INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print), 2222-5234 (Online)
http://www.innspub.net
Vol. 16, No. 4, p. 277-289, 2020

RESEARCH PAPER OPEN ACCESS

# Length-weight relationship and condition factor for cyprinid fish species found in lower Zhob river, northern Balochistan, Pakistan

**Nadia Naseeb, Asmatullah Kakar*, Wali Mohammad, Mahrukh Naseem, Zafarullah, Farah Naz**

[1]*Government Post-Graduate Girls College Cantt., Department of Zoology, University of Balochistan, Quetta-87300, Pakistan*

**Key words:** Cyprinid fishes, Condition factor, Length-weight relationships, Zhob River.

http://dx.doi.org/10.12692/ijb/16.4.277-289 Article published on April 29, 2020

## Abstract

This research study was conducted with the aim to evaluate the length-weight relationship (LWR) parameters and condition factor (K) for three native fish species, namely, *Labeo rohita*, *Cyprinion watsoni* and *Garra gotyla* . A total of 756 specimens including 251 *L. rohita*, 255 *C. watsoni*, and 250 *G. gotyla* were caught by scoop net in the months of February, March, and September, October 2019 from the lower Zhob River, in northern Balochistan. The estimated total length and total weight for these specimens were ranged from 7 to 18.9 cm and 5 to 79 g; 6.8 to 18.9 cm and 2 to 73 g; 7.5 to 17.6 cm and 5 to 68 g respectively. Based on the results, the values of b varied between 1.25 for *Garra gotyla*, to 3.19 for *Cyprinion watsoni*. All length-weight relationships were significant (P<0.001), with r greater than 0.97. The condition factor (K value) were found to be between 0.035±0.034 for *G. gotyla* to 0.33±.0.11 for *C. watsoni,* whereas the r2 values ranged from 0.976 (*L. rohita*) to 0.955 (*G. gotyla*). r 2 >0.98 indicated highly significant correlation between length-weight, total length, and standard length for the three fish species. All linear regressions were highly significant (P<0.05).The overall value of the exponent of LWR (*b* = 1.25) suggested negative allometric growth. Furthermore, the first reference for separate male, female and combined (mixed) sex of length-weight relationships for *L. rohita*, *C. watsoni*, *G. gotyla* were furnished. The results of the present study will contribute to the proper management, growth of collected fish species and might be used to fill a space in the current knowledge in this area.

* **Corresponding Author:** Asmatullah Kakar ✉ asmardanzai@yahoo.com

## Introduction

Length-weight relationships (LWRs) of fish species are essential parameters for fisheries management and conservation programs, as well as for exploitation prevention of young individuals and the consequent reduction in the spawning stock (Le Cren, 1951; Froese, 2006; Vicentin *et al.*, 2012). In fisheries biology, LWRs are normally used to convert length measures into weight and to determine the growth characteristics related to those variables (GallI and Norbis, 2016). On the other hand, LWRs are utilized for estimating fishes' condition factor, these values are used for comparing the "condition", "fatness" or "well-being" of fish (Le Cren, 1951; Froese, 2006). The condition factor (K) could reflect the physiology of a fish, which is influenced by both intrinsic (gonadal development, organic reserves, presence or absence of food in the gut) and extrinsic (food availability, environmental variability) factors (Nikolsky, 1969). Condition factor is used as an indirect morphological indicator for fish farmers and ichthyologists to estimate fish growth. It is an index of feeding intensity and growth (Fagade, 1979) which reveals information on the biological state of fish in relation to its well-being (Abowei, 2010; Omar *et al.*, 2015; Stavrescu-Bedivan *et al.*, 2016). In terms of nutrition it shows a proper accumulation of fat due to proper feeding. Moreover, it also reveals the appropriateness of a specific water body for fish growth (Le Cren, 1951).

Morphometric information has an eminent role in fishery biology involving various trends with the life history of fishes (Ferdaushy and Alam, 2015). Statistical relationships among morphometric measurement of fishes are also vital for both taxonomists (Simon *et al.*, 2010) and fishery biologists (Mustafa and Brooks, 2008). Length-weight relationships in fisheries management are dominant and widely employed techniques that are used to estimate the biomass (Adarsh and James, 2016). The relationship between length and weight of fish is a known tool in fisheries sciences to calculate mean weight of the fish stock from known length of the group by establishing precise mathematical equation between length and weight (Le Cren, 1951; Gupta and Banerjee, 2015).

LWR studies are often used to indicate the prosperity of a fish (Safran, 1992), aquatic habitat (Pauly, 1993) and ecosystem modeling (Kulbicki *et al.*, 2005). It is a valuable technique that provides evidence on the spatial distribution of different fish species and reproductive history (Kara and Bayhan, 2008). Moreover, it is also a pivotal prerequisite to find some aspects of fish population dynamics like age structure and growth pattern i.e., allometric or isometric (Le Cren, 1951; Quist *et al.*, 2012).

Zhob River is the main basin in the north-western Balochistan and the second largest river of the province with a water shedding a distance of about 400 km (https://en.wikipedia.org.List of rivers of Pakistan, 2017). From Kunder Mountains, lies between Muslim Bagh and Kan-Mehtarzai, the meltwater forms the Zhob River which flows through eastnorthly and drains into the Gomal River near Khajuri Kach (Khyber Pakhtunkhwa province, Pakistan) after passing 4 km of Zhob city. The Zhob town is located on the east banks of Zhob River. There is still a scarcity of biometric data on fish species living in this water basin. Hence, the aim of this study was to calculate the length-weight relationship, and Fulton's condition factor for the fish species collected in order to expand the biological knowledge especially the growth pattern and physical or heath conditions of fishes at Zhob river basin. These are the first estimated parameters of length-weight relationships for the fish species inhabiting the Zhob River.

## Materials and methods

*Study sites*

A total of 756 specimens belong to the fish family Cyprinidae (Labeo rohita, Cyprinion watsoni, Garra gotyla) were captured by drag net on monthly base (February, April, August, September) 2019 from lower Zhob River at Badanzai dame (gps-coordinates: 32°03'60.00" N 69°50'59.99" E), Deragai village basin (31°.41'8373" N , 69°.39'4416" E) and Viyala tributary (31°25'02.5"N 69°27'56.6"E) during 2019

(Figs.1,2A,B,C). The dame is located across Zhob River at about 27 km South of Zhob Town, while Deragai basin and Viyala tributary lies nearly14 km North West of the town (District Zhob) in Balochistan province. Total catch comprise 251 individuals of Labeo rohita, 255 Cyprinion watsoni and 250 Garra gotyla.


**Fig. 1.** Map of district Zhob showing sampling points (red) of study area.

*Measurement and identification of specimens*

Total length (cm) and wet body weight (g) was measured, on arrival to laboratory, to the nearest 0.1cm and 0.01g, by using wooden measuring tray with centimeter scale and electronic weight balance for each fish sample was noted respectively. Measurement of each fish species was done from the tip of snout to the end of caudal fin then fishes were immediately preserved in 4% formaldehyde solution for about one week, and after that stored in 70% ethanol for long time preservation. Each specimen was identified to species level in the field as well as in laboratory by using the keys of (Talwar and Jhingran, 1991).

