Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(2): 1533-1538
Received: 22-01-2020
Accepted: 24-02-2020

Iqra Farooq Wani
Faculty of Fisheries, Rangil, Ganderbal, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Jammu and Kashmir, India

Dr. Tasaduq H Shah
Faculty of Fisheries, Rangil, Ganderbal, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Jammu and Kashmir, India

Dr. Farooz Ahmad Bhat
Faculty of Fisheries, Rangil, Ganderbal, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Jammu and Kashmir, India

Dr. Adnan Abubakr
Faculty of Fisheries, Rangil, Ganderbal, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Jammu and Kashmir, India

Dr. Bilal A Bhat
Faculty of Fisheries, Rangil, Ganderbal, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Jammu and Kashmir, India

Dr. Masood H Balkhi
Faculty of Fisheries, Rangil, Ganderbal, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Jammu and Kashmir, India

Nimat Syed
Faculty of Fisheries, Rangil, Ganderbal, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Jammu and Kashmir, India

Ishrat Mohammad
Faculty of Fisheries, Rangil, Ganderbal, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Jammu and Kashmir, India

Corresponding Author:
Iqra Farooq Wani
Faculty of Fisheries, Rangil, Ganderbal, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Jammu and Kashmir, India

Comparative studies on length-weight relationship and condition factor of *Cyprinus carpio* and *Schizothorax niger* from Dal lake, Kashmir

Iqra Farooq Wani, Dr. Tasaduq H Shah, Dr. Farooz Ahmad Bhat, Dr. Adnan Abubakr, Dr. Bilal A Bhat, Dr. Masood H Balkhi, Nimat Syed and Ishrat Mohammad

Abstract
The present study was carried out to calculate the length-weight relationship and condition factor of *Cyprinus carpio* var. *communis* and *Schizothorax niger*. A total of 360 samples each of *C. carpio* var. *communis* and *S. niger* were collected from Dal lake from August 2018 to July 2019. Length-weight relationship of *C. carpio* var. *communis* and *S. niger* both indicates negative allometric growth. The functional form of Length-weight relationship of *C. carpio* was fitted as Log W = -3.984+2.615 Log L (Pooled), Log W = -3.754 +2.516 Log L (Male) and Log W = -4.162+2.692 Log L (Female) while for *S. niger* Length-weight relationship was established as Log W = -3.577+2.399 Log L (Pooled), Log W = -3.644 +2.424 Log L (Male) and Log W = -4.162+2.692 Log L (Female) . The value of growth coefficient (b) for pooled data was found to be greater for *C. carpio* (2.615) than that of *S. niger* (2.399) which indicates better growth in *C. carpio* as compared to *S. niger*. The value of the condition factor (K) of the common carp ranged from 1.151 to 1.928 while as in case of *S. niger* it ranged from 0.966 to 1.32 which indicates better growth of *C. carpio.*

Keywords: Length-weight relationship, condition factor, *Cyprinus carpio* var. *communis*, *Schozothorax niger*, Dal lake

1. Introduction
The common carp (*Cyprinus carpio*) is one of the world's most invasive fish (Kulhanek *et al*., 2011) [32]. It is a freshwater cyprinid fish that is widely farmed and distributed in the world. It occurs in shallow ponds, lakes rich in vegetation and slow moving rivers. It burrows in mud in the dry season or winter and tolerates cold, organic pollutants and low oxygen concentration in water (Weber *et al.*, 2010) [61]. Since it is a fast growing and hardy fish that can withstand adverse environmental conditions, it has been successfully introduced into fresh waters throughout the world (Seegers *et al*., 2003; Golemi *et al.*, 2013) [52, 23]. The common carp was brought to India in 1939 from Sri Lanka and introduced into the Nilgiris. Later, in 1947 this species was introduced in Nainital and other lakes of Kumaon and was carried to Bangalore (Fotedar and Qadri, 1974) [20]. It is an ideal species for cold water of the hills and was introduced in Dal Lake of Kashmir in 1956. It has, since then, shown remarkable adaptation in various water bodies of the state, and constitutes a major fishery of flat land temperate waters of Kashmir (Fotedar and Qadri, 1974) [20].
The introduction of the exotic common carp caused a sharp decline in the population and of Schizothoracine fishes in Kashmir valley (Yousuf and Qadri, 1992; Zutshi and Gopal, 2000) [64, 65, 67]. Among schizothoracids, *Schizothorax niger* is a valuable fish of Kashmir region, but is now, in stiff competition with other exotic fishes including *C. carpio* (Yousuf, 1996) [62]. *S. niger* locally known as Ael Gad is a prized fish of Kashmir and belongs to family Cyprinidae. It is a lacustrine fish, occuring in lakes of Kashmir in good numbers including Dal Lake. As all other schizothoracids show breeding migrations, moving upstream to spawn, however, *S. niger* does not show any such migration and spawns in the shallow peripheral areas of the lake in close vicinity of springs on sandy bottoms (Vass and Raina, 1979) [59]. It contributes significantly to capture fisheries landings of the flatland lakes of the valley, especially Dal, Manasbal and Wular.
Several authors have reported that the introduction of common carp during mid-fifties in Kashmir has severely affected the indigenous schizothoracid population (Fotedar and Qadri, 1974; Saxena and Koul, 1966; Subla, 1967; Qureshi *et al.*, 1971) [20, 51, 55, 45]. Three varieties of *C. carpio* namely *C. carpio* var. *communis* (scale carp), *C. carpio* var. *specularis* (mirror carp) and *C. carpio* var. *nudus* (leather carp) are known worldwide.

