147*** |
| Log total length (x)<br>Log post orbital length(y) | 0.8429*** | -0.8306 | 0.8616 | 0.0457 | -21.020*** |
| Log total length (x)<br>Log pre-dorsal length (y) | 0.9443*** | -0.2857 | 0.8807 | 0.0255 | -38.335*** |
| Log total length (x)<br>Log post dorsal length (y) | 0.8850*** | -0.7163 | 1.1246 | 0.0491 | -19.242*** |
| Log total length (x)<br>Log pre-pelvic distance (y) | 0.9441*** | -0.3012 | 0.8978 | 0.0260 | -37.564*** |
| Log total length (x)<br>Log caudal peduncle length (y) | 0.8325*** | -0.9914 | 1.0830 | 0.0599 | -15.611*** |
| Log total length (x)<br>Log caudal peduncle height (y) | 0.7476*** | -0.9832 | 0.8728 | 0.0644 | -14.655*** |
| Log total length (x)<br>Log dorsal fin length (y) | 0.9214*** | -0.6713 | 0.9595 | 0.0336 | -28.802*** |
| Log total length (x)<br>Log dorsal fin base (y) | 0.6377*** | -1.4336 | 1.3729 | 0.1377 | -5.889*** |
| Log total length (x)<br>Log pectoral fin base (y) | 0.7180*** | -1.6519 | 1.0894 | 0.0877 | -10.313*** |
| Log total length (x)<br>Log pelvic fin length (y) | 0.8975*** | -0.7805 | 0.9154 | 0.0374 | -25.823*** |
| Log total length (x)<br>Log pelvic fin base (y) | 0.7516*** | -1.7822 | 1.1661 | 0.0850 | -10.599*** |

**Table 2**. continues.

| | | | | | |
|---|---|---|---|---|---|
| Log total length (x)<br>Log anal fin length (y) | 0.8747*** | -0.7975 | 0.9536 | 0.0439 | -21.825*** |
| Log total length (x)<br>Log anal fin base (y) | 0.7512*** | -1.6554 | 1.2031 | 0.0878 | -10.186*** |
| Log total length (x)<br>Log caudal fin length (y) | 0.8266*** | -0.4086 | 0.8116 | 0.0459 | -20.975*** |
| Log total length (x)<br>Log caudal fin base (y) | 0.8486*** | -1.0572 | 0.9459 | 0.0490 | -19.462*** |
| Log total length (x)<br>Log maxillary barbles (y) | 0.5704*** | -1.2123 | 1.0188 | 0.1218 | -7.191*** |
| Log total length (x)<br>Log mandibular barbles (y) | 0.7311*** | -1.1324 | 0.9548 | 0.0740 | -12.559*** |

r = Correlation coefficient; a = intercept; b = slope; S.E= standard error; ***=P < 0.001; **=P < 0.01.

**Table 3.** Morphometric relationships between body weight (W, g) and fins weight for hatchery reared immature *T. putitora* from Pakistan.

| Relationshi | r | a | b | S. E. (b) | t value when b= 1 |
|---|---|---|---|---|---|
| Log body weight (x)<br>Log dorsal fin weight (y) | 0.369** | -1.632 | 0.391 | 0.122 | -7.793*** |
| Log body weight (x)<br>Log pectoral fin weight (y) | 0.358** | -2.014 | 0.335 | 0.109 | -8.870*** |
| Log body weight (x)<br>Log caudal fin weight (y) | 0.375** | -1.529 | 0.373 | 0.114 | -8.364*** |

r = Correlation coefficient; a = intercept; b = slope; S.E= standard error; ***=P < 0.001; **=P < 0.01.

**Table 4.** Morphometric relationships between total length (TL, cm) and fins weight for hatchery reared immature *T. putitora* from Pakistan.

| Relationship | r | a | b | S. E. (b) | t value when b= 0.33 |
|---|---|---|---|---|---|
| Log total length (x)<br>Log dorsal fin weight (y) | 0.340** | -2.283 | 0.969 | 0.332 | -8.061*** |
| Log total length (x)<br>Log pectoral fin weight(y) | 0.363** | -2.662 | 0.916 | 0.291 | -9.384*** |
| Log total length (x)<br>Log caudal fin weight (y) | 0.385** | -2.260 | 1.029 | 0.306 | -8.765*** |

r = Correlation coefficient; a = intercept; b = slope; S.E= standard error; ***=P < 0.001; **=P < 0.01.

*Sperata sarwari* and Abowei (2009) on *Sardinella madernensis.* However, Naeem et al. 2010b found the condition factor to remain constant with increasing length or weight in the farmed hybrid (*Catla catla* ♂ x *Labeo rohita* ♀). This variation in different studies may be due to a number of factors, such as age, sex, maturity, food availability, parasitism and fluctuating periods of growth in the summer and winter which can also bring about variations in the value of 'K' (LeCren, 1951; Javaid and Akram, 1972; Salam and Junjua, 1991).