*Length-weight relationship (LWR)*

Length-weight relationship (L

WR) was calculated separately for male, female and combined (mixed) sexes of each fish species. The LWR was measured by using cubic law suggested by Le Cren (1951) as follows: b w=aL

Where, W is the wet weight in grams, L is the total body length in centimeters; a is the intercept and b is the exponent or regression slope.

In order to confirmed that whether length and weight were linearly related with each other, the slope of the regression line (b) was subjected to t-test at 5% significant level ($p<0.05$).

*Log W=Log a+b log L*

The values of an exponent b of the length-weight relationship was tested for departure from its ideal value, that is b=3, when growth is isometric. Where b is an exponent or allometric growth coefficient usually has value between 2.5 to 4.0. Therefore, Hence, LWRs (logarithmic) was used to check whether the growth was positive or negative allometric (Kumolu Johnson and Ndimele, 2010).

*Condition factor (K)*

Fulton's condition factor (K) of three fish species were calculated using the formula with the help of following formula suggested by Offem *et al.* (2009) as follows:

$K = 100 \times W/(TL)3$

Where W is the total body weight and L is the total body length.

*Parabolic Cube law*

Parabolic Cube law equation [Weight (W) = a × Total Length (TL) b] is mostly used to depict the LWR (Le Cren, 1951). Linear regression [Log W = a + b Log TL] of this cube law equation was adopted to estimate LWRs.

Where: a = intercept of the regression, b = slope or regression coefficient Moreover, for LWRs, outliers were detected by plotting a straight line graph of log (a) against (b), and regression analyses were redone after excluding outliers. Multiple regression analysis was also performed for total length, weight and condition factor.

*Statistical analysis*

Data were treated statistically by using MS-Excel and MINITAB for Windows-7. In all the tests, the significance level considered was $p$=0.05.The statistical significance of the slope (b), the intercept (a) and the correlation coefficient (r) using Student's *t*-test (Sokal and Rohlf, 1995) were analyzed. In order to check whether fish growth was statistically different from isometric growth (b=3), a Student *t*-test was performed.

**Results and discussion**

A total of 756 specimens including 339 male and 417 female belonging to three fish species (*Labeo rohita*, *Cyprnion watsoni* and *Garra gotyla*) representing the single family Cyprinidae were used for calculation of the length-weigh relationships (Table 1).

**Table 1.** Fish species count captured from different water basin on lower Zhob River.

| Fish species | Family | Subfamily | No. of specimens collected | | | | Collection site |
|---|---|---|---|---|---|---|---|
| | | | Male | Female | Total | Average | |
| *Labeo rohita* (Hamilton, 1822) | Cyprinidae | Labeoninae | 113 | 138 | 251 | 33.20 | Badanzai dame |
| *Cyprinion watsoni* (Day, 1872) | Cyprinidae | Cyprininae | 109 | 146 | 255 | 33.73 | Viyala village tributary |
| *Garra gotyla* (Gray, 1830) | Cyprinidae | Labeoninae | 117 | 133 | 250 | 33.06 | Deragai village basin |
| Grand Total | | | 339 (44.84) | 417 (55.2) | 756 | | |

**Table 2.** Average length and weight for *Labeo rohita*.

| Mean length | | | | Mean weight | | | |
|---|---|---|---|---|---|---|---|
| Length groups | Mixed | Male | Female | Length groups | Mixed | Male | Female |
| 7-8 cm | 0.90 | 0.9 | 0.9 | 7-8 cm | 0.88 | 0.86 | 0.89 |
| 9-10 cm | 1.00 | 1 | 1 | 9-10 cm | 1.13 | 1.13 | 1.13 |
| 11-12 cm | 1.08 | 1.08 | 1.08 | 11-12 cm | 1.43 | 1.42 | 1.43 |
| 13-14 cm | 1.15 | 1.15 | 1.15 | 13-14 cm | 1.53 | 1.52 | 1.53 |
| 15-16 cm | 1.20 | 1.2 | 1.2 | 15-16 cm | 1.64 | 1.64 | 1.64 |
| 17-18 cm | 1.25 | 1.25 | 1.25 | 17-18 cm | 1.8 | 1.81 | 1.8 |

Bayesian length-weight: a=0.00955 (0.00597 -0.01527), b=3.01 (2.88 - 3.14).

All the estimated regression coefficients were highly significant ($p$<0.0001), and ranged from 0.95 for *G. gotyla* to 0.96 for *C. watsoni* and 0.97 for *Labeo rohita*. All the b values were within the expected range from 1.3 to 3.2 (Froese, 2006). Parameter b ranged from 1.244 (*G. gotyla*) to 3.205 (*L. rohita)*, r2 values ranged from 0.976 (*L. rohita*) to 0.955 (*G. gotyla*) (Tables 5 and fig. 3, 4 & 5), whereas the average K values variegated between 0.035±0.034 for *G. gotyla* to 0.20±0.081 and 0.33±.0.11 for *L. rohita,* and *C. watsoni* respectively (Table 5).

**Table 3.** Average length and weight for *Cyprinion watsoni*.

| Mean Length | | | | Mean Weight | | | |
|---|---|---|---|---|---|---|---|
| Length Groups | Mixed | Male | Female | Length Groups | Mixed | Male | Female |
| 6-8.9 cm | 0.92 | 0.92 | 0.92 | 6-8.9 cm | 0.68 | 0.78 | 0.69 |
| 8.9-9.9 cm | 0.89 | 0.97 | 0.97 | 8.9-9.9 cm | 0.91 | 0.85 | 0.92 |
| 10-10.9 cm | 1.02 | 1.02 | 1.02 | 10-10.9 cm | 1.06 | 1.11 | 1.09 |
| 11-11.9 cm | 1.06 | 1.06 | 1.06 | 11-11.9 cm | 1.22 | 1.28 | 1.24 |
| 12-12.7 cm | 1.09 | 1.09 | 1.09 | 12-12.7 cm | 1.29 | 1.56 | 1.3 |
| 13-15.8 cm | 1.16 | 1.17 | 1.16 | 13-15.8 cm | 1.48 | 1.62 | 1.47 |
| 16-16.9 cm | 1.22 | 1.21 | 1.22 | 16-16.9 cm | 1.65 | 1.79 | 1.66 |
| 17-18.9 cm | 1.25 | 1.25 | 1.25 | 17-18.9 cm | 1.8 | 1.78 | 1.81 |

Bayesian length-weight: a=0.00955 (0.00597 - 0.01527), b=3.01(2.88 - 3.14).