The introduction of scale carp and mirror carp in the valley waters have led to the predominance of these exotic species over *Schizothorax* population (Foteder and Qadri, 1974) [20]. Length-weight relationships of fishes are important in fisheries biology because they allow the estimation of the average weight of the fish of a given length group by establishing a mathematical relation between the two (Beyer, 1987) [10]. Length weight relationships are needed to estimate weight from length because direct weight measurements can be time consuming in the field (Koutrkis and Tsiklirs, 2003; Sinoveic *et al.*, 2004) [31]. Like any other morphometric character, the length-weight relationship can be used as a character for the differentiation of taxonomic units and the relationship changes with various developmental events in life such as metamorphosis, growth and the onset of maturity (Thomas *et al*., 2003) [58]. The relative condition factor is an important quantitative parameter of well being of the fish in question and by extension its health status (Blackwell *et al.*, 2000) [12]. It determines present and future population success by its influence on growth, reproduction and survival. Condition factor is an important concept in fisheries management and can be used to assess the health and potential of any fishery to support the fishing pressure. It is estimated by comparing individual fish weight of a given length to a standard weight. It is assumed that heavier fish reflect a healthier physiological state (Ricker, 1975) [48].

2. Materials and Methods

A total of 360 specimens each of *C. carpio* and *S. niger* in the length range of 114.20mm to 294.81mm and 122.07mm to 280.00mm and weight range of 20.5g to 350.0g, 23.5 to 232.0g respectively were collected from the Dal Lake and were transported to the FRM laboratory at Faculty of Fisheries, Rangil in insulated boxes containing ice packs. The fish samples was cleaned under running tap water, and then dried with a clean cotton cloth. After cleaning, total length of the individuals was measured using digital Vernier calliper (Trusize) and weight by electronic digital weighing balance (Shimadzu) upto the nearest 0.01millimeter (mm) and 0.1 g respectively.

2.1 The length-weight relationship was estimated using the allometric formula proposed by Le-Cren (1951) [35] using the equation.

$W=aL^b$

where, W = Weight of fish (g) L = Length of fish (cm) a = y-intercept or the initial growth coefficient b = Slope or the growth coefficient. "a" and "b" will be estimated by the following formulae:

$a = \ddot{y} - b\ddot{x}$ and,

$b=[n\Sigma xy-\Sigma x\Sigma y] / [n\Sigma x^2-(\Sigma x)^2]$

To test "b" value against the value of "3", student's t-test will be employed to predict any significant deviation. The t-statistics will be calculated as follows:

The hypothesis given is,
H_0: Growth is isometric i.e. H_0: b=3
H_1: Growth is not isometrici.e. H_1: b≠3

The t statistics used are given by:

$t = \left| b-3 \right| / S_b$

Where, S_b=Standard error of "b" and t has (n-2) degrees of freedom.

$S_{b=}\sqrt{(1/(n-2))}* [(S_y/S_x)^2-b^2]$

Where, "S_x" and "S_y" are the standard deviations of x and y respectively. The t-value will be compared with t-table value for (n-2) degrees of freedom at 1% and 5% significance level.

2.2 Condition factor

Condition factor (K) was used to calculate Fulton's Condition Factor Index using the following equation (Fulton, 1904):

$$K = \frac{W}{L^3} \times 10^5$$

Where, K is the condition factor, W is the weight of fish in grams (g) and L is the total length in mm.

3 Results

3.1 Length-weight relationship: The length-weight regression equations obtained for *C. carpio* were:

Male: Log W = -3.754 +2.516 Log L (r^2 =0.838)

Female: Log W = -4.162+2.692 Log L (r^2 = 0.864)

Combined: Log W = -3.984+2.615 Log L (r^2 = 0.851).