## Wet body weight and external body parts length

Food is the major limiting biotic factor affecting growth in fishes. Fish which eats other fish tend to have large mouth gaps and large well developed teeth, fish which feed on small prey items usually have small mouths and teeth, longer and numerous gill rackers and long intestines (Nikolski, 1963). In the case of mouth gap, it showed isometric growth against total length; this study is in general agreement with the conclusions drawn for silver carp and grass carp (Ammanullah et al., 1999).

Highly significant positive correlation was found between log transformed data of all the parameters versus log wet body weight. Relative growth of the body parts was classified as negative or positive allometery where 'b' differed significantly ($P < 0.05$) from 0.33. Allometery with 'b' values not differing significantly from 0.33 was classified as isometry (b= 0.33).

### Total length and external body parts length

Relative growth of an external body part was classified as negative allometric (b<1) or positive allometric (b>1), where b differed significantly ($P < 0.05$) from unity. An allometery not differing significantly from unity was classified as isometry (b= 1). These studies were also showed in *Brycinus nurse* (Saliu and Fagade, 2004) and in *Trachurus mediterraneus ponticus* (Yankova and Raykov, 2006).

### Wet body weight and body parts weight relationship

Relative growth of the external body parts was classified as negative or positive allometery, where 'b' differed significantly ($P < 0.05$) from unity. Allometery with 'b'value not differing significantly from 0.33 was classified as isometry. This was also shown in *Ctenopharyngodon idella* (Ammanullah et al., 1999), in *B. nurse* (Saliu and Fagade, 2004) and in *T. mediterraneus ponticus* (Yankova and Raykov, 2006).

### Total length and body parts weight relationship

During growth, change in size brings about changes in shape and body proportions. The analysis of allometric relationship in animal has attracted considerable attention among zoologists (Huxley, 1932; Wootton, 1990; Alexander, 1971; Lagler et al., 1977; Schmidtt and Nielson, 1984; Salam and Davies, 1992). Relative growth of external body parts was classified as negative or positive allometery, where 'b' differed significantly ($p < 0.05$) from 3. Allometery with 'b' value not differing significantly from 3 was classified as isometry (b= 3). These studies were also showed in *Hypophthalamicthys molitrix* (Ammanullah et al., 1999).

### Conclusion

This investigation showed an increasing trend in the growth of all the studied external body parts with increase in the size of the fish. Total length of the fish showed negative allometric growth. The condition factor was found to remain constant with increasing weight, while it showed a highly significant inverse correlation with an increase in the total length of the fish. However, there would be need for more studies on the morphometrics and condition factors of the same fish species from different localities, to be able to improve body weight for fish breeding and commercial growth.

### REFERENCES


Abowei JFN (2009). The Abundance, Condition Factor and Length-Weight Relationship of *Sardinella madernensis* (Jenyns, 1842) from Nkoro River Niger Delta, Nigeria. Adv. J. Food Sci. Technol. 1(1): 66-71.

Alexander RM (1971). Size and shape. Institute of Biology. Students in Biology Series No. 29. Edward Arnold Press, London.

Ammanullah, Salam A, Bahtti MN (1999). Effect of size on the processing yield components of grass carp, *Ctenopharyngodon idella* Val: Acta Sci. 9(2): 33-50.

Bagenal T, Tesch FW (1978). Age and Growth In Bagenal T (ed) Method for Assessment of Fish Production in Fresh water. IBP Handbook, Blackwell Scientific Press, Oxford.

Carpenter K, Sommer HJ III, Marcus LF (1996). Converting truss interlandmark distances to Cartesian Coordinates. In: Marcus LF, Corti M, Loy A, Naylor G and Slice DE (eds). Advances in morphometrics. ATO ASI series A; Life Sciences, New York Plenum Publ. 284: 103-111.

Frost WE (1945). The age and growth of eels. (*Angulla angulla*) from the Windermere Catchment area. Part 2. J. Anim. Ecol. 4: 106-124.

Hile R, Jobes FW (1940). Age, growth and production of yellow perch, *Perca flavescens* (Mitchill) of saginaw Bay. Trans. Am. Fish. Soc. 70: 102-122.

Huxley JS (1932). Problems of relative growth. Methven. , London.

Javaid MY, Akram M (1972). Length - Weight relationship of some fishes of Punjab. Bull. Dept. Zool. Pub. Univ. 6: 1-*27.*

Javed MY, Salam A, Khan MN, Naeem M (1992). Weight length and condition factor relationships of fresh water wild Mahseer, *Tor putitora* from Islamabad, Pakistan. Proc. Pak. Cong. Zool. 12: 335-340.

Jhingran VG (1968). Synopsis onbiological data on *Catla catla* (Ham.,1822), FAO Fish synops. (32): 1.

King M (2007). Fisheries biology, assessment and management. 2nd Ed. Oxford: Blackwell Scientific Publications, pp. 1-381.

Lagler KF, Bardach E, Miller RR, Passino DM (1977). Ichthyology, 2'a ed., John Willey and sons, Inc., New York.