**Table 4.** Average length and weight for *Garra gotyla*.

| Mean Length | | | | Mean Weight | | | |
|---|---|---|---|---|---|---|---|
| Length Groups | Mixed | Male | Female | Length Groups | Mixed | Male | Female |
| 7-8 cm | 0.91 | 0.91 | 0.9 | 7-8 cm | 0.71 | 0.71 | 0.71 |
| 9-10 cm | 1.00 | 0.99 | 1 | 9-10 cm | 0.97 | 0.95 | 0.98 |
| 11-12 cm | 1.08 | 1.08 | 1.08 | 11-12 cm | 1.21 | 1.2 | 1.22 |
| 13-14 cm | 1.14 | 1.14 | 1.15 | 13-14 cm | 1.43 | 1.4 | 1.44 |
| 15-16 cm | 1.19 | 1.2 | 1.19 | 15-16 cm | 1.58 | 1.58 | 1.57 |
| 17-18 cm | 1.23 | 1.23 | 1.23 | 17-18 cm | 1.77 | 1.77 | 1.77 |

Bayesian length-weight: a=0.00891 (0.00742 -b=3.02 (2.97 -3.07).

The species *Labeo-rohita and Garra gotyla* grew more quickly in length than in weight (i.e. negative allometry b<3), while *Cyprinion watsoni* grew more rapidly in weight than in length (positive allometry b>3) (Table 2 & 3).

Bayesian length-weight was found for *Labeo rohita*: a=0.00955 (0.00597 -0.01527), b=3.01 (2.88 - 3.14), for *Cyprinion watsoni*: a=0.00955 (0.00597 - 0.01527), b=3.01(2.88 - 3.14), and for *Garra gotyla* the Bayesian length-weight was found to be: a=0.00891 (0.00742 -b=3.02 (2.97-3.07). The length-length relations between total length, fork length, and standard length for the six fish species were highly significant (r 2 >0.98). All linear regressions were found highly significant (P<0.05).

**Table 5.** Estimated parameters of length-weight relationships and condition factor for fishes collected from lower River Zhob, northern Balochistan, Pakistan. s (sex); n=number of individuals included in the analysis; a=intercept; b=slope; r=correlation coefficient; $r^2$=coefficient of determination).

| Parameters | Fish species | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | *Labeo rohita* | | | *Cyprinion watsoni* | | | *Garra gotyla* | | |
| Sex | Male | female | mixed | male | female | mixed | male | female | mixed |
| Number (n) | 113 | 138 | 251 | 109 | 146 | 255 | 117 | 133 | 250 |
| Mean length | 3.721±1.51 | 3.668±1.49 | 3.691±1.5 | 3.3905±1.9202 | 3.3800±1.6950 | 3.10±1.1194 | 3.443±1.4059 | 3.4603±1.4126 | 3.45±0.22 |
| Mean weight | 20.818±8.49 | 20.207±8.24 | 20±8.366 | 19.2599±6.8093 | 20.374±7.20331 | 201±7.0367 | 20.19561±8.2 | 20.19021±8.24 | 20±8 |
| Exponential | 0.9509 | 0.9536 | 0.9524 | 0.1055 | 0.1136 | 0.10917 | 0.9339 | 0.94808 | 0.9345 |
| Condition factor (K) | 0.21±0.07 | 0.211±0.083 | 0.2001±0.081 | 0.0791±0.208 | 0.0341±0.168 | 0.333±0.105 | 0.092±0.048 | 0.0804±0.032 | 0.0841±0.034 |
| Coefficient correlation (r) | 0.9767 | 0.9754 | 0.9754 | 0.9689 | 0.9659 | 0.09623 | 0.9565 | 0.9545 | 0.9554 |
| Intercept (a) | 0.0503 | 0.0354 | 0.0486 | 2.2490 | 2.1747 | 2.215 | 0.0683 | 0.0533 | 0.68 |
| Slop (b) | 1.3367 | 1.3375 | 1.3373 | 3.2058 | 3.1778 | 3.198 | 1.2442 | 1.2583 | 1.2521 |
| Mini-Maximum length | 5-18.8 | 7-18.9 | 7-18.9 | 6.8-18.7 | 7-18.9 | 6.8-18.9 | 7.5-17.6 | 7.6-17.3 | 7.5-17.6 |
| Mini-Maximum weight | 5-77 | 5-79 | 5-79 | 2-70 | 2-73 | 2-73 | 5-68 | 5-68 | 5-68 |

Fish in better condition usually bear high (K) value than those in deprived condition. Applicability of (K) factor arises from the assumption that a heavier fish of a specific length contains better energy reserves and accordingly is in a better condition (Bolger and Connolly, 1989).