The calculated 'b' value of length-weight relationships was obtained as 2.516 for males, 2.692 for females and 2.615 for pooled data. In order to test whether the pooled length-weight relationship follows the isometric growth pattern or not, students t-test was applied. The hypothesis given is:

H_0: Growth is isometric i.e., H_0 : b=3
H_1: Growth is not isometric i.e., H_1 : b≠3

The calculated "t" value (-4.71) was found to be significant at 1% level indicating negative allometric growth for *C. carpio*. The values of '*b*' indicated that growth was more pronounced in case of females (2.692) than males (2.516).
The regression equations obtained for *S. niger* were:

Male: Log W = -3.644 +2.424 Log L (r^2 =0.818)

Female: Log W = -3.455+2.349 Log L (r^2 = 0.814)

Combined: Log W = -3.577+2.399 Log L (r^2 = 0.824).

The calculated 'b' value of length-weight relationships was found as 2.424 for males, 2.349 for females and 2.399 for pooled data. In order to test whether the pooled length- weight relationship follows the isometric growth pattern or not, students t-test was applied. The hypothesis given is:

H_0: Growth is isometric i.e., H_0: b=3
H_1: Growth is not isometric i.e., H_1: b≠3

The calculated "t" value (-8.82) was found to be significant at 1% level indicating negative allometric growth for *S.niger*. Males showed higher values of 'b' as compared to females showing better growth.

From the above equations the 'b' value of combined data of *C. carpio* var. *communis* was found greater (2.615) than that of *S. niger* (2.399) which indicates better growth of common carp than the snow trout.

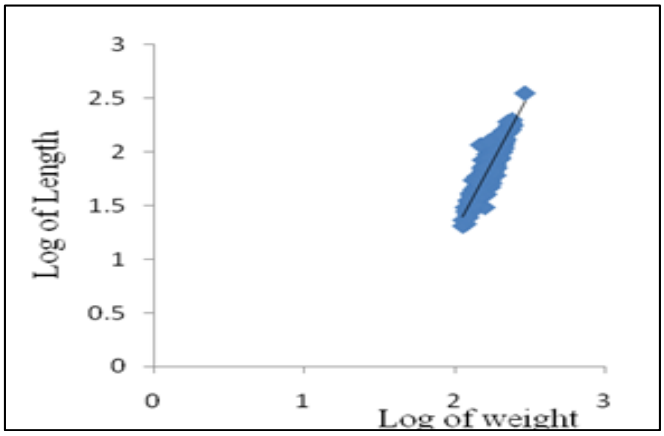

Fig 1: Logarithmic relationship between length and weight of *C. carpio* var. *communis* (Pooled)

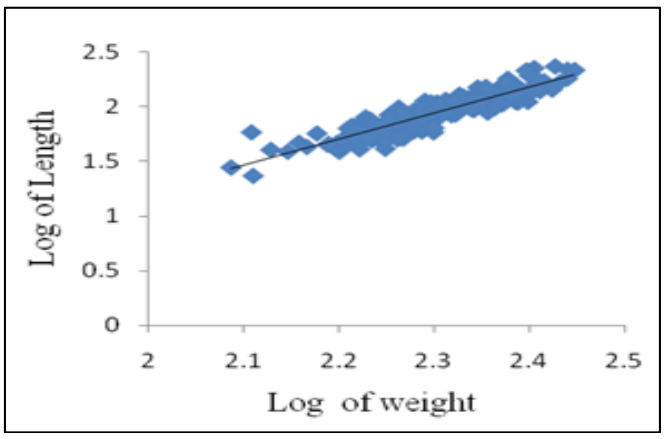

Fig 2: Logarithmic relationship between length and weight of *S. niger* (Pooled)

3.2 Condition factor. The value of condition factor of *C.carpio* ranged from a minimum of 1.151 in December to the maximum of 1.928 in March, while in case of *S. niger*, the value of condition factor ranged from a minimum of 0.966 in November to the maximum of 1.328 in May. Condition factor values of *C. carpio* var. *communis* were found to be higher as compared to that of *S. niger*.

