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LENGTH-WEIGHT RELATIONSHIP OF SIX FRESHWATER FISH SPECIES IN THE PONDS IN CLOSE VICINITY TO RIVER GANGES, VARANASI

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Abstract

The length-weight relationships and the condition factor were monitored for six different varied commercially important freshwater fish species, namely, *Ompak pabda, Labeo bata, Channa punctatus, Rita rita, Ailia coila* and *Clarias batrachus* collected from ponds near the close vicinity of River Ganges in Varanasi to assess the significance of allometric growth factor and their well-being. In total 362 specimens 'b' value ranged from 1.53 (minimum; *R. rita*) to 3.65 (maximum; *L. bata*) and *O.pabda, L. bata, C. punctatus, R. rita* and *C. batrachus* indicates negative while *A. coila* indicates positive allometric growth.Condition factor value for the *R. rita* (1.14) and *A. coila* (0.96) indicates the good health symptoms, while for *C. punctatus* (1.28) it is best in terms of weight gain and it attains economic size, which further reaps benefit to the fisherman. A new maximum length was recoded for *Ompak pabda* (32 cm TL).

Keywords : River Ganges; Length-weight relationship (LWRs); Condition factor; Allometric growth; Fish

1. Introduction

Fishes play a vital role in the economic development of a nation as it is directly related with the socio-economic status of local fisher people. It is not only the cheapest source of protein but also it contains essential nutrients required for better human health status. The Ganges, also called as Ganga is a trans-boundary river of Asia which flows through the nation of India and Bangladesh. It has been estimated that about 350 fish species live in the entire Ganges drainage, including several endemics. The most frequently observed fishes mainly belong to order Cypriniformes (50%), Siluriformes (23%), and Perciformes (14%) variety of the total fish catch. The morphometric relationship between length and weight of a fish obtained from the present study is required for proper capitalization and management of fish population and also for determining growth rate, feeding stages, survival, maturity age structures and other essential components of fish population dynamics (Anene, 2005; Kohler et al., 1995). Thus, Length-Weight relationships (LWRs) studies can be used in fisheries management by setting yield equations for estimating and comparing the population that can provide information on stock condition spatially and temporally (Kumary and Raj, 2016).

The information acquired from LWRs can have important role in developing modern aquaculture techniques for better commercial yield productions of such economically and commercially important fish species (Kumar et al., 2014) and can provide useful information for fishery managers (Pitcher and Hart, 1982). At various places, these differences occur more frequently in fish due to varied seasonal variation, spawning time and multiple spawning and also food availability (Das et al., 1997). However, though there is a large fish population available that are commercially important. In fisheries, the condition factor denotes the comparison between the fishes based on the "condition", "fatness" or well-being of fish. It can act as an index to observe the feeding intensity, age and growth status in fish (Oni et al., 1983). All these six species monitored in the present study are commercially playing a pivotal role in fisheries sphere of this region.

Hence, the main objective of this study is to estimate the LWRs and condition factor for these six freshwater commercially important fish species collected from different areas located in close vicinity of the River Ganges in the Varanasi region, India.

2. Materials and Methods

The present study was conducted on the fishes available in the ponds near the river Ganges (Lat.25.32˚N, Long. 82.97˚E) and a total of 362 samples were collected between July 2017 to December 2017 with the support of local professional fishermen using various traditional fishing gears (e.g. cast net, square lift net and gill net) and brought to the laboratory for identification purpose. Total length (TL) (starting from tip of the snout up to the end of caudal fin) and total body weight (BW) for each individual was measured using digital slide calipers and an electronic balance with 0.1 cm and 0.1 g accuracy respectively. The identification and the taxonomic keys of these species were followed by Fishes of U.P and Bihar, Srivastava (2014).The data obtained from all these fishes were analyzed through statistical analysis with the help of Microsoft Excel 2010.