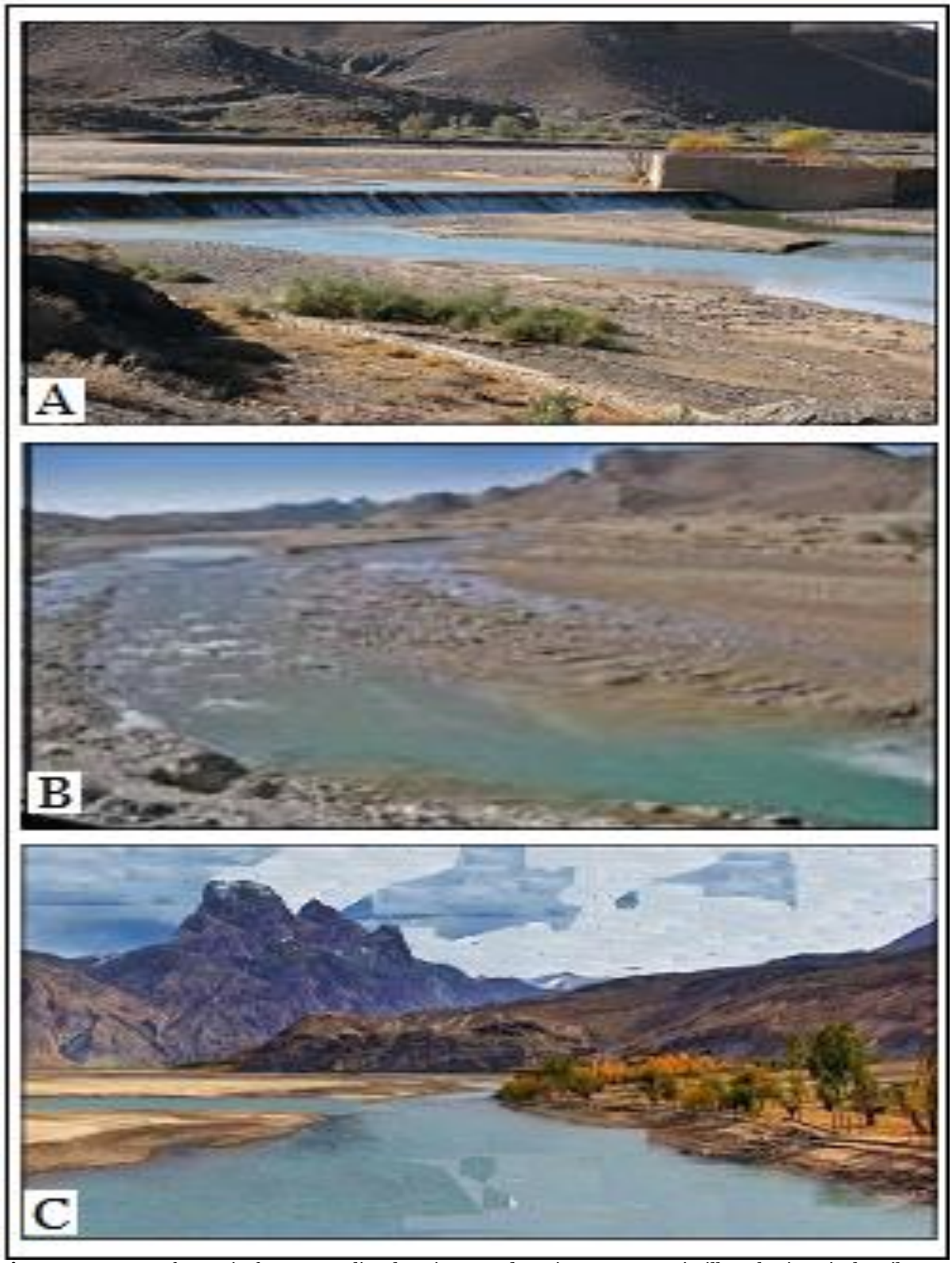


**Fig. 2.** A-C. Map of aquatic fauna sampling locations: Badanzai Dam, Deragai village basin, Viyala tributary. (PAK: Balochistan Water Resources Development: Environmental Impact Assessment.Sector Project No. 48098-002, March 2019).

The log-transformed length fitted over weight provides linear growth show the three dimensional growth structures of most fish species (Lagler *et al*., 1977; Bagenal and Tesch, 1978; Nehemia *et al*., 2012; Mozsar *et al*., 2015). When the growth is isometric, this implies that fish did not gain weight faster than the cube of their total length. However, when the weight increases faster than the cube of their total lengths (i.e. value of b>3), this describes that fish gain width or height more than its length. Conversely, when the value of 'b' is less than 3, this represents long body shape as in large specimens (Froese, 2006).

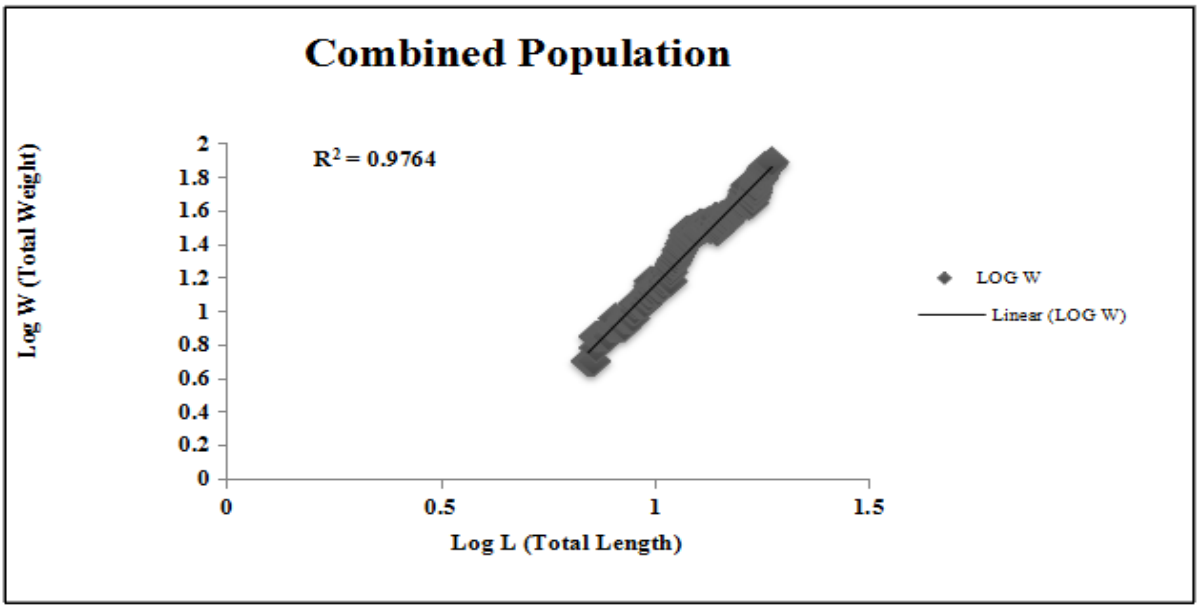


**Fig. 3.** Show $R^2$ value, total length (TL) & total weight (TW) parameters for *L. rohita*.

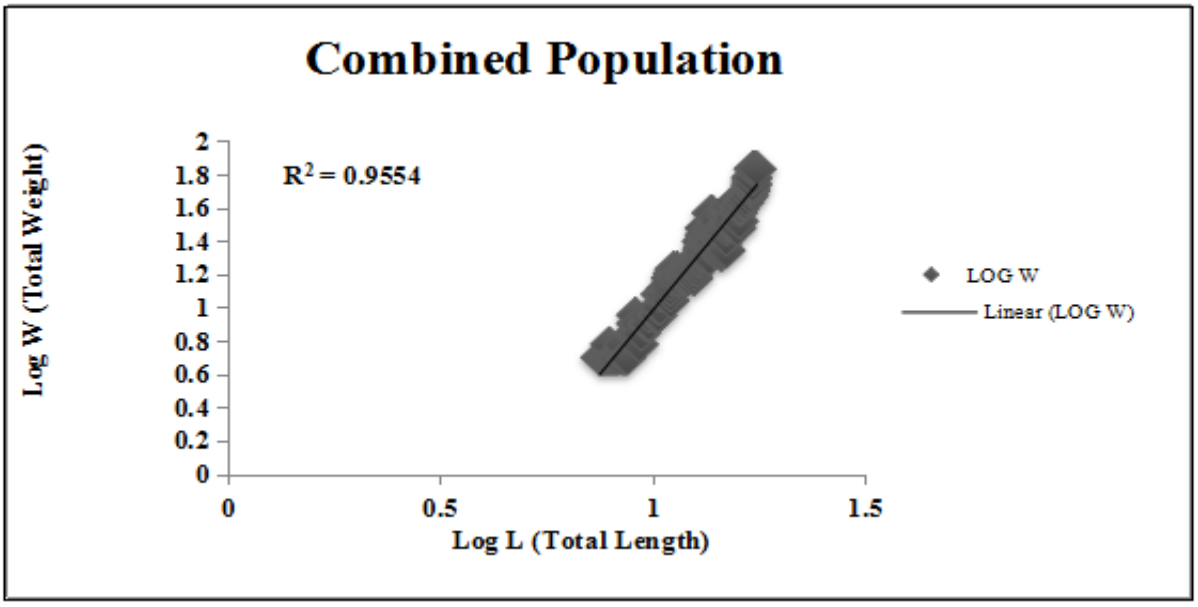


**Fig. 4.** Show $R^2$ value, TL & TW parameters for C. *watsoni*.

In the present study, a total number of 756 specimens of three freshwater fish species with a total weight and total length ranging from 7 to 18.9cm and 5 to 79g; 6.8 to 18.9cm and 2 to 73g; 7.5 to 17.6cm and 5 to 68g respectively were used for the assessment of LWRs and condition factor (Figs. 6 to 11). It can be observed from the results that total length and weight for *L. rohita*, *C. watsoni*, *G. gtyla*, and their mean values were highest in group 1 fishes and lowest in group 2 and 3 (Table 2,3,4 and 5, Figs. 2,3 and 4).