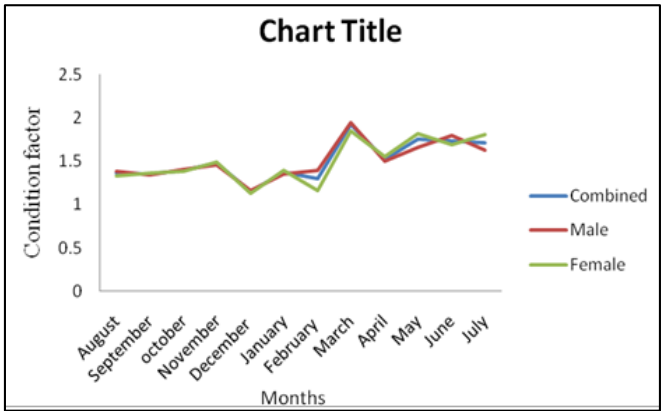

Fig 3: Month wise condition factor in *C. carpio* var. *communis.*

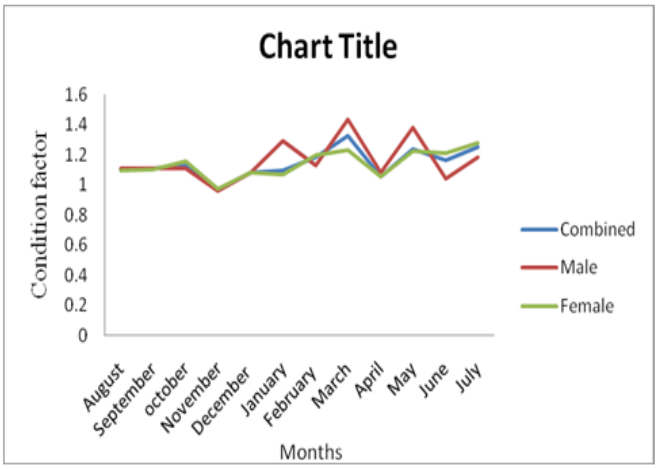

Fig 4: Month wise condition factor in *S. niger*

4. Discussion

The length-weight relationship is important for comparing life history of fish from different localities (Petrakis and Stergion, 1995). Length-weight relationships are useful in fisheries research because they allow the conversion of growth-in-length equations to growth-in-weight, biomass estimation, the condition of the fish, differences of life histories of fish species and are useful in population and fish stock assessments (Moutopoulos and Stergiou, 2002) [39]. An overview of literature reveals that the length –weight relationship of fish differs from species to species. Natarajan *et al.* (1977) [40] recorded the difference in the length –weight relationship of intra- specific populations although inhabiting the same water body. The length-weight relationship of fish varies and depends upon the condition of life in aquatic environment (Basheer *et al*., 1993) [8]. In the present study, the length –weight relationship of both the fishes showed a significant difference although they inhabit the same water body. Several biological factors like sex (Pal *et al*., 2013) [41], size of fish (Devaraj, 1973) [15] have significant influence over length-weight relationship of fishes. Also the physiological condition and the gonadal maturity (Bashirullah 1975, Le Cren, 1951, Reddy and Rao, 1992) [9, 35, 47] and fatness influence the length-weight relationship of fishes. Length weight relationship is generally established so that time only one of these two parameters is known, the other can be computed easily by substituting the values of co-efficient 'a' and 'b'. Further, values of the exponent 'b' provide growth pattern of fish species. When b=3, increase in weight is isometric i.e., length increases in equal proportions with body weight. When the value of b is other than 3, weight increase is said to be allometric (positive if b>3 and negative if b<3). According to Allen (1938) [3], ideally the regression coefficient 'b' of a fish should be very close to 3.0. However, cube law does not hold good throughout the life period and the weight gain in a fish may not be always cube of its length gain (Rounsefell & Everhart 1953; Lagler 1956) [49, 34]. In the present study, lower regression coefficient (b<3) were recorded for both the sexes for the two studies indicating of negative allometric growth. Hile (1936) [26] and Martin (1949) [37] suggested that the value of 'b' may range between 2.5 and 4.0 and according to Tesch (1971) [57] the value 'b' of varies between 2 and 4. Antony (1967) [5] found the value of 'b' within a range of 2.0 to 5.4. The 'b' value obtained in the present study was within this range. The variation in 'b' value may be due to environmental factors, season, food availability, sex, life stage and other physiological factors (Le

Cren, 1951) [35]. The present study revealed that the males recorded slightly higher exponential value in *S. niger* as compared to females. Higher values of 'b' in case of males were also reported by Sunder *et al.* (1984) [56] and Yousuf *et al.* (2001) [63]. While in case of *C. carpio* var. *communis* higher values of 'b' was found in females. Hatikaktoa & Biswas (2004) [25] and Rao and Sreeramullu (2006) [46] found higher values of 'b' in females, while higher values of 'b' in females were also observed by Kulshrestha *et al*. (1993) [33] and Firdous (1995) [19]. Qadri and Mir (1983) [43] found the value of 'b' to be equal to 2.448 in *Schizothorax richardsonii* of Sindh Nallah while Mir *et al.* (2012) [38] calculated different values of 'b' (<3) in case of *Schizothorax curvifrons* in different months from river Jhelum. Shah *et al.* (2013) [53] while calculating length-weight relationship of *Oncorhynchus mykiss* observed 'b' value as 2.9618 in the fish. Khan and Sabah (2013) [30] calculated 'b' values of 2.69, 2.66, 3.08, 2.64 and 2.86 for *S. curvifrons*, *S. niger*, *S. esocinus*, *S. labiatus* and *S. plagiostomus*, respectively. Bhat *et al.* (2010) [11] recorded the values of 'b' for *S. labiatus* (3.0997), *S. esocinus* (3.0034) and *S. plagiostomus* (2.9467) in the Lidder River of Kashmir. Yousuf *et al.* (1992, 2001) [64, 65] found 'b' values for *S. niger* of Manasbal Lake, Dal Lake and Anchar Lake as 3.014, 2.977 and 2.974 respectively. Khan and Sabah (2013) [30] recorded the value of 'b' equal to 2.66 in *S. niger*. Farooq *et al*. (2017) [18] observed 'b' value as 2.578 in *S. labiatus* and found negative allometric growth in the fish. Qadri *et al.* (2017) [44] calculated the 'b' value as 2.6138 in *S. curvifrons* While Hussain *et al.* (2018) [28] recorded higher 'b' values in males (2.8391) than in case of females (2.6) in snow trout *Schizopyge niger* from Dal Lake. Wali *et al.* (2019) [60] recorded 'b' value as 3.028 in *Oncorhynchus mykiss*. Comparing the present values of 'b' in *S. niger* with previous studies, it is evident that the value of 'b' is less. The present low values of 'b' of *S. niger* (2.399) as compared to *C. carpio* var. *communis* (2.615) indicates that *C. carpio* var. *communis* shows better growth as compared to *S. niger*.

