Length And Weight Relationship of Heniochus Acuminatus In Coromandal Coast of India

R. Anbarasu[1], T. Manikandarajan[2], G. Sankar[3], K. Ramamoorthy[4], K. Kathirvel[5] ,A. Eswar[6]
Centre of Advanced Study in Marine Biology, Faculty of Marine Sciences
Annamalai University, Parangipettai - 608 502, Tamil Nadu, India.

Abstract- *The length-weight relationship gives a colossal contribution in fisheries field as it exposes the mathematical relationship between the variables length and weight of fish. For the study on Length-weight relationship, specimens of H. acuminatus were collected from the commercial catches brought to the five major fish landing centers of Coromandel Coast for the period of one year from January 2013 to December 2013. The regression plot of the data indicated a linear relationship between the two variables. It can be inferred from the figures that points are very close to the line indicating a linear relationship between body length and body weight. The result of this study provides valuable information for the online Fish Base database, as well as provides important baseline data for future studies.*

Keywords- Coromandal, Fishbase, Fisheries, Mathematical and relationship

I. INTRODUCTION

Studies on Length-weight relationship are very important in fishery biology because they allows the estimation of average weight of fish of a given length group by establishing a mathematical relation between the two variables. Length–weight relationships are useful for the conversion of growth-in-length equations to growth-in-weight for use in stock assessment models and to estimate stock biomass from limited sample sizes (Ecoutin *et al.,* 2005; Froese and Pauly, 2012). It is an important parameter and is helpful in understanding the growth dynamics of fish populations (Morato *et al.,* 2001). Besides these, it can be used to predict the wellbeing of the fish population (Le Cren, 1951; Pauly, 1993) and in comparing the life history. Length and weight relationship can also be used in setting yield equations for estimating the number of fish landed and comparing the population in space and time (Beverton and Holt, 1957). Furthermore, length-weight relationships allow inter alia; i) estimation of average weight of the fish of a given length group (Beyer, 1987); ii) conversion of length-growth equations to weight-growth equivalents (i.e., length-at-age to weight-at age) in yield- per- recruit and related models; iii) inter specific and inter population morphometric comparison of fish species; and iv) assessing the relative well-being of fish population (Bolger and Connolly, 1989; Kulbicki *et al.,* 1993 and King, 1996).

In tropical and subtropical waters, the growth fluctuation is more frequent in fish due to variations in seasons, multiple spawning and food composition (Das *et al.,* 1997). Studies on length-weight relationship are also helpful to the researchers and policy makers in the preparation of effective management plans for fishery resources (Karna *et al.,* 2012; Le Cren, 1951; Pauly, 1993; Petrakis and Stergiou, 1995). This relationship is particularly important in parameter zing yield equations and in estimations of stock size (Abdurahiman *et al.,* 2004).

Length-weight relationship is helpful in evaluation of the condition or general wellbeing of the animal through the study of condition factor (K) or relative condition factor (Kn) (Bolger and Connolly, 1989; Kulbicki *et al.,* 1993; King, 1996). Condition factor has been used as an index for monitoring feeding intensity, age and growth rates in fish (Fagade, 1979; Oni *et al.,* 1983). The exact relationship between length and weight differs among species of fish according to their inherited body shape and within a species according to the condition (robustness) of individual fish (Schneider *et al.,* 2000).

There is no information on length-weight relationship of *H. acuminatus* from Coromandel Coast of India. Therefore the present study was undertaken to estimate the length-weight relationship of *H. acuminatus* from Coromandel Coast.

II. MATERIAL AND METHODS

For the study on Length-weight relationship, specimens of *H. acuminatus* were collected from the commercial catches brought to the five major fish landing centers of Coromandel Coast for the period of one year from January 2013 to December 2013. A total of 455 specimens (212 males and 243 females) ranging in size from 10 cm to 16.4 cm for males and 9.8 cm 16.7 cm to for females were used for the present study. The total length (TL) of each fish was measured from the anterior most edge of the snout to the posterior most edge of caudal fin to the nearest mm with a measuring board. Weight (W) was measured to the nearest 0.1 g by an electronic balance (Roy Electronic balance) after draining the water from the buckle cavity and wiping the moisture content on the body of fish (King, 1996). Fishes with damaged caudal fin were discarded.

The length-weight relationship was calculated separately for each category based on the methodology of Le Cren (1951). The hypothetical and parabolic equation used by him is

W = a Lb.

