E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2017; 5(2): 15-19

www.fisheriesjournal.com
Received: 04-01-2017
Accepted: 05-02-2017

Naeem M
Professor of Zoology, Institute of Pure and Applied Biology (Zoology Division), Bahauddin Zakariya University, Multan, Pakistan

Khan M
Institute of Pure and Applied Biology (Zoology Division), Bahauddin Zakariya University, Multan, Pakistan

Ishtiaq A
Institute of Pure and Applied Biology (Zoology Division), Bahauddin Zakariya University, Multan, Pakistan

Correspondence
Prof. Dr. Muhammad Naeem
Professor of Zoology, Institute of Pure and Applied Biology (Zoology Division), Bahauddin Zakariya University, Multan, 60800, Pakistan

Length–weight, length-length and condition factor relationships of *Labeo gonius* (Hamilton) from Taunsa Barrage, River Indus, Pakistan

Naeem M, Abidi SZA, Khan M, Ishtiaq A and Naeem Z

Abstract
The present work reports the length–weight (LWR), length-length (LLR) and condition factor relationships for *Labeo gonius* collected from Taunsa Barrage, River Indus, Pakistan. The results of LWR ($W = a\ TL^b$) indicated $W = -2.4032\ TL^{3.29}$, for *L. gonius,* representing positive allometric growth pattern. All LWRs and LLRs and condition factor relationships were found significantly correlated. Fork length and eye diameter showed isometric growth pattern with both total length and body weight; standard length, pelvic fin length and caudal fin width showed the same pattern only with TL; while head width and caudal fin length grew isometrically with an increase in body weight of the *L. gonius.* On the other hand, head length, snout length, mouth gap, body girth, dorsal fin length, pectoral fin length and anal fin length showed allometric growth with the increase in size of wild captured *L. gonius.* Mean condition factor (K) value was found 0.98±0.06 in this study. The results also showed significant correlations of wet body weight and all studied lengths of *L. gonius* with condition factor. Length–length relationships for *Labeo gonius* were unknown to Fish Base. The results of this work would be beneficial for sustainable management as well as fishery managers.

Keywords: Wild fish, LWR, LLR, condition factor, growth pattern

1. Introduction
Length-weight relationships (LWRs) can be used as a character for the disparity of taxonomic units and the relationship changes with the various developmental events in life such as onset of maturity and growth (Thomas *et al.*, 2003) [19]. Nevertheless, parameters in this relationship may vary temporally and/or spatially for a particular species, and require a regular update and estimation for each population separately (Ismen *et al.*, 2007) [10]. The length-weight (LWR) and length-length relationships (LLR) are also useful for calculation of fish stocks and provide information on growth patterns and the condition of fish (Ricker, 1968) [17]. Moreover, LWRs and LLRs are also useful for conversion purposes when comparisons are made with literature values and consequently to estimate fish biomass (Ault *et al.*, 2005; Aburto-Oropeza *et al.*, 2011) [2, 1].

In addition, condition factor (K) is calculated from the relationship between the weight of a fish and its length, with the intention of describing the "condition" of that individual fish (Froese, 2006) [6]. Different values in 'K', indicate the degree of food sources availability, age and sex, state of sexual maturity and environmental conditions (Gomiero, 2005) [8].

A freshwater medium sized carp *Labeo gonius* (Hamilton, 1822) (Cypriniformes: Cyprinidae) is the common species found in the natural waters of Pakistan, India and Myanmar (Mirza, 1982) [12]. This species is also cultured in ponds along with other carp species (Froese and Pauly, 2016) [4].

In the present investigation, LWRs and LLRs and condition factor relationships of *Labeo gonius* from Taunsa Barrage, River Indus, District Muzaffargarh, southern Punjab, Pakistan, were studied. To the best of our knowledge, no estimates on length–length relationships for this carp species were ever been reported and thus neither recorded in the global electronic data bank on fishes, "FishBase" (Froese and Pauly, 2016) [4], nor in national and international literature.

2. Materials and methods

Taunsa Barrage (30°42'N 070°50'E) is located across the River Indus, District Muzaffargarh, southern Punjab, Pakistan, and was constructed mainly for irrigation purposes. The barrage also provides water to the River Chenab through Taunsa-Pujnad (TP) Canal. Taunsa Barrage was designated a Ramsar site (site No. 817) in 1996. Beside irrigation, this site is important for commercial fishing.