4.1 Condition factor

The relative condition factor (Kn) is an indicator of general well-being of the fish (Le Cren, 1951; George *et al*,. 1985) [35, 22]. Kn greater than one (1) is indicative of the general well being of fish, whereas its value less than one (1) indicates that fish is not in a good condition. Le Cren (1951) [35] correlated the condition factor (K) with the attainment of maturity, feeding intensity and the spawning behavior of a fish. Yousuf and Shafi (2012) [66] found that the condition factor of *S. niger* varied seasonally with gonadal development and feeding intensity. Dar *et al*. (2012) [13] calculated the relative condition factor (Kn) of *Schizopyge esocinus* from Jhelum River, Kashmir and revealed that the fluctuations in 'Kn' values can be attributed to spawning cycle as well as feeding intensity. Shah *et al*. (2013) [53] calculated the ponderal index of rainbow trout (*Oncorhynchus mykiss*) as 1.15 from Dachigam stream in Kashmir. The condition factor is used to compare the condition, fatness or wellbeing of fish (Ahmed *et al*. 2011) [1]. It is based on the hypothesis that heavier fish of a particular length are in a better physiological condition (Bagenal, 1978) [6]. Accoding to Johnson and Ndimele (2010) [29], condition factor is a useful index for monitoring of feeding intensity, age and growth rates of fish. Anene (2005) [4] found that condition factor is strongly influenced by both biotic and abiotic environmental conditions and can be used as an index to assess the status of aquatic ecosystem in which fish live. 'K' remained constant with increase in length and weight of fish (Salam *et al.* 2005) [50]. Low mean Kn value in *Aristichthys nobilis* was attributed to spawning strain, spent condition and low feeding rate (Mahapatra and Datta, 2004) [36]. Likewise, Hatikakoty and Biswas (2004) [25] suggested increase in the weight of body due to weight of mature gonads. Farooq *et al.* (2017) [18] calculated condition factor in *S. labiatus* in males and females as 1.4 and 1.5 respectively and indicated good condition of the fish. In the present study, it was observed that the value of condition factor of *C. carpio* var. *communis* ranged from a minimum of 1.151 (December) to the maximum of 1.928 (March), while in case of *S. niger*, the value of condition factor ranged from a minimum of 0.966 in November to the maximum of 1.32 in March. The highest values of K of both the fishes was obtained in March which may be due to maturity of gonads during spawning. From the present study, it becomes clear that the breeding cycle has a significant effect on the condition factor of the fish. The condition factor of fishes has been reported to be influenced by a number of factors such as onset of maturity (Hoda 1987) [27], spawning (De-Silva and Silva 1979, Al-Daham and Wahab 1991) [14, 2], sex and maturity (Gowda *et al.* 1987, Doddamani and Shanbouge 2001) [24, 17] and pollution (Bakhoum 1999, Devi *et al.* 2008) [7, 16]. During the present study also, the monthly fluctuations in condition factor of the fish seemed to be influenced by gonadal development and availability of food. The value of condition factor of *C. carpio* var. *communis* was found to be higher as compared to *S. niger* indicating better condition of the former than the latter.

5. Conclusion

From the present study, it was concluded that the allometric growth coefficient (b) in *S. niger* was found low as compared to *C. carpio* var. *communis* which indicates poor growth. Condition factor in *S. niger* was also found low as compared to *C. carpio* var. *communis* indicating poor condition of the fish.