Its logarithmic transformation is

Log e W=log e a + b log e L i.e., Y= a + bx

According to Ramasesaiah and Murty (1997), where 'W' represents weight (g) and 'a' and 'b' the constants, which were estimated by the method of least squares.

The linear equation was fitted separately for males and females of *H. acuminatus.* Analysis of Covariance (ANCOVA) was employed to test the significance of difference between regression coefficients (b) at 5% level of both sexes (Snedecor, 1956; Snedecor and Cochran, 1967). The t test (Snedecor and Cochran, 1967) was employed to test whether the regression coefficient (b) departed significantly from the expected hypothetical cubic value 3.

III. RESULTS

The estimated coefficients of the length-weight relationship and other statistical details of *H. acuminatus* are given in Tables 1, 2 and 3. The logarithmic values of observed length and corresponding weights of males (Fig. 1 and 2 and females Fig. 4 and 5) are plotted in respectively. Similarly the observed values of length and weight of males and females of *H. acuminatus* are plotted. The regression plot of the data indicated a linear relationship between the two variables. It can be inferred from the figures that points are very close to the line indicating a linear relationship between body length and body weight.

Analysis of covariance used to test the difference in regression coefficients between males and females revealed significant differences at 5% level (F= 0.2199) (P<0.05) and hence separate equation were maintained for each sex.

Table.1. Sum of squares of length-weight relationship in males and females of *H. acuminatus*

Category	N	∑X	∑Y	$\sum X^2$	$\sum Y^2$	∑XY
Male	212	231.85	227.61	254.16	250.56	250.56
Female	243	281.05	305.70	327.10	401.84	359.30

∑X, ∑Y= sum of X and Y
$\sum X^2$, $\sum Y^2$ and ∑XY = sum of squares and products

Fig.1. Different size of Banner fish (*H. acuminatus)*

Table.2. Regression analysis for length-weight relationship in males and females of *H. acuminatus*

Category	Df	Sum of squares and products			'b'	Errors of estimation	
		x^2	Xy	y^2		Df	SS
Males	212	0.5918	1.9342	6.493	3.006	211	0.17213
Females	243	2.0407	4.3307	17.267	2.809	242	8.07039
Total	455	2.6325	6.2649	23.754	5.815	453	8.24252

x^2 , xy and y^2 =corrected sum of squares and products
df -degrees of freedom, b-regression coefficient and SS-sum of squares

Table.3. Analysis of covariance difference between regression of length- weight relationship in males and females of *H. acuminatus*

Sources of variation	Df	Sum of squares	Mean squares	F	P
Deviation from individual regression	453	8.2425299	0.0181954	0.2199	P> 0.05
Difference between regressions	1	0.6027	0.6027		

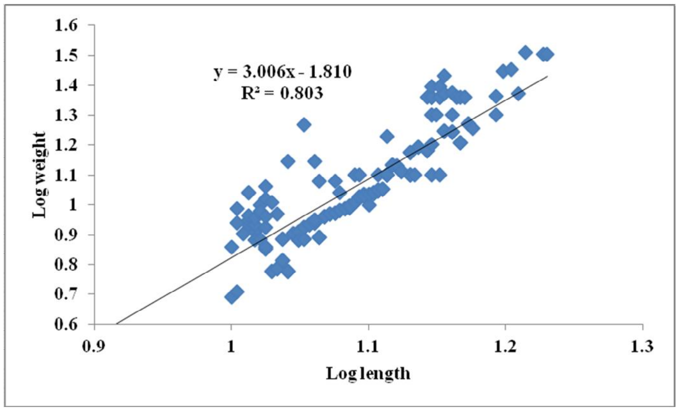

Fig.2. Logranthamic relationship between length and weight in male of *H. acuminatus*

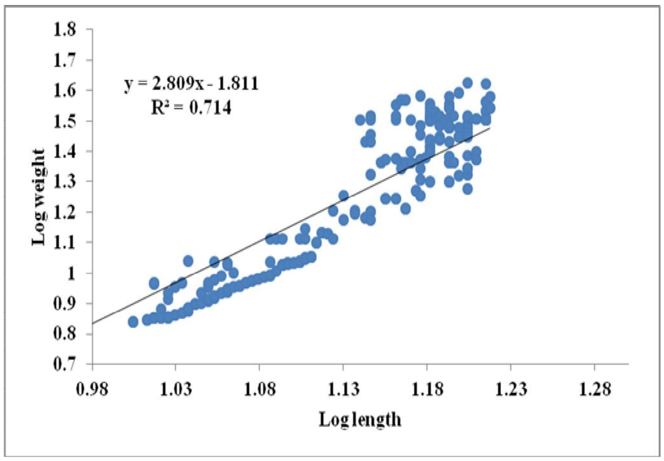

Fig.3. Logranthamic relationship between length and weight in female of *H. acuminatus*