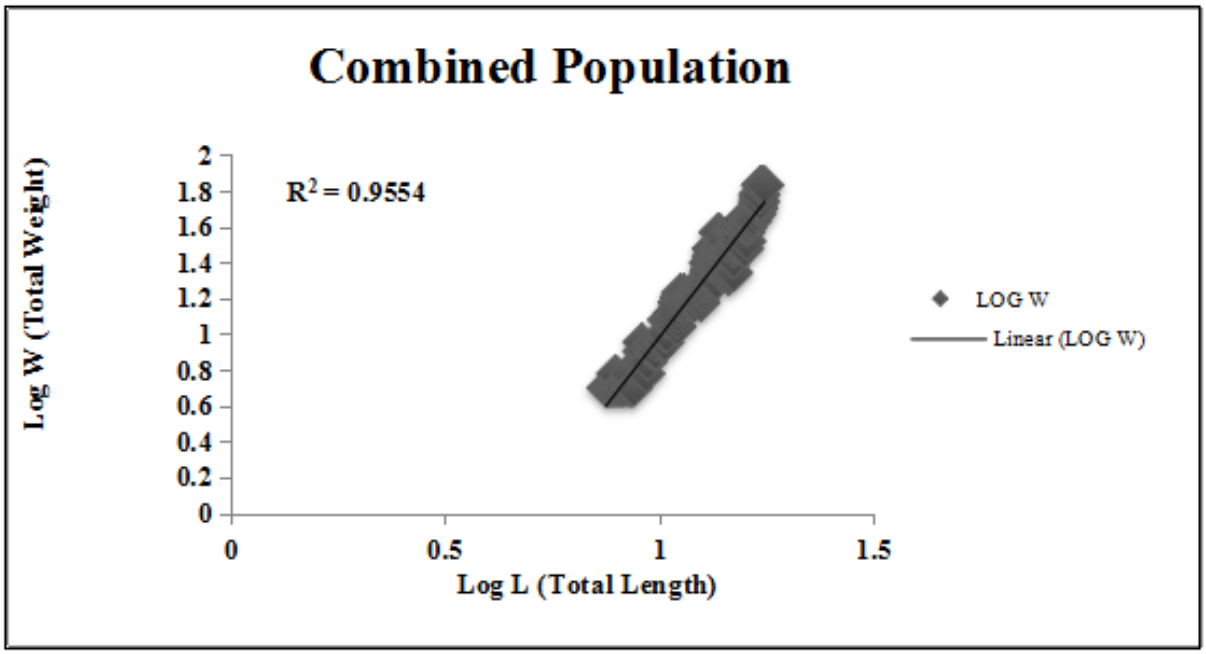


**Fig. 5.** Show $R^2$ value, TL & TW parameters for *G. gotyla*.

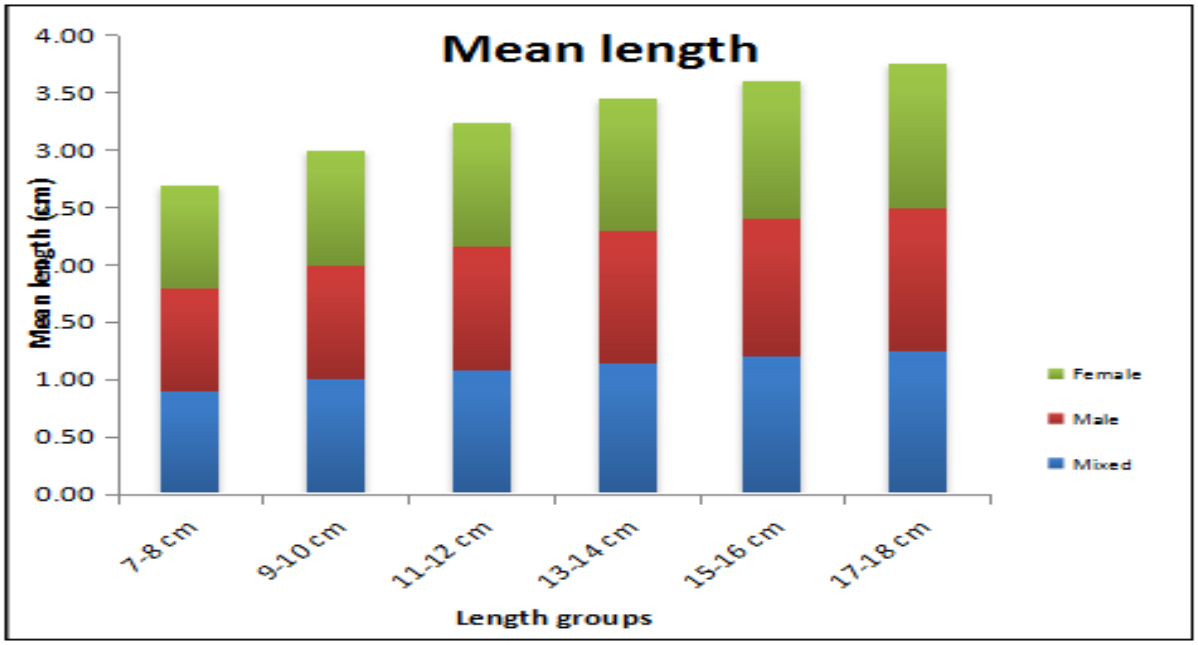


**Fig. 6.** Indicates mean length (cm) and length groups of *Labeo rohita*.

These results are in general agreement with the study of Naeem *et al.* (2012) who worked on the fish species, *Mystus blakeeri* and reported the highest weight of fish.

In the present study parametric quantity b extended from 1.337 ( *L. rohita*) to 3.288 (*C. watsoni*), these results are partially in agreement with findings of Mala-Maria *et al.* (2017) where they estimated parameter b ranged from 1.339 (*Leucaspius delineatus*) to 3.277 (*Gobio gobio*). In our study r2 values ranged from 0.976 (*L. rohita*) to 0.955 (*G. gotyla*) as shown in Figs. 4 to 6.

These results are partially in line with Mala-Maria *et al.* (2017) where they estimated the r2 values ranged from 0.723 (*Pseudorasbora parva*) to 0.935 (*Alburnus alburnus*). According to Pauly and Gayanilo (1997), b values may range from 2.5 to 3.5 suggesting that the result of the present study is valid.