Thirty six fish samples of *Labeo gonius* were caught from the Taunsa Barrage, River Indus, District Muzaffargarh, southern Punjab, in September, 2015, by employing cast net. Various lengths were measured to the nearest 0.1 cm and total wet weight obtained at 0.01 g precision after blotting fish dry on paper towels.

The relationships between all body length parameters were calculated by the method of least squares to fit a linear regression as: $Y = a + bX$ (Le Cren, 1951) [11]. Where,

Y=various body lengths,

X=total length (TL), body weight (W), or condition factor (K)

a=proportionality constant

b=regression coefficient

The relationship between length and weight was determined by $W= aTL^b$ (Le Cren, 1951) [11]. Where:

W=wet body weight of fish (g)

TL=total length of fish (cm)

To estimate the parameters *a* and *b*, the logarithm transformation of the equation was expressed as:

$Log\ W=Log\ \alpha+b\ Log\ TL$ (Salam *et al.*, 2005) [18].

The fit of the model to the data was determined by the coefficient of Pearson *r*-squared (r^2) and correlation coefficient (r).

Fulton's condition factors (K) was calculated according to Le Cren (1951) [11] and Froese (2006) [6]:

$K=100\ W/TL^3$

3. Results

In this study, *Labeo gonius* of different body size ranging 18.1 - 28.5 cm total length and 57.00 – 235.00 g body weight, were used for the evaluation of parameters of length-weight (LWR) and length-length relationships (LLRs) to investigate growth type. Mean (±SD) fork length and standard length were recorded 20.46± 0.05 cm and 18.84±0.05 cm for *L. gonius.* Ranges and mean values (± S.D) of various studied length parameters of *L. gonius* are provided in Table 1.

LWRs for simple and log-transformed data for wild *L. gonius* are plotted as Figure 1 and 2, respectively. In LWRs, regressions were highly significant (P < 0.001), with the coefficient of determination (r^2) value, 0.974. Slop (b) value in LWRs, more than 3.00 (b= 3.29) in *L. gonius* showing positive allometric growth.

Results of regression analyses of log transformed total length with log length parameters for wild *L. gonius* are provided in Table 2. All the length–length linear regressions were highly significant (P<0.001) with *r* values ranged from 0.659 to 0.992, except for mouth gap which was significantly correlated with TL ($P < 0.01$; r = 0.493). Total length (TL) was found isometric (b value 1.00 or close to 1.00) with fork length (FL), standard length (SL), eye diameter (ED), pelvic fin length (PvFL) and caudal fin width (CFW). Head width (HW), body girth (BG), dorsal fin length (DFL), pectoral fin length (PtFL), anal fin length (AFL) and caudal fin length (CFL) showed positive allometric (b-value more than 1.00) growth while head length (HL), snout length (SnL) and mouth gap (MG) showed a negative allometric (*b*-value less than 1.00) growth with an increase in total length of wild *L. gonius.*

Regression analyses of log transformed data of wet weight with different log length parameters (cm) for wild *L. gonius* described highly significant correlation (P < 0.001) with correlation coefficient (r) value ranged 0.516-0.984. Positive allometric growth was indicated in BG, DFL, PtFL and AFL with wet weight of wild captured *L. gonius, b*-value being more than 0.33. SL, HL, SnL, MG and CFW showed negative allometric growth with an increase in body weight of the fish. However, slope (b) values of regression analyses of FL, HW, ED and CFL with wet weight were found very close to 0.33, hence indicating isometric growth (Table 3).

Condition Factor (K) ranged 0.85 - 1.12 with a mean value 0.98±0.06 (Table 1). Descriptive statistics and regression parameters of log condition factor with different length parameters for *L. gonius* are described in Table 4. In log-transformed data, FL, HW, SnL, BG and DFL were found highly correlated ($P < 0.001$) with condition factor (K) with correlation coefficient (r) value 0.513 to 0.761. Significant ($P < 0.01$) correlation was indicated in TL, SL, HL, PtFL and PvFL while least significant ($P < 0.05$) in ED, MG, AFL, CFL and CFW with K-value.

Table 1: Ranges and mean values (± S.D) of various parameters of *Labeo gonius* collected from Taunsa Barrage, River Indus, Pakistan.