LWRs were assessed by logarithmic transformation of the linear regression equation: $\log W = \log a + b \log TL$, where W is the total body weight (g) of the fish, and TL is the total length (cm) of the fish. The parameter, 'a' denote the intercept and 'b' denote the slope of the regression curve (Ruiz-Campos et al., 2010). Additionally, 95% confidence intervals of 'a' and 'b' and the coefficient of determination (r^2) calculated for regression analysis. Extreme outliers of collected data were removed. The significance off the study parameters were checked by t-test analysis of 'b' values obtained in linear regression.

3. Results

Length weight relationship of six different fish species belonging to different family showed along with the descriptive analysis and for this purpose total 362 specimens were sampled. The regression parameters (a and b) with 95% confidence intervals (CI) for 'a' and 'b' of the LWRs, coefficients of determination (r^2) of important freshwater fish species *Ompak pabda, Labeo bata, Channa punctatus, Rita rita, Ailia coila and Clarias batrachus* are given in Table 1. As evident from the Figure 1of the exponent 'b' for all six species, 'b' value ranged from 1.53 (minimum; *R. rita*) to 3.65 (maximum; *L. bata*).The 'b' values greater than 3 indicate positive while lower than 3 indicate negative allometric growth. Box-Whiskers plot (Figure 2) drawn for the 'b' values in combined sexes of *O. pabda, L. bata, C. punctatus, R. rita* and *C. batrachus*indicates negative while for *A. coila*in dicates positive allometric growth.

Average length and weight (Figure 4) were observed for the fishes *O. pabda* ($L_{average}$ = 28.59 cm, $W_{average}$ = 154.89 g), *L. bata* ($L_{average}$ = 20.78 cm, $W_{average}$ = 85.39 g), *C. punctatus* ($L_{average}$ = 15.98 cm, $W_{average}$ = 46.47 g), *R. rita* ($L_{average}$ = 17.77 cm, $W_{average}$ = 69.77), *A. coila* ($L_{average}$ = 15.72 cm, $W_{average}$ = 22.00 g) and *C. batrachus* ($L_{average}$ = 21.42 cm, $W_{average}$ = 76.80 g), and a new maximum length record was observed for the *O. pabda* (32 cm). Condition factor is a measure of the well-being of fish and denotes the direct relation between fish health and nutritional condition of ponds environment, K value near to unity shows the good condition of pond as well as fish. In the present study K value for the *R. rita* (1.14) and *A. coila* (0.96) indicates the good health symptoms, they are the most preferred fish for the given ponds, while for *C. punctatus* (1.28) growth is very fast and it grows very fast in the selected area of study as shown in Figure 5.

All LWRs were significant ($P < 0.05$), with all r^2 values ≥ 0.567. A new maximum length was recoded for *Ompakpabda* (32 cm TL).

		Sample (n)	Total length (TL, cm)		Weight (W, g)		Regression parameter				
Species	Sex		Min	Max	Min	Max	a	b	95% CI of a	95% CI of b	r^2
Ompak pabda	Mix	46	24.5	32	110	218	0.37	1.8	0.31 - 0.46	1.43 - 2.16	0.693
Labeo bata	Mix	75	17	24.5	42	122	0.31	1.84	0.28 - 0.4	1.51 - 2.18	0.635
Channa punctatus	Mix	62	14	18	34	64	0.67	1.53	0.28 - 0.45	1.17 - 1.88	0.553
Rita rita	Mix	58	16.6	19.5	54	85	0.05	2.54	0.3 - 0.38	2.26 - 2.81	0.867
Ailia coila	Mix	42	14.4	17.5	13	34	0.0009	3.65	0.18 - 0.25	3.05 - 4.25	0.799
Clarias batrachus	Mix	79	18.1	24.5	42.5	133.5	0.13	2.09	0.18 - 0.29	1.61 - 2.56	0.567

Table 1: Estimated parameters of length weight relationships ($BW = a \times TL^b$) of six different fish species from the ponds near River Ganges, Varanasi, India