LeCren ED (1951). The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). J. Anim. Ecol. 20: 201-219.

Menon AGK (1992). Taxonomy of mahseer fishes of the genus Tor Gray with description of a new species from the Deccan. J. Bombay Nat. Hist. Soc. 89(2): 210-228.

Mohindra V, Khare, Praveen, Lal KK, Punia P, Singh RK, Barman AS, Lakra WS, Lakra (2007). Molecular discrimination of five Mahseer species from Indian peninsula using RAPD analysis. Acta Zool. Sin. 53(4): 725-732.

Naeem M, Salam A, Gillani Q, Ishtiaq A (2010a). Length-weight relationships of *Notopterus notopterus* and introduced *Oreochromis niloticus* from the Indus River, southern Punjab, Pakistan J. Appl. Ichthyol. 26(4): p. 620.

Naeem M, Salam A, Ishtiaq A, Shafique S (2010b). Length- weight and condition factor relationship of farmed hybrid (*Catla catla* ♂ x *Labeo rohita* ♀) from Multan, Pakistan. Sindh Univ. Res. J. Sci. Ser. 42(2): 35-38.

Naeem M, Salam A, Khan MN (1992). Morphometric studies of an exotic fish *Oreochromis nilotica* in relation to body size. Proc. Pak. Cong. Zool. 12: 599-605.

Nikolski GV (1963). The ecology of fishes. Academic Press. New York, p. 352.
Ricker WE (1963). Hand book of computations for biological statistics of fish population. Fish. Res. Bd. Can. Bull. p. 191.
Roberts TR (1999). Fishes of the cyprinid genus Tor in the Nam Theun watershed, Mekong Basin of Laos, with description of a new species. Raffles Bull. Zool. 47(1): 225-236.
Salam A, Davies PMC (1992). Weight-Length relationship of fresh water gold fish, *Carassius auratus.* Pak. J. Zool. 24: 329-331.
Salam A, Khaliq R (1992). Weight-length and condition factor relationship of a farmed mirgala, *Cirrhinus mirgala*. J. Res. Sci. 4: 39-43.
Salam A, Mahmood JA, 1993. Weight-Length and condition factor relationship of a fresh water under yearling wild, *Catla catla* (Hamilton) from River Chenab (Multan). Pak. J. Zool. 25 (2): 127-130.
Salam A, Naeem M, Bokhari ZD (1993). Weight Length and condition factor relationship of a fresh water Chinese carp, *Aristichthys nobilis* from fish hatchery, Islamabad, Pakistan. J. Res. Sci. 5(2): 45-48.
Salam A, Janjua MY (1991). Morphometric studies in relation to body size of farmed rahu, *Labeo rohita.* A cultureable major carps from Multan. J. Res. Sci. 3: 59-63.
Saliu JK, Fagade SO (2004). The structural and functional morphology of the hard parts of *Brycinus nurse* (Pisces: Cypriniformes, Characidae), From Asa Reservoir, Horin, Nigera. Turk. J. Fish. Aquat. Sci. 4: 23-31.
Samat A, Shukor MN, Mazlan AG, Arshad A, Fatimah MY (2008). Length-weight Relationship and Condition Factor of *Pterygoplichthys pardalis* (Pisces: Loricariidae) in Malaysia Peninsula. Res. J. Fish. Hydrobiol. 3(2): 48-53.
Schmidtt-Nielson K (1984). Scaling: Why is animal Size so important? Cambridge University Press, Cambridge.
Sen TK, Jayaram KC (1982). The Mahseer Fish of India - a Review. Rec. Zoological Survey of India. Misc. Publ. Occasional Paper 39, p. 38.
Shakir HA, Mirza MR, Khan AM, Abid M (2008). Weight-length and condition factor relationship of S*perata Sarwari* (singhari), from Mangla Lake, Pakistan. J. Anim. Plant Sci. 18(4): 158-160.
Shearer KD (1994). Factors affecting the proximate composition of cultured fishes with emphasis on salmonids. Aquaculture, 119: 63-88.
Shrestha TK (1990). Behaviour of golden mahseer *T. putitora* (Ham) in nature and captivity. J. Freshwat. Biol. 2: 209-2019.
Weatherley AH, Gill HS (1987). The biology of fish growth. Academic Press, London, pp. 1-443.
Weatherley AH (1972). Growth and Ecology of Fish Populations. Academic Press, London.
Wootton RJ (1990). Ecology of Teleost Fishes. Chapman and Hall, London.
Yankova MH, Raykov VS (2006). Morphological properties of horse Mackerel, Trachurus nediterraneus ponticus Aleev, 1956 (Osteichthyes; Caranchdae) from the black sea. Turk. J. Fish. Aquat. Sci. 6: 85-91.
Yousaf M, Salam A, Naeem M (2009). Length–weight relationships of *Wallago attu* and *Sperata sarwari* from the Indus River, southern Punjab, Pakistan. J. Appl. Ichthyol. 25: 614-615.