Body Measurements	Range	Mean ± S.D
Wet body weight (W)	57.00 -235.00	134.17 ± 10.54
Total length (TL)	18.1 - 28.5	23.58 ± 0.16
Fork length (FL)	15.5 – 26	20.46± 0.05
Standard length (SL)	14.4 - 22.5	18.84±0.05
Head length (HL)	2.8 - 4.3	3.64±0.05
Head width (HW)	2 - 3.8	2.79±0.07
Eye diameter (ED)	0.7 - 1.3	1.00±0.08
Snout length (SnL)	0.8 - 1.6	1.17±0.07
Mouth gap (MG)	0.5 - 1.4	0.81±0.06
Body girth (BG)	9.2 - 17.2	12.40±0.10
Dorsal fin length (DFL)	1.9 - 5.1	4.14±0.08
Pectoral fin length (PtFL)	2.4 - 4.7	3.54±0.10
Pelvic fin length (PvFL)	2.3 - 3.9	3.19±0.07
Anal fin length (AFL)	0.9 - 1.9	1.36±0.06
Caudal fin length (CFL)	3.3 – 6	4.67±0.07
Caudal fin width (CFW)	3 - 6.5	4.71±0.07
Condition factor (K)	0.85 - 1.12	0.98±0.06

S.D = Standard Deviation

Table 2: Descriptive statistics and regression parameters of log total length with log length parameters for *L. gonius* collected from Taunsa Barrage, River Indus, Pakistan.

Equation	Relationship Parameters		95% CI of a	95% CI of b	r
	a	b			
logFL =a+b logTL	-0.0225	0.95	-0.0785 to 0.0335	0.90 to 0.99	0.982***
logSL =a+b logTL	-0.1421	1.06	-0.2400 to -0.0442	0.99 to 1.13	0.992***
log HL = a + b logTL	-0.3374	0.65	-0.6370 to -0.0379	0.44 to 0.87	0.722***
log HW = a + b logTL	-1.1214	1.14	-1.5032 to -0.7396	0.86 to 1.42	0.819***
log ED = a + b logTL	-1.4294	1.04	-1.9021 to -0.9567	0.70 to 1.39	0.725***
log SnL = a + b logTL	-1.0657	0.82	-1.5153 to -0.6161	0.50 to 1.15	0.659***
log MG = a + b logTL	0.9597	-0.79	0.2927 to 1.6267	-1.28 to -0.30	0.493**
log BG = a + b logTL	-0.6916	1.30	-1.1399 to -0.2432	0.97 to 1.62	0.810***
log DFL = a + b logTL	-1.8412	1.79	-2.3877 to -1.2946	1.39 to 2.19	0.842***
log PtFL = a + b logTL	-1.2471	1.31	-1.4791 to -1.0150	1.14 to 1.48	0.937***
log PvFL = a + b logTL	-0.9933	1.09	-1.2012 to -0.7855	0.94 to 1.24	0.929***
log AFL = a + b logTL	-1.6757	1.31	-2.1113 to -1.2401	1.00 to 1.63	0.822***
log CFL = a + b logTL	-0.9159	1.15	-1.2025 to -0.6293	0.95 to 1.36	0.887***
log CFW = a + b logTL	-0.7374	1.03	-1.2498 to -0.2250	0.65 to 1.40	0.691***

Cl: confidence intervals, *** $P < 0.001$, ** $p < 0.01$

Table 3: Descriptive statistics and regression parameters of log wet weight with different log length parameters for *L. gonius* collected from Taunsa Barrage, River Indus, Pakistan.

Equations	Relationship Parameters		95% CI of a	95% CI Of b	r
	a	b			
logTL = a+b logW	0.7287	0.34	0.6839 to 0.7736	0.31 to 0.36	0.968***
logFL =a+b logW	0.6392	0.32	0.5963 to 0.6820	0.30 to 0.34	0.984***
logSL=a+b logW	0.6821	0.28	0.6428 to 0.7213	0.26 to 0.30	0.982***
logHL =a+b logW	0.1447	0.20	0.0072 to 0.2822	0.13 to 0.26	0.726***
logHW =a+b logW	-0.2953	0.35	-0.4625 to 0.1279	0.27 to 0.43	0.838***
logED =a+b logW	-0.6535	0.31	-0.8739 to 0.4330	0.21 to 0.41	0.717***
logSnL =a+b logW	0.6821	0.28	0.6428 to 0.7213	0.26 to 0.30	0.982***
logMG =a+b logW	0.39806	-0.25	0.0951 to 0.7010	-0.39 to -0.10	0.516***
logBG =a+b log W	0.2088	0.42	0.0342 to 0.3834	0.34 to 0.50	0.869***
logDFL =a+b logW	-0.5337	0.54	-0.7782 to-0.2892	0.43 to 0.66	0.852***
logPtFL =a+b logW	-0.2781	0.39	-0.3871 to 0.1692	0.34 to 0.44	0.935***
logPvFL=a+b logW	-0.1777	0.32	-0.2814 to 0.0740	0.27 to 0.37	0.916***
logAFL =a+b logW	-0.6901	0.39	-0.8976 to 0.4825	0.29 to 0.49	0.808***
logCFL=a+b logW	-0.0473	0.34	-0.1893 to 0.0947	0.27 to 0.41	0.869***
logCF=a+b logW	0.0281	0.30	-0.2107 to 0.2670	0.19 to 0.42	0.683***