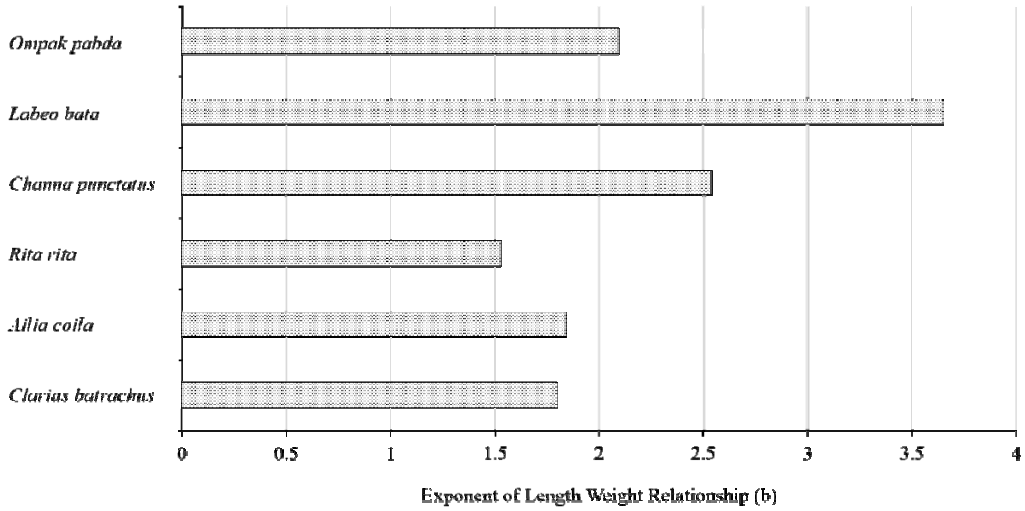

Figure 1: Exponent of Length Weight Relationship (b) for six fish species from the ponds near the River Ganges, Varanasi region.

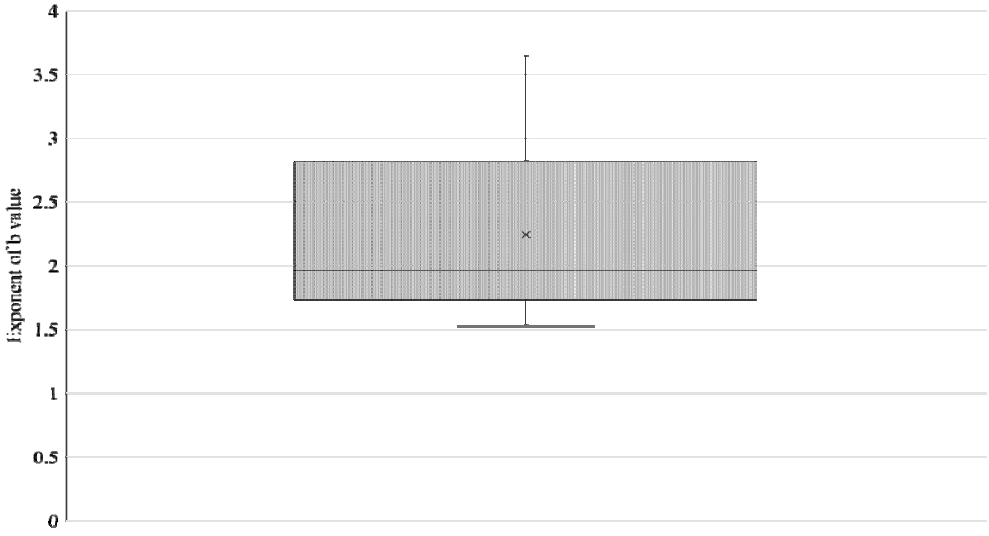

Figure 2 : Box-Whiskers plot of the exponent b of the LWR for six fish species from the ponds near the River Ganges, Varanasi region.