6. References

1. Ahmed EO, Ali ME, Aziz AA. Length-weight Relationships and condition factors of six fish species in Atbara River and Khashm et-girba Reservoir, Sudan. International Journal of Agricultural Sciences. 2011; 3(1):65-70.
2. Al-Daham NK, Wahab NK. Age, growth and reproduction of the greenback mullet, *Liza subviridis* (Valenciennes) in an estuary in Southern Iraq. J. Fish Biol., 1991; 38: 81-88.
3. Allen KR. Some observations on the biology of the trout (*Salmo truta*) in Windermere. Journal of Animal Ecology. 1938; 7:333-349.
4. Anene A. Condition factor of four Cichlid species of a man-made Lake in Imo State, South-eastern Nigeria. Turkish Journal of Fisheries and Aquatic Sciences. 2005; 5:43-47.
5. Antony RPT. Length weight relationship in the oil sardine *Sardinella longicepes.* Indian Journal of Fisheries. 1967; 14:159-190.
6. Bagenal TB. Aspects of fish fecundity. In: Ecology of freshwater fish production (Ed. S.D. Gerking), Blackwell Scientific Publications. Oxford. UK. 1978, 75-101.
7. Bakhoum SA. Comparative study on length-weight relationship and condition factor of the genus *Oreochromis* in polluted and non-polluted parts of lake Mariut, Egypt. Bull. Nat. Inst. Oceanogr. Fish (Egypt), 1999.