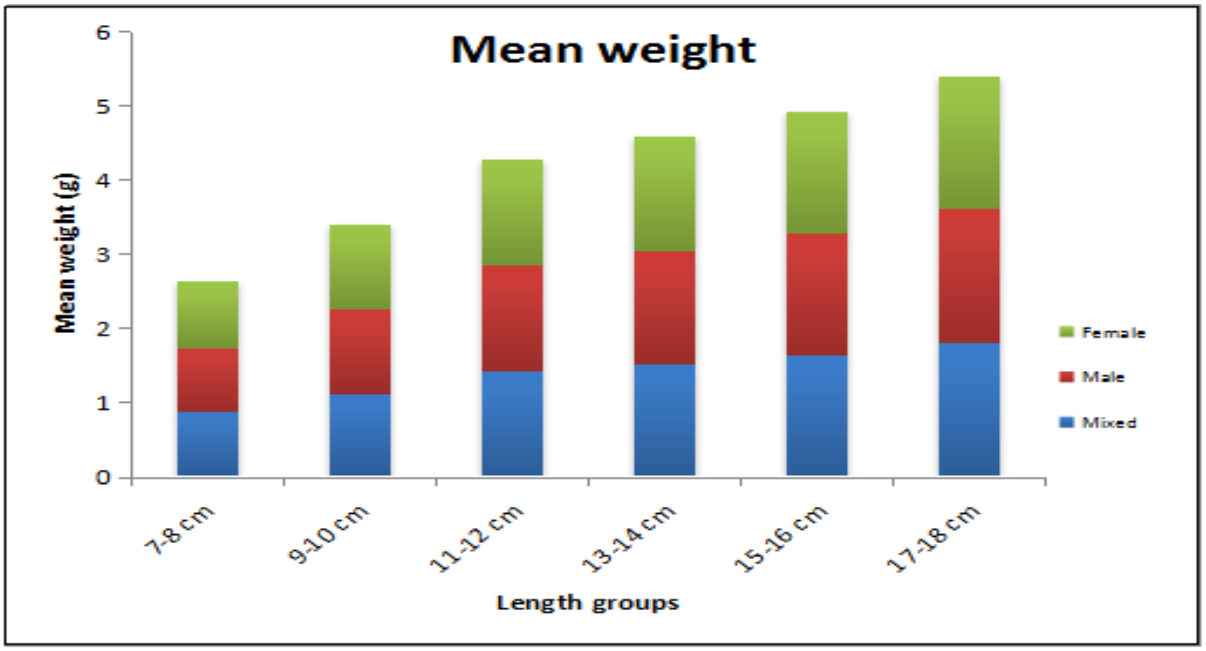


**Fig. 7.** Indicates mean weight (gm) and length groups of *Labeo rohita*.

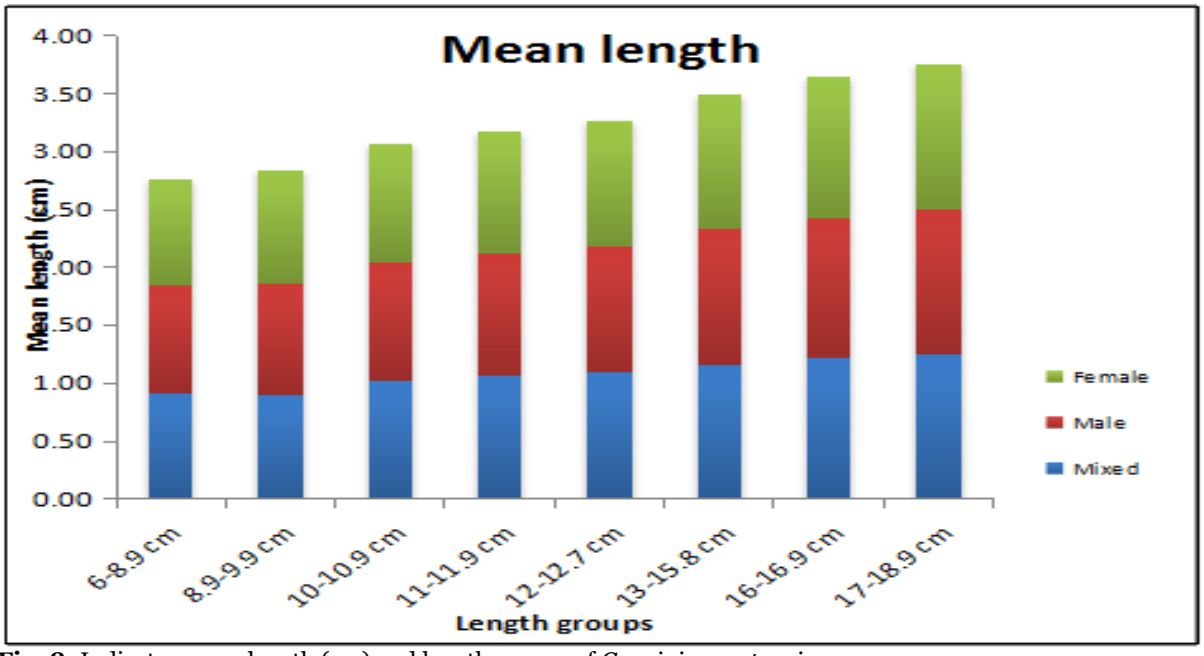


**Fig. 8.** Indicates mean length (cm) and length groups of *Cyprinion watsoni*

As far as the the average K values is concerned, it was found in the present study between 0.035±0.034 for *G. gotyla* to 0.33±.0.11 for *L. C. watsoni* (Table 5).

Shakir *et al.* (2010) has also stated that properly fed fish would bear value of condition factor equal to or greater than 1.0, whereas a value of less than 1.0 is attributed to undernourished fish.

However, the value of this factor may fluctuate due to different size of fish, feeding intensity (Le Cren, 1951; Thakur, 1975) state of sexual maturity, age and sex of fish (Gomiero, 2005) and environmental conditions (Thakur, 1975; Blackwell *et al.*, 2000; Gomiero, 2005).

Hence the present study provides a baseline information on LWR and Fulton's condition factor (K) for three fish species from lower Zhob River. It will be useful for researchers and fishery managers.