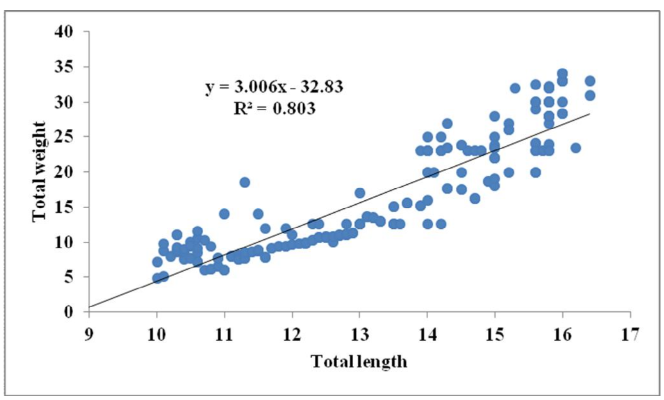

Fig.4. Parabolic relationship between length and weight in male of *H. acuminatus*

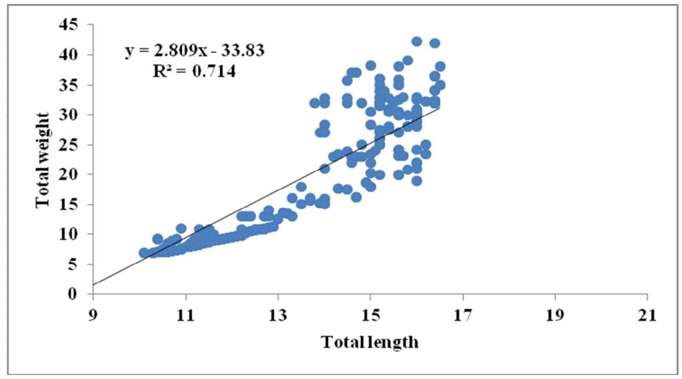

Fig.5. Parabolic relationship between length and weight in female of *H. acuminatus*

The logarithmic equations derived for males and females are given below**:**

For males: $\log_e W = -1.810 + 3.006 \log_e L$

For females: $\log_e W = -1.811 + 2.809 \log_e L$

And the parabolic relations derived are:

For males: $W = 32.83L^{3.006}$

For females: $W = 33.83L^{2.809}$

Analysis of covariance used to test the difference in regression coefficients between males and females revealed significant differences (F= 0.2199, P<0.005). The t-test showed that the regression coefficient 3.00 obtained with 212 males departed slightly from the cube value (3) at 5% level (t=1.44, P>0.05). The regression coefficient 2.80 obtained with 243 females also depart slightly from the cube value (t=1.822, P>0.05). Thus males exhibited slight positive allometric growth pattern, whereas females exhibited negative allometric growth.

IV. DISCUSSION

From the regression equation obtained in the present study it is clear that the 'b' values traced for males (3.006) was greater than 3 and females (2.809) were less than 3, showing the allometric pattern of growth. Allen (1938) pointed out that the exponent coefficient (b) in the length-weight relationship of fishes is usually 3. Later Carlander (1969) pointed out that the 'b' value is very close to 3.0 but varies between 2.5 and 3.5. Length-weight relationship studied by Frosta *et al.*, (2004) in 30 species of marine fishes in Eastern Brazil also showed the b values in the above range for most of the fishes. If the 'b' value for fish is 3, the fish grows isometrically; if it is greater than 3, the fish exhibits positive allometry and if it is lower than 3 the fish exhibits negative allometry (Tesch, 1968). It is noticed that the 'a' and 'b' values not only differ in different species but differ in the same species depending on sex, stage of maturity, food habits and so on (Qasim, 1973; Bal and Rao, 1984). According to Jhingran, (1968) and Frosta *et al.,* (2004), the slope value 'b' indicates the rate of weight gain relative to growth in length and varies among different populations of the same species or within the same species. The increasing in weight of