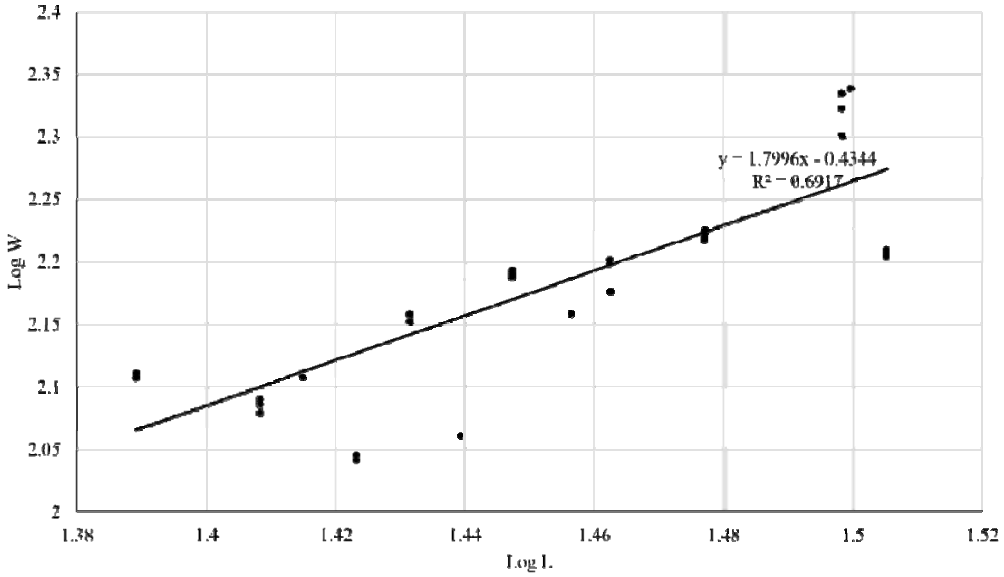

Figure 3 : Scatter diagram plotted for the Log L and Log W values showing linear curve fitting for the fish *Ompak pabda* (recorded for the maximum length, 32 cm).

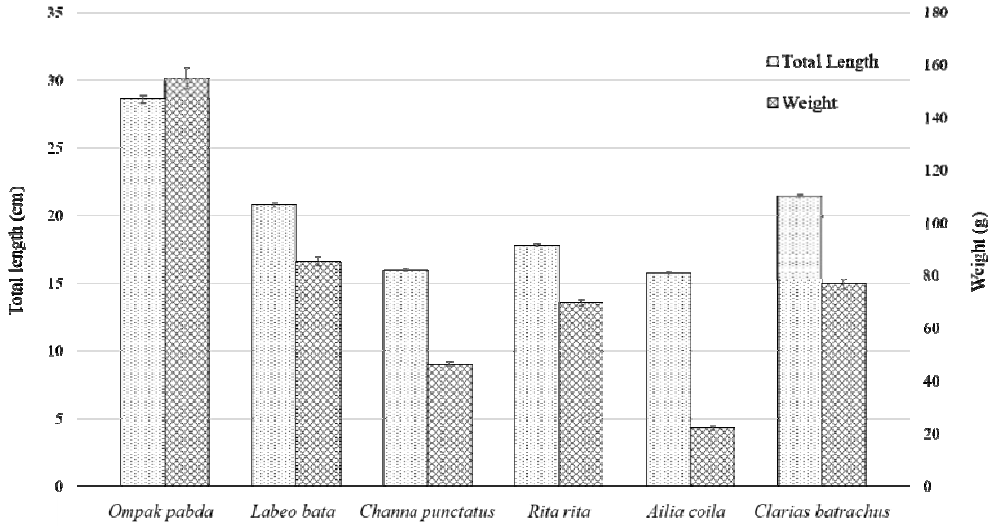

Figure 4 : Average length and weight of six different fish species from the ponds near the River Ganges, Varanasi region.