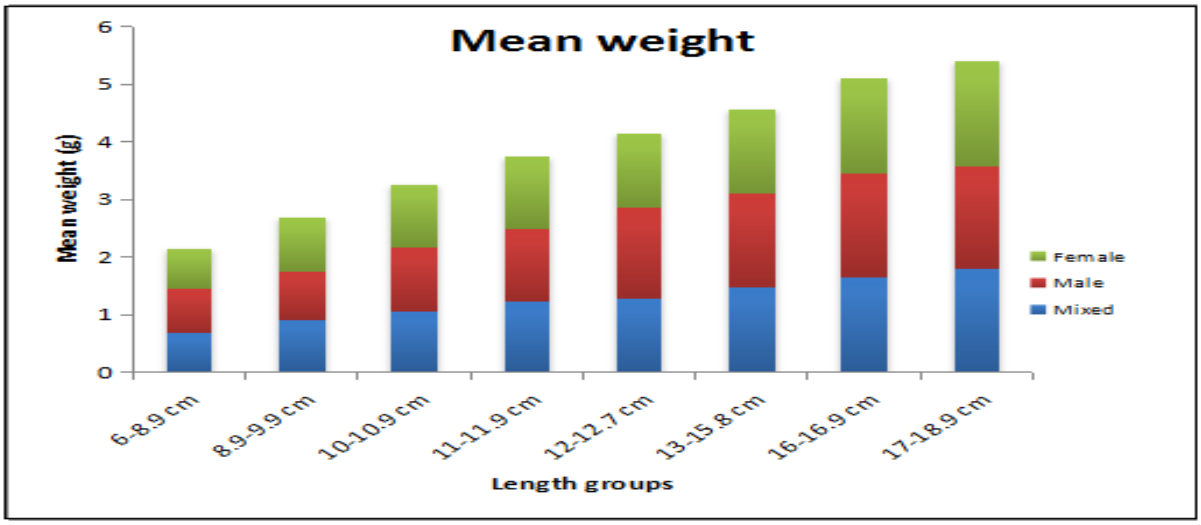


**Fig. 9.** Indicates mean weight (gm) and length groups of *Cyprinion watsoni*.

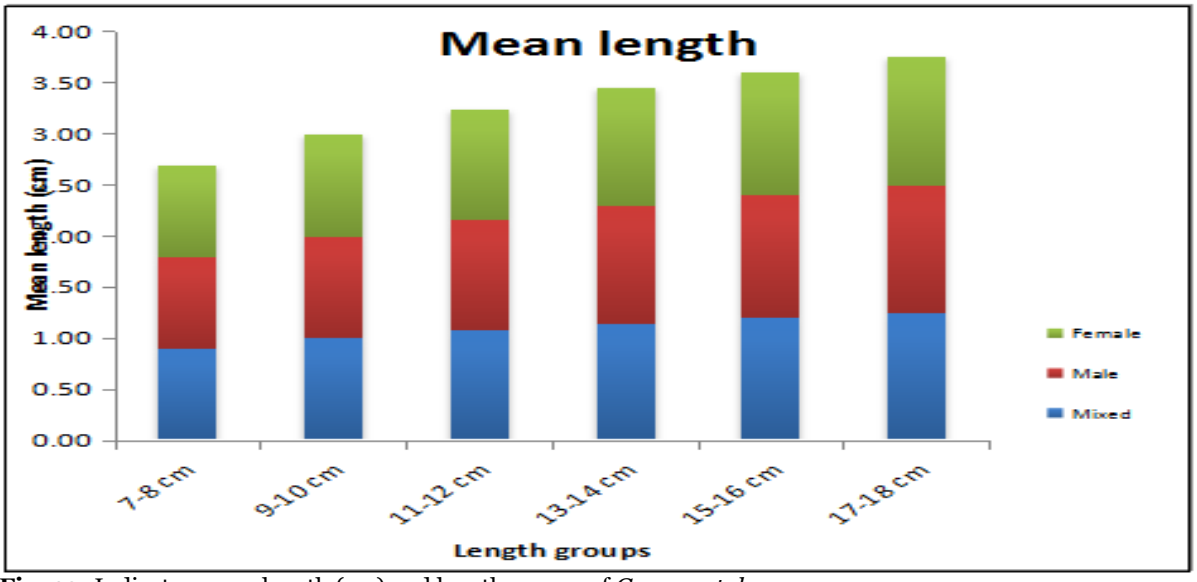


**Fig. 10.** Indicates mean length (cm) and length groups of *Garra gotyla*.

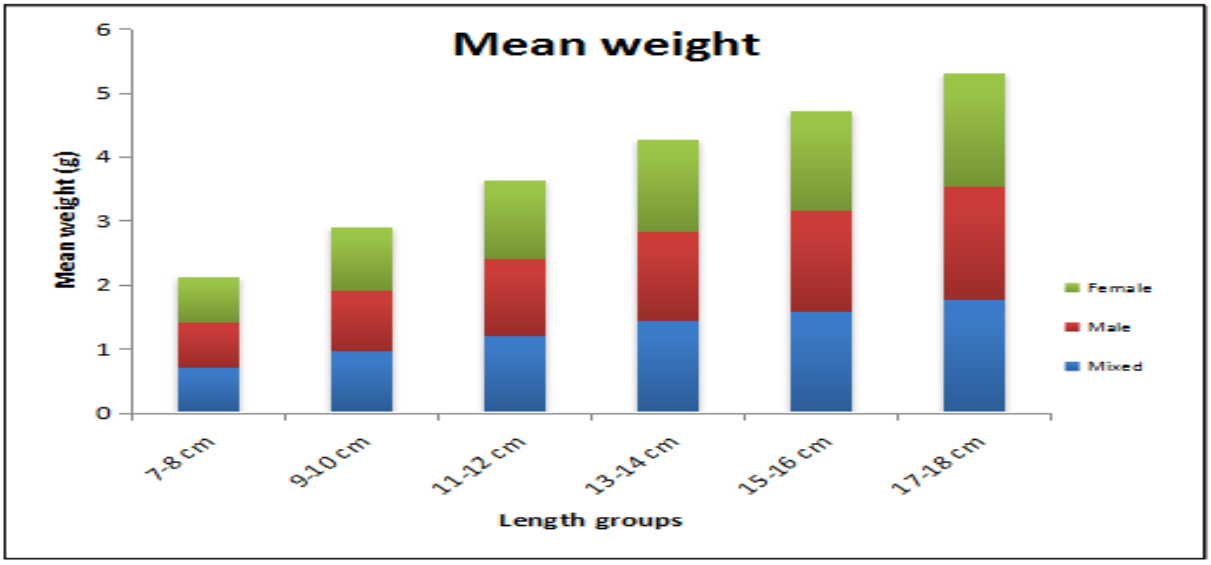


**Fig. 11.** Indicates mean weight (gm) and length groups of *Garra gotyla*.

## Conclusion

Results indicated that the species *Labeo rohita and Garra gotyla* grew more quickly in length than in weight (i.e. negative allometry b<3), while *Cyprinion watsoni* grew more rapidly in weight than in length (positive allometry b>3), hence, showing a definite effect of diet composition on the fish diet.

The present work provides baseline information on the length weight relationships regarding these three cyprinind (Carp) fish species of the genus *Labeo*, *Cyprinion* and *Garra* from this regions of Pakistan and will able to understand their growth, welfare and stock assessments for the betterment of fisheries management.

## Acknowledgements

The authors would like to thank the Head Department of Zoology for providing facilities in the laboratory of Entomology & Fish Parasitology, University of Balochistan, Quetta, Pakistan. Thanks also to Fisheries Linkages Programme (ALP) for moral support, and the staff members of Department of Fisheries, Zhob Division, Balochistan, Pakistan for their cooperation.

## References

**Abowei JFN.** 2010. The condition factor, length-weight relationship and abundance of Ilisha africana (Block, 1795) from Nkoro River Niger Delta, Nigeria. Advance Journal of Food Science and Technology **2(1),** 6-11.