Table 4: Descriptive statistics and regression parameters of log condition factor with different length parameters for *L. gonius* collected from Taunsa Barrage, River Indus, Pakistan.

Equations	Relationship Parameters		95% CI of a	95% CI of b	r
	a	b			
logTL = a + b logK	1.3775	0.78	1.36192 to 1.3930	0.27 to 1.28	0.472**
logFL = a+b logK	1.3171	0.96	1.3011 to 1.3331	0.44 to 1.48	0.543***
logSL=a+b logK	1.2807	0.75	1.2659 to 1.2954	0.28 to 1.24	0.485**
logHL = a + b logK	0.5654	0.612	0.5508 to 0.5800	0.14 to 0.14	0.411**
logHW = a + b logK	0.4531	1.26	0.4325 to 0.4736	0.60 to 1.93	0.551***
logED = a+b logK	0.0040	0.83	-0.0196 to 0.0277	0.07 to 1.60	0.354*
logSnL = a+b logK	0.1393	1.16	0.0568 to 0.0933	0.57 to 1.75	0.563***
logMG = a + b logK	-0.1336	-1.03	-0.1597 to 0.1076	-1.88 to -0.19	0.393*
logBG = a + b logK	1.1059	2.00	1.0876 to 1.1243	1.41 to 2.60	0.761***
logDFL = a + b logK	0.6239	1.79	0.5917 to 0.6561	0.75 to2.83	0.513***
logPtFL = a + b logK	0.5552	1.14	0.5338 to 0.5766	0.44 to 1.83	0.496**
logPvFL= a + b logK	0.5086	0.84	0.4899 to 0.5273	0.23 to 1.45	0.436**
logAFL = a + b logK	0.1349	0.98	0.1086 to 0.1611	0.13 to 1.83	0.373*
logCFL= a + b logK	0.6731	0.81	0.6518 to 0.6944	0.12 to 1.50	0.380*
logCFW = a + b logK	0.6750	0.81	0.6503 to 0.6998	0.01 to 1.61	0.332*

* $p < 0.05$

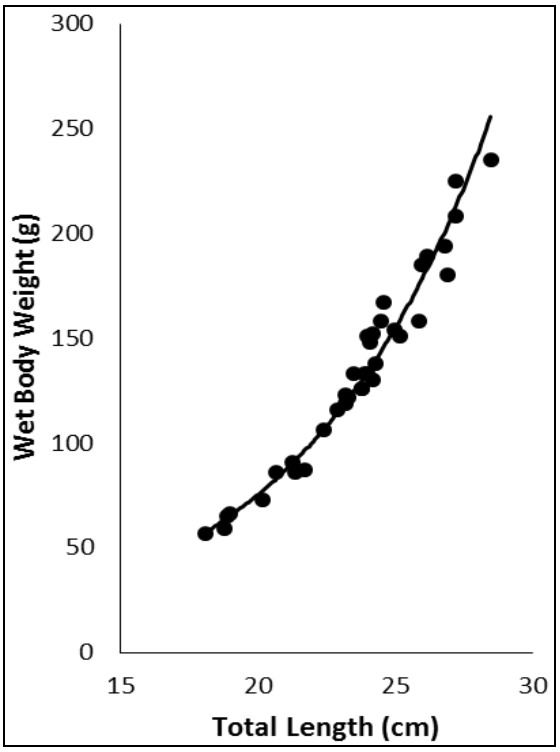

Fig 1: Length weight relationship of *Labeo gonius* collected from Taunsa Barrage, River Indus, Pakistan.