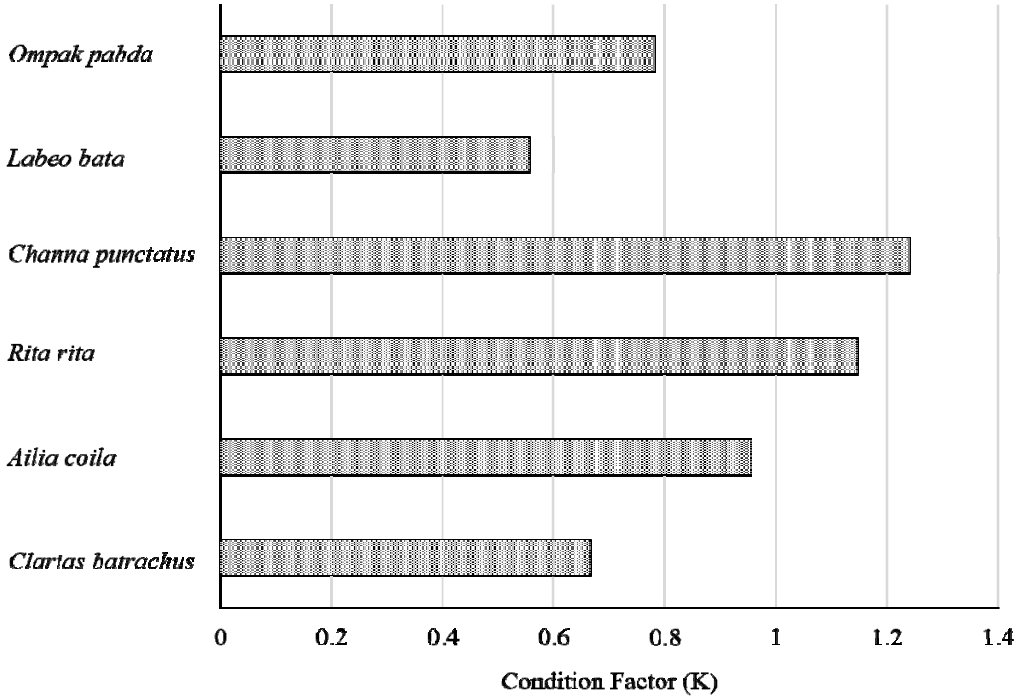

Figure 5 : Condition factor (K) of six different fish species from the ponds near the River Ganges, Varanasi region.

4. Discussion

The shape and fatness of fish species is decisive for the determination of the value of parameter 'b' for length-weight relationships (Gubiani et al., 2009). Various other factors such as temperature, salinity, food availability, sex, time and stage of maturity are also responsible at some extent (Pauly, 1983) but in the current study, we focused on value of parameter 'b' and condition factor. In the present study, the values of both parameters 'a' and 'b' for the six studied species fit the expected ranges, as suggested by the Bayesian length–weight approach (Froese and Pauly, 2015). Differences in observed 'b' values can be attributed to a combination of one or more factors such as number of specimens examined, fish habitat, degree of stomach fullness, sex, gonadal maturity, and observed length and weight variations of specimens caught (Froese, 2006; Ruiz-Campos et al., 2010), all of which were not strictly considered in the current investigation. In our study, we did sampling at different sites in the Varanasi region. However, data from the different waters bodies combined in order to provide a more species-specific overall relationship.

Ideally the value of 'b' is 3in a healthy fish (Allen, 1938), but under natural conditions it usually ranges between 2.5 and 4 (Hile, 1936; Martin, 1949). In the present study 'b' varied between 1.53 and 3.65 in the various size categories of all six species.

The results of the present study are in conformity with the views of other researchers (Le Cren, 1951; Wootton, 1992; Khan et al., 2012;Chakravarty et al., 2012; Kumar et al.,2013; Nair et al., 2015) that the fish normally does not retain the same shape or body outline throughout the life. Variations in the slope is a parameter affected by environmental factors like temperature, food supply, spawning conditions, life stages, sex, fishing area, fishing time and sample size variations (Ricker,1973; Bagenal and Tesch,1978; Kleanthids et al., 1999). It is evident from the study of Weatherley and Gill (1987) that higher metabolic activity with spawning season lowers the 'b' value while less metabolic activities, accumulation of fat, weight of gonad etc. during the pre-spawning period increases the 'b' values. The closeness of 'b' values to 3 also suggests a healthy environment for the fishes with respect to feeding and growth.

Condition factor represents the quality of fish, which is actually the result of the interactions between biotic and a biotic factors and their effect on the physiological condition of the fish. However, fluctuations in condition factor observed during phase change, rhythmic feeding and other physico-chemical factors of the environment, age, physiological state (Kurup and Samuel, 1987; Kurup, 1990; Kalita and Jayabalan, 1997; Nehemia et al., 2012).The condition factor observed for six species in the present study suggests that the fishes were in a good condition, the values of condition factor fluctuate from 0.55 to 1.24.