8. Basheer VS, Khan AA, Sidiqqui IA. Length-weight relationship of *Channa punctatus* (Bloch) from the river Yamuna. Advances in limnology, 1993, 241-246.
9. Bashirullah AKN. Biology of *Lutjanus griseus* (L) of the Cubagua Island, Venezuela, Length-weight, body length, gut length relationships and condition factor. Biol Inst Oceanogr Univ Oriente. 1975; 14(1):101-107.
10. Beyer JE. On length-weight relationship. *Fishbyte* 1987; 5:11-13.
11. Bhat FA, Yousuf AR, Balkhi MH, Mahdi MD, Shah FA. Length-weight relationship and morphometric characteristics of *Schizothorax* spp. in the river Lidder of Kashmir. Indian J. Fish. 2010; 57:73-76.
12. Blackwell BG, Brown ML, Willis DW. Relative Weight: Status and current use in fisheries assessment and management. Rev. Fish. Sci. 2000; 8(1):44-52.
13. Dar SA, Najar AM, Balkhi MH, Rather MA, Sharma R. Length weight relationship and relative condition factor of *Schizopyge esocinus* (Heckel) from Jhelum River, Kashmir. International Journal of Aquatic Science. 2012; 3(1):29-38.
14. De Silva SS, Silva EIL. Biology of young grey mullet, *Mugil cephalus* (L.). Populations of a coastal lagoon in Sri lanka. J. Fish. Biol. 1979; 15:9-20.
15. Devaraj M. Biology of the large snakehead *Ophiocephalus marulius* (Ham) in Bhavanisagar waters. Indian J fish., 1973; 20(2):280-307.
16. Devi JO, Nagesh TS, Das SK, Mandal B. Length-weight relationship and relative condition factor of *Pampus argenteus* (Euphrasen) from Kakdwip estuarine region of West Bengal. J. Inland Fish. Soc. India. 2008; 40(2):70-73.
17. Doddamani MTJR, Shanbhogue SL. Length-weight relationship and condition factor of *Stolephorus bataviensis* from Mangalore area. Indian J. Fish. 2001; 48(3):329-332.
18. Farooq I, Bhat FA, Balkhi MH, Najar AM, Bhat BA, Shah TA *et al*. Length-weight relationship and condition factor as indicators of growth pattern and health of a snow trout, *Schizothorax labiatus* Mcclelland in River Jhelum, Kashmir. Eco. Env. and Cons. 2017; 23(2):846-851.
19. Firdous G. Fish and Fisheries of Anchar Lake, Kashmir. Ph.D. Thesis, Kashmir University, 1995.
20. Fotedar DN, Qadri MY. Fish and fisheries and the impact of *Cyprinus Carpio* L. on endemic fish. J. Sci. univ. Kash. 1974; 2:79-90.
21. Fulton TW. The rate of growth of fishes. Fisheries Board of Scotland Annual Report 22 Edinburgh. 1904; (3):141-241.
22. George JP, Sharma AK, Venkatshvaran K, Sinha PSRK, Venogopal G, Birader RS. Length-weight relationship and relative condition factor in *Cirrhina mirgala* and *Labeo rohita* froma sewage-fed tank. The Annals of Zoology, 1985; XXIII(2):79-90.
23. Golemi S, Medjda N, Lacej D. Influence of sex on the hematological and Morphometric parameers of *Cyprinus carpio* (Linnaeus, 1758) from Shkodra Lake. Academic Journal of Interdisciplinary studies. 2013; 2(8):45-49.
24. Gowda G, Shanbougu SL, Udupa KS. Length-weight relationship and relative condition of greymullet, *Valamugil sehci* (Forskal) from Manglore waters. Indian J. Fish. 1987; 34(4): 340-342.
25. Hatikakota G, Biswas SP. Length-weight relationship and condition factor of *Oreochromis mossambicus* from a domestic pond, Nazira, upper Assam. In: (Arvind Kumar eds.) Fishery Management, A.P.H. Publication Corporations, New Delhi, 2004, 223-232.
26. Hile R. Age and growth of the Cisco, *Amloplites rupestris* (Refineseque) in Nebish Lake, Wisconsin. Trans. Wis. Acad. Sci. Arts. Lett. 1936; 33:189-337.
27. Hoda SMS. Relative growth of body parts and length weight relationship in *Boleopthalamus dussumieri* and *B. dentatus* of Karachi Coast. Indian J. Fish. 1987; 34(1):120-127.
28. Hussain S, Bhat FA, Hakim MM, Balkhi MH, Najar AM. Morphometric relationships of length-weight and length-length in snow trout *Schizopyge niger* (Heckel, 1838) from Dal Lake, Kashmir. Indian J. Fish. 2018; 65(3):105-109.
29. Johnson CAK, Ndimele PE. Length-weight relationship and condition factors of twenty-one fish sps. In: Ologe lagoon, Lagos, Nigeria. Asian Journal of Agricultural Sciences 2010; 2(4):174-179.
30. Khan MA, Sabah. Length-weight and length-length relationships for five fish species from Kashmir Valley. J. Appl. Ichthyol., 2013; 29:283-284.
31. Koutrakis ET, Tsikliras AC. Length–weight relationships of fishes from three northern Aegean estuarine systems (Greece). J Appl. Ichthyol. 2003; 19:258-260.
32. Kulhanek SA, Leung B, Ricciardi A. Using ecological niche models to predict the abundance and impact of invasive species: application to the common carp. Ecological Applications. 2011; 21:203-213.
33. Kulshrestha SK, Srivastava M, George MP, Saxena R, Tieari A. Length weight relationship of a major carp *Catla catla* (Ham) from two water bodies of Bhopal. In: *Advances in Limnology* (Ed. H.R.Singh). Narendra Publishe, Delhi, 1993, 329-392.
34. Lagler KF. Freshwater fishery biology. Wm. C. Brown Co., Dubuque, Iowa. USA. 1956, 421.
35. Le Cren ED. The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Percafluviatilis*). J. Anim. Ecol. 1951; 20:201-219.
36. Mahapatra BK, Datta NC. Relative condition factor (Kn) of the big head carp, *Aristichthyes nobilis* (Richardsoni). In: Fishery Management (Avind Kumar eds.) Environmental Biology Research Unit S.K.M. University Dumka, A.P.H. Publishing Corporation, New Delhi – 110002. 2004, 47-53
37. Martin WR. The mechanism of environmental control of body form in fishes. Univ. Toronto. Stu. Biol. 58: Ont. Fish. Res. Lab. 1949; 70:1-91.
38. Mir JI, Shabir R, Mir FA. Length-Weight Relationship and Condition Factor of *Schizopyge curvifrons* (Heckel, 1838) from River Jhelum, Kashmir, India. World Journal of Fish and Marine Sciences 2012; 3:325-329.
39. Moutopoulos DK, Stergion KI. Length-weight and length-length relationships of fish species from Aegean Sea (Greece). J. Appl. Ichthyol. 2002; 18:200-203.
40. Natarajan AV, Desai VR, Mishra DN, Srivastava NP. Some new light on the population ecology of the Gangetic major carp *Catla catla* (Ham) from Rihand reservoir (U.P., India). Matsya. 1977; 3:46-59.
41. Pal M, Mahapatra BK, Mondal B. Length-Weight Relationship and Condition Factor of *Puntius sophore* (Hamilton, 1822) collected from Kolkata and Sub Urban Fish Markets. Environ Ecol., 2013; 31(3):1255-1259.