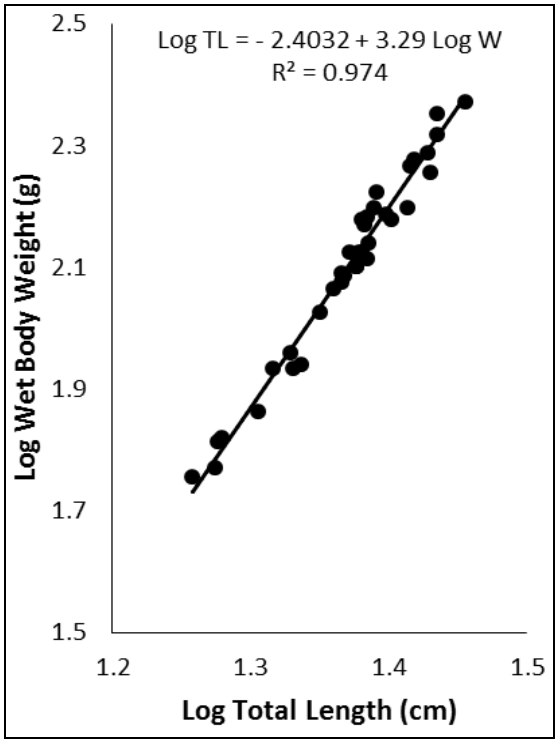

Fig 2: Length weight relationship for log transformed data of *L. gonius* collected from Taunsa Barrage, River Indus, Pakistan.

4. Discussion

Length-weight, length-length and condition factor relationships are important in effective management of fisheries. The present investigation reveals that the value of coefficient of determination (r^2) for *Labeo gonius* was found closer to 1.0 (0.974) which indicates high degree of relationship in LWR. The results of the present study also indicate that wild estimated relationships of LWR had *b*-value within the usual range (2.5–3.5) as defined by Froese (1998)[7]. The study also shows that the value of '*b*' deviates from 'cube law' as it remains constant at 3.0 for an ideal fish in a particular environmental condition.

Generally, fish growth models follow the "cube law", however, some fish species do not conform this law, because exponent (*b*) value may be higher or lower than 3.00. In LWRs of fish, exponent (*b*) value = 3.00, assumes that body shape maintains a constant proportion to length (Weatherley and Gill, 1987) [20]. *b*-value, less than 3.00 shows that fish becomes lighter as it grows. In the present study, b (3.29) value significantly higher from 3.00, indicating positive allometric growth pattern, suggested that *L. gonius* becomes heavier for its length, as it grows in size.

To compare our estimates the log *a* vs *b* graph of LWRs in FishBase was applied and found to be very close to those existing for *Labeo gonius* (Froese, 2006) [6]. Some previous studies (Naeem *et al.*, 2011; 2012a) [13, 14], reported negative allometric growth in wild fish from Pakistan. Naeem *et al.*, (2012b) [15] has reported *b* = 2.92 in closely related species of this genus, *Labeo bata,* from Head Panjnad, Pakistan. While Dars *et al.* (2010) [3] in their previous study on LWR has found *b* = 3.46 (positive allometric growth) in *Labeo gonius* from Pakistan.

Difference in *b*-values can be attributed to the combination of one or more factors such as: sex, maturity of the gonads, stomach fullness, health and differences in the observed length ranges of the specimens caught (Wootton, 1998) [21]. According to Ozaydin *et al.* (2007) [16], *b*-value unlikely may vary seasonally, and even daily, and between habitats. However, all of these were not accounted in the present study.

Relationships among different length types in LLRs are of great importance for comparative growth studies (Froese and Pauly, 2000) [5]. Correlation coefficient in LLRs were found significant in the present study. This is an accordance with Hossain (2010) [9] and Naeem *et al.* (2011) [13] that all LLRs were highly correlated. The high values of correlation coefficient (*r*) indicate that the LLRs are linear over the observed range of values.

Isometric growth was observed in FL, SL, ED, PvFL and CFW with increasing total length (b = 1) and in FL, HW, ED and CFL with body weight (b = 0.33) of the fish. This indicated a proportional increase in these length parameters with an increase in total length or body weight. While other studied length parameters showed allometric growth pattern with increasing body size of the *L. gonius* and hence showed an increase in the same proportion as fish grows in size.

Mean condition factor (K) value was found very close to 1.00 for *Labeo gonius* showing proper environmental conditions of habitat for this species in Taunsa Barrage, River Indus, Pakistan. Naeem *et al.* (2011) [13] documented insignificant correlation in condition factor and total length, while highly significant in condition factor and weight of hatchery reared *Tor putitora*. However, present study showed significant correlations of wet body weight and all studied lengths of *L. gonius* with condition factor. Variation between studies may be due the fact that the K-value is an index reflecting interaction between biotic and abiotic factors in the physiological conditions of fishes.