**Adarsh S, James RA.** 2016. Morphometric Role on Length-Length and Length Weight Relationship of Sulphur goatfish (*Upeneus sulphureus,* Cuvier*, 1829)* From Mandapam Coast, Southern India. International Journal of Advanced Research **4(1),** 825-839. http://dx.doi.org/10.21474/IJAR01/10434

**Bagenal TB, Tesch FW.** 1978. Age and growth. In: Methods for assessment of fish production in fresh waters. T. B. Bagenal (Ed.) Blackwell Scientific Publications, Oxford, p 101–136.

**Blackwell BG, Brown ML, Willis DW.** 2000. Relative Weight (Wr) Status and Current Use in Fisheries Assessment and Management. Reviews in Fisheries Science **8,** 1-44. https://doi.org/10.1080/10641260091129161

**Fagade SO.** 1979. Observation of the biology of two species of Tilapia from the Lagos lagoon Nigeria. *Bull. Inst. Fond Afr. Nore (Ser. A),* **41,** 627-658.

**Ferdaushy MH, Alam MM.** 2015. Length-length and length-weight relationships and condition factor of nine freshwater fish species of Nageshwari, Bangladesh. International Journal of Aquatic Biology **3(3),** 149-154. https://doi.org/10.22034/ijab.v3i3.91

**Froese R.** 2006. Cube law, condition factor and weight–length relationships: history, meta-analysis and recommendations. Journal of Applied Ichthyology **22(4),** 241-253. https://doi.org/10.1111/j.14390426.2006.00805.x

**Galli O, Norbis W.** 2016. Length-weight relationships and condition factor of two Sciaenid species Micropogonias furnieri and Cynoscion guatucupa from the Rio de la Plata and Uruguayan ocean coast, Southwestern Atlantic. Revista de Biología Marina y Oceanografía **51(2),** 347-57. https://doi.org/10.22370

**Gomiero LM, de Souza Braga FM.** 2005. The condition factor of fishes from two river basins in São Paulo state, Southeast of Brazil. Acta Scientiarum*:* Biological Sciences, 73-78. http://dx.doi.org/10.4025/actascibiolsci.v27i1.1368

**Gupta S, Banerjee S.** 2015. Length weight relationship of Mystus tengara (Ham.-Buch., 1822), a freshwater catfish of Indian subcontinent. International Journal of Aquatic Biology **3(2),** 114-118. https://doi.org/10.22034/ijab.v3i2.55

**Gurdek R, Plavan AA.** 2014. Weight-length relationships of 12 fish species from the Pando tidal creek estuary (subsystem of the Río de la Plata, Uruguay). Journal of applied Ichthyology **30(2),** 426-427.
https://doi.org/10.1111/jai.12241

**Kara A, Bayhan B.** 2008. Length-weight and length-length relationships of the bogue *Boops boops* (Linneaus, 1758) in Izmir Bay (Aegean Sea of Turkey). Belgian Journal of Zoology **138(2),** 154-157.

**Kulbicki M, Guillermot N, Amand M.** 2005. A general approach to length-weight relationships for New Caledonian lagoon fishes. Cybium International Journal of Ichthyology **29,** 235-252.
https://doi.org/10.26028/cybium/2019-434-001

**Kumolu Johnson CA, Ndimele PE.** 2010. Length-weight relationships and condition factors of twenty-one fish species in Ologe Lagoon, Lagos, Nigeria. Asian Journal of Agricultural Sciences **2,** 174-179.

**Lagler KF, Bardach JE, Miller RR.** 1977. Lethology, the study of fishes. Wiley, New York 156-163 p.

**Le Cren ED.** 1951. The length–weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). The Journal of Animal Ecology **20(2),** 201–219.
https://doi.org/10.2307/1540

**Stavrescu-Bedivan MM, Aioanei FT, Scăeţeanu GV.** 2017. Length-weight relationships and condition factor of 11 fish species from the Timiş River, western Romania. Agriculture & Forestry **63(4),** 281-285. Poljoprivredai Sumarstvo.
https://doi.org/10.17707/AgricultForest.63.4.27.

**Mustafa MG, Brooks AC.** 2008. Status of fisheries resource and management approach in the open *Beels* of Bangladesh: a comparative case study. Asian Fishies Society **21,** 189-203.
https://hdl.handle.net/20.500.12348/1514

**Nikolsky GV.** 1969. Theory of the Fish Population Dynamics as the Biological Background for Rational Exploitation and Management of Fisheries Resources. Oliver and Boyd: Edinburgh. 322 p.

**Naeem M, Zuberi A, Hasan Z, Salam A, Khalid M, Khan MJ, Ayaz MM, Ashraf M, Nasir MF, Rasool SA, Aziz M.** 2012. Length-weight and length-length relationships of freshwater wild catfish *Mystus bleekeri* from Nala Daik, Sialkot, Pakistan. African Journal of Biotechnology **11(50),** 11168-11172.
http://www.academicjournals.org/AJB

**Offem, BO, Samsons YA, Omoniyi IT.** 2009. Length-weight relationship, condition factor and sex ratio of forty six important fishes in a tropical flood river. Research Journal of Fisheries and Hydrobiology **4(2),** 65-72.

**Pauly D.** 1993. Fishbyte section editorial.NAGA ICLARM Q, **16,** 26.

**Quist MC, Pegg MA, Devries DR.** 2012. Age and growth. In: Fisheries techniques (ed. A.V. Alexander, D. L. Parrish and T.M. Sutton), American Fisheries Society, Bethesda, MD, USA, p 677–731.

**Safran P.** 1992. Theoretical analysis of the weight–length relationships in the juveniles. Marine Biology **112(4),** 545–551.
https://doi.org/10.1007/BF00346171

**Shakir HA, Qazi JI, Hussain A, Ali S.** 2010. Growth coefficient and condition factor of three carp species reared under semi-intensive culture. Punjab University Journal of Zoology **25(1-2),** 13-20.

**Simon KD, Mazlan AG, Samat A, Zaidi CC, Aziz A.** 2010. Size, growth andage of two congeneric archer fishes (Toxotes jaculatrix Pallas, 1767 and Toxotes chatareus Hamilton, 1822) inhabiting Malaysian coastal waters. Sains Malaysiana **39(5),**

697-704.

**Sokal RR, Rohlf RF.** 1995. *Biometry*. In: The Principles and Practice of Statistics in Biological Research. Fourth edition, Stony Brook University. Publisher: W.H. Freeman and Company New York. p. 915.

**Talwar PK, Jhingran AG.** 1991. Inland fishes of India and adjacent countries. **1-2,** p 543-1064.

**Thakur NK.** 1975. On the Length – weight relationship and relative condition factor in *Clariasbatrachus* (Linn.). Proceedings of National Academy of Sciences, India **45,** 197-202.

**Vicentin W, Costa FES, Suarez YR.** 2012.Length–weight relationships and length at first maturity for fish species in the upper Miranda River, southern Pantanal wetland, Brazil. Journal of Applied Ichthyology **28(1),** 143-145.