The maximum lengths recorded for the *O.pabda, L. bata, C. punctatus, R. rita, C. batrachus,* and *A. coila* were 30 cm (Bhuyian, 1964), 61 cm (Talwar and Jhingran, 1992a), 31 cm (Talwar and Jhingran, 1992b), 150 cm (Talwar and Jhingran, 1992c), 30 cm (Talwar and Jhingran, 1992d) and 47 cm (IGFA, 2001) respectively. Previous maximum length recorded for the *Ompak* was 30 cm TL while in our study it was observed 32 cm which was a new record for the *O. pabda*.

This study may be helpful for the study of growth parameters for given fishes but cannot be sufficient to conclude any inference regarding the growth statistics of any fish because with the variation of time temperature and photoperiod conditions vary which affects the nutritional availability to fishes, their reproductive status also changes which further negatively or positively affect the growth parameters, so this study needs further investigations in long run for the same ponds selected in this study for better judgement of growth parameters.

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References

Allen, K. R. (1938). Some observations on the biology of the trout (Salmo trutta) in Windermere. *The Journal of Animal Ecology*, 333-349.

Anene, A. (2005). Condition factor of four Cichlid species of a man-made lake in Imo State, Southeastern Nigeria. *Turkish Journal of Fisheries and Aquatic Sciences*, *5*(1).

Bagenal, T. B., & Tesch, A. T. (1978). Conditions and growth patterns in fresh water habitats.

Bhuiyan, A. L. (1964). *Fishes of dacca* (No. 13). Asiatic Society of Pakistan.

Chakravarty, M. S., Pavani, B., & Ganesh, P. R. C. (2012). Length-weight relationship of ribbon fishes: Trichiurus lepturus (Linnaeus, 1758) and Lepturacanthus savala (Cuvier, 1829) from Visakhapatnam coast. *J Mar Biol Ass India*, *54*, 99-101.

Das, N. G., Majumder, A. A., & Sarwar, S. M. M. (1997). Length–weight relationship and condition factor of Catfish Arius tenuispinis, Day, 1877. *Indian J. Fish*, *44*(1), 81-85.

Froese, R. (2006). Cube law, condition factor and weight–length relationships: history, meta□analysis and recommendations. *Journal of applied ichthyology*, *22*(4), 241-253.

Froese, R., & Pauly, D. (2015). FishBase 2015: World Wide Web electronic publication. *Google Scholar*.

Gubiani, E. A., Gomes, L. C., & Agostinho, A. A. (2009). Length–length and length–weight relationships for 48 fish species from reservoirs of the Paraná State, Brazil. *Lakes & Reservoirs: Research & Management*, *14*(4), 289-299.

Hile, R. (1936). *Age and growth of the cisco, Leucichthys artedi (Le Sueur), in the lakes of the northeastern highlands, Wisconsin*. US Government Printing Office.

International Game Fish Association. (2001). Database of IGFA angling records until 2001. *IGFA, Fort Lauderdale, USA*.

Kalita, B., & Jayabalan, N. (1997). Length-weight relationship and relative condition factor of the golden scad, Caranx kalla Cuv. from Mangalore coast. *Indian. J. Fish*, *44*(1), 87-90.

Khan, M. A., Khan, S., & Miyan, K. (2012). Length–weight relationship of giant snakehead, Channa marulius and stinging catfish, Heteropneustes fossilis from the River Ganga, India. *Journal of applied ichthyology*, *28*(1), 154-155.

Kleanthidis, P. K., Sinis, A. I., & Stergiou, K. I. (1999). Length-weight relationships of freshwater fishes in Greece. *Naga, The ICLARM Quarterly*, *22*(4), 37-40.

Kohler, N. E., Casey, J. G., & Turner, P. A. (1995). Length-weight relationships for 13 species of sharks from the western North Atlantic. *Fishery Bulletin*, *93*(2), 412-418.