42. Petrakis G, Stergion KI. Weight-length relationship of 33 species in Greek waters. Fisheries Research. 1995; 21:465-469.
43. Qadri MY, Mir S, Yousuf AR. Breeding biology of *Schizothorax richardsoni* Gray & Hard. J. Indian Inst. Sci. 1983; 64:73-81.
44. Qadri S, Shah TH, Balkhi MH, Bhat BA, Bhat FA, Najar AM *et al*. Morphometrics and length-weight relationship of *Schizothorax curvifrons* Heckel 1838 in River Jhelum, Kashmir, India. Indian J. Anim. Res. 2017; 51(3):453-458.
45. Qureshi MY, Singh JP, Das SM. On the problem of depletion of endemic fishes of Kashmir by the introduction of exotic carp (*Cyprinus carpio*). In: All India Symposium on Ichthyology and Hydrobiology and Fisheries, 1971, 18-19.
46. Rao AKVCS, Sreeramullu K. Length-weight relationship of the Gobilid fish *Psudocrypts lanceolatus* (Bloch) and Schneider, 1801 of the Vasist Godavari Estuary, East coast in India. In: Fish Management and Aquatic Environment 2006, 110-135.
47. Reddy VS, Rao MB. Length-weight relationship and relative condition of *Puntius sophore* (Ham- Buch) from lake Hussain Sagar, Hyderabad, India. J. Inland Fish Soc India. 1992; 24(1):22-25.
48. Ricker WE. Computation and interpretation of biological statistics of fish populations. Fish Res. Board Canada Bull. 1975; 191(1):82.
49. Rounsenfell GA, Everhart WH. Fishery Science. The Method and Application. Jhon Wiley and sons, New York, 1953.
50. Salam A, Naeem M, Kauser S. Weight length relationship and condition factor relationship of freshwater wild *Puntius chola* from Islambad, Pakistan. Pakistan Journal of Biol. Sic. 2005; 8(8):1112-1114.
51. Saxena DB, Koul DN. Fish and fisheries of Jammu and Kashmir State, Part I. Fisheries resources and problems. Ichthyologica. 1966; 5:45-52.
52. Seegers L, De Vos L, Okayo DO. Annotated checklist of the freshwater fishes of Kenya from Lake Victoria. J.E Afr. Nat. Hist. 2003; 92:11-47.
53. Shah TH, Balkhi MH, Asimi OA, Khan I. Length weight relationship and ponderal index of rainbow trout (*Oncorhynchus mykiss* W. 1792) from Dachigam stream in Kashmir. African Journal of Agricultural Research. 2013; 8(4):1277-1279.
54. Sinoveic G, Franicevic M, Zorica B, Cikes-Kec V. Length–weight and length–length relationships for 10 pelagic fish species from the Adriatic Sea (Croatia). J Appl Ichthyol. 2004; 20:156-158.
55. Subla BA. Studies on the functional anatomy of the alimentary canal. Part III. On the functional anatomy of feeding apparatus and the food of some Kashmir fishes. Kash. Sci. 1967; 4:148-177.
56. Sunder S, Kumar K, Raina HS. Food and feeding habits and length weight relaitonship of *Cyprinus carpio specularis* of Dal Lake, Kashmir. Indian J Fish. 1984; 31(1):90-99.
57. Tesch FW. Age and growth. In: Methods for assessment of fish production in freshwaters, Ricker, W.E (ed). Blacwell Scientific Publications, Oxford. 1971, 98-130.
58. Thomas J, Venu S, Kurup BM. Length-weight relationship of some deep-sea fish inhabiting the continental slope beyond 250m depth along the west coast of India. NAGA, ICLARM Quarterly. 2003; 26(2):17-21.
59. Vass KK, Raina HS. Ecology of a mountain lake in Kashmir. V. Internat. Symp. Trop. Ecol. Malaysia. 1979, 212.
60. Wali A, Shah TH, Balkhi MH, Bhat BA, Bhat FA, Qadri S *et al*. Morphometry and length-weight relationship of rainbow trout *Oncorhynchus mykiss* Walbaum, 1792 (Salmoniformes: Salmonidae) from Kashmir. Journal of entomology and zoology studies. 2019; 7(1):1653-1656.
61. Weber MJ, Brown ML, Wills DW. Spatial variability of common carp populations in relation to lake morphology and physicochemical parameters in the upper Midwest United States. Ecology of Freshwater Fish. 2010; 19(4):555-565.
62. Yousuf AR. Fishery resources of Kashmir. In: Ecology, Environment and Energy (Ed. A. H. Khan & A. K. Pandit) Kashmir Uni. 1996, 75-128.
63. Yousuf AR, Firdous G, Pandit, Anil K. Length-weight relationship in *Schizothorax niger* Heckel, an endemic lacustrine fish of Kashmir. J. Res. Dev. 2001; 1:54-59.
64. Yousuf AR, Gazala F, Balkhi MH, Pandit AK. Studies on the length-weight relationship in some cyprinid fish in Manasbal Lake, Kashmir. In: Yousuf, A. R., Raina, M. K. and Qadri, M. Y. (Eds.), Current trends in fish and fishery biology and aquatic ecology. Postgraduate Department of Zoology, University of Kashmir, Srinagar, India, 1992, 185-189.
65. Yousuf AR, Qadri MY. Current trends in Fish and Fishery Biology and Aquatic Ecology. University of Kashmir. 1992, 43-52.
66. Yousuf AR, Shafi S. Length-weight relationship and condition factor of *Schizothorax niger* (Heckel, 1838) from Dal lake, Kashmir. International Journal of Scientific and Research Publications. 2012; 2:1-3.
67. Zutshi DP, Gopal B. State of biodiversity in lakes & wetlands of Kashmir Valley. Enviromental Biodiversity & Conservation. 2000, 15-16.