This study represents the first reference on LLRs for *Labeo gonius* based on the data in FishBase (Froese and Pauly, 2016) [4]. It is hoped that this work will support investigators in future for ecological studies and reliable growth estimation.

5. References

1. Aburto-Oropeza O, Erisman B, Galland GR, Mascareñas-Osorio I, Sala E, Ezcurra E. Large Recovery of Fish Biomass in a No-Take Marine Reserve. PLoS One. 2011; 6(8). e23601. doi:10.1371/journal.pone.0023601
2. Ault JS, Smith SG, Bohnsack JA. Evaluation of average length as an estimator of exploitation status for the Florida coral—reef fish community. ICES J. Marine Sci. 2005; 62:417-423. doi: 10.1016/j.icesjms.20 04.12.0 01.
3. Dars BA, Narejo NT, Dayo A. Relative condition factor and length-weight relationship of a carp, *Labeo gonius* (Hamilton) from Keenjhar Lake, District Thatta, Sindh, Pakistan. Sindh University Research Journal (Science Series). 2010; 42(2):67-70.
4. Froese R, Pauly D. (Editors). FishBase. World Wide Web electronic publication. 2016. www.fishbase.org, version (10/2016).
5. Froese R, Pauly D. FishBase Concepts, design and data sources. ICLARM, Los Bańos, Laguna, Philippines. 2000, 344.
6. Froese R. Cube law, condition factor and weight length relationship: history, meta-analysis and recommendations. Journal of Applied Ichthyology. 2006; 22:241-253.
7. Froese R. Length–weight relationships for 18 less studied fish species. Journal of Applied Ichthyology. 1998; 14:117-118.
8. Gomiero LM, Braga FMS. The condition factor of fishes from two river basins in Sao Paulo Stae, Southeast of Brazil. 2005. Acta Scientiae Maringa. 2005; 27:73-78.
9. Hossain MY. Morphometric relationship of Length-weight and length-length of four cyprinid small Indigenous fish species from the Padma river (NW Bangladesh). Turkish Journal of Fisheries and Aquatic Sciences. 2010; 10:131-134.
10. Ismen A, Ozen O, Altinagac U, Ozekinci U, Ayaz A. Weight-length relationships of 63 fish species in Saros Bay, Turkey. Journal of Applied Ichthyology. 2007, 1-2.
11. Le Cren ED. The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). Journal of Animal Ecology. 1951; 20:201-219.
12. Mirza MR. A contribution to the fishes of Lahore, Polymer Publications Urdu Bazaar, Lahore. 1982, 48.
13. Naeem M, Salam A, Ashraf M, Khalid M, Ishtiaq A. External morphometric study of hatchery reared mahseer (*Tor putitora*) in relation to body size and condition factor. African Journal of Biotechnology. 2011; 10(36):7071-7077.
14. Naeem M, Zuberi A, Hasan Z, Salam A, Khalid M, Khan MJ *et al.* Length-weight and length-length relationships of freshwater wild catfish *Mystus bleekeri* from Nala Daik, Sialkot, Pakistan. African J. Biotech. 2012a; 11(50):11168-11172.
15. Naeem M, Zuberi A, Khan NA, Rasool SA, Ismail HF, Qamar A. Some morphometric relationship traits of *Labeo bata* (Hamilton, 1822) from Head Panjnad, Pakistan. African Jounal of Biotechnology. 2012b; 11(88):15465-15468.
16. Ozaydin O, Uckun D, Akalin S, Leblebici S, Tosunoglu Z. Length–weight relationships of fishes captured from Izmir Bay, Central Aegean Sea. Journal of Applied Ichthyology. 2007; 23:695-696.
17. Ricker WE. Methods for Assessment of Fish Production in Freshwaters. IBP Handbook No. 3. Blackwell Scientific Publicatio ns, Oxford and Edinburgh, UK. 1968.
18. Salam A, Naeem M, Kauser S. Weight length and condition factor relationship of a freshwater wild *Puntius chola* from Islamabad, Pakistan. Pakistan Journal of Biological Sciences. 2005; 8:1112-1114.
19. Thomas J, Venus, Kurup B. Length weight relationship of some deep sea fish inhabiting continental slope beyond 250m depth along west Coast of India. Naga World Fish Center Quart. 2003; 26:17- 21.
20. Weatherley AH, Gill HS. The biology of fish growth. Academic Press, London. 1987, 1-443.
21. Wootton RJ. Ecology of Teleosts fishes. 2nd edition, Kluwer, Dordrecht. 1998.