Kumar, K., Lalrinsanga, P. L., Sahoo, M., Mohanty, U. L., Kumar, R., & Sahu, A. K. (2013). Length-weight relationship and condition factor of Anabas testudineus and Channa species under different culture systems. *World J Fish Marine Sci*, *5*(1), 74-78.

Kumar, R., Yadav, S. S., & Tripathi, M. (2014). Studies on length–weight relationship of seven commercially important freshwater fish species of Gomti River Lucknow (UP) India. *International Journal of Fisheries and Aquatic Studies*, *1*(3), 1-3.

Kumary, A. K. S., & Raj, S. (2016). Length–weight relationship and condition of climbing perch Anabas testudineus Bloch population in Kuttanad, Kerala. *International Journal of Advanced Research in Biological Sciences*, *3*, 21-26.

Kurup, B. M. (1990). Population characteristics. *Bionomics and Culture of Labeo dussumieri (Val), Final Report Submitted to Indian Council of Agricultural Research*, 1-108.

Kurup, B. M., & Samuel, C. T. (1987). Length-weight relationship and relative condition factor in Daysciaena albida (Cuv.) and Gerres filamentosus (Cuv.). *Fishery Technology*, *24*(2), 88-92.

Le Cren, E. D. (1951). The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (Perca fluviatilis). *The Journal of Animal Ecology*, 201-219.

Martin, W. R. (1949). The mechanism of environmental control of body form in fishes. University of Toronto. *Studies in Biology Series*, *58*.

Nair, P. G., Joseph, S., & Pillai, V. N. (2015). Length-weight relationship and relative condition factor of Stolephorus commersonii (Lacepede, 1803) exploited along Kerala coast. *Journal of the Marine Biological Association of India*, *57*(2), 27-31.

Nehemia, A., Maganira, J. D., & Rumisha, C. (2012). Length-weight relationship and condition factor of tilapia species grown in marine and fresh water ponds. *Agriculture and Biology Journal of North America*, *3*(3), 117-124.

Oni, S. K., Olayemi, J. Y., & Adegboye, J. D. (1983). Comparative physiology of three ecologically distinct freshwater fishes, Alestes nurse Ruppell, Synodontis schall Broch & Schneider and Tilapia zillii Gervais. *Journal of Fish Biology*, *22*(1), 105-109.

Pauly, D. (1983). *Some simple methods for the assessment of tropical fish stocks* (No. 234). Food & Agriculture Org.

Pitcher, T., & Hart, P. J. (1982). *Fisheries ecology* (No. 597: 504.4 PIT).

Ricker, W. E. (1973). Linear regressions in fishery research. *Journal of the fisheries board of Canada*, *30*(3), 409-434.

Ruiz-Campos, G., Ramírez-Valdez, A., González-Guzmán, S., González-Acosta, A. F., & Acosta Zamorano, D. (2010). length–weight and length–length relationships for nine rocky tidal pool fishes along the Pacific coast of the Baja California Peninsula, Mexico. *Journal of Applied Ichthyology*, *26*(1), 118-119.

Srivastava, G. J. (2014). Fishes of UP and Bihar.

Talwar, P.K. and A.G. Jhingran, 1992a. Inland fishes of India and adjacent countries. vol 1. A.A. Balkema, Rotterdam. Pp199.

Talwar, P.K. and A.G. Jhingran, 1992b. Inland fishes of India and adjacent countries. Volume 2. A.A. Balkema, Rotterdam. pp1020.

Talwar, P.K. and A.G. Jhingran, 1992c. Inland fishes of India and adjacent countries. Volume 2. A.A. Balkema, Rotterdam. pp578.

Talwar, P.K. and A.G. Jhingran, 1992d. Inland fishes of India and adjacent countries. Volume 2. A.A. Balkema, Rotterdam. pp593.

Weatherley, A. H., & Gill, H. S. (1987). Tissues and growth. *The biology of fish growth*, 147-175.

Wootton, R. J. (1990). Ecology of Teleost Fishes Chapman & Hall London 404 Google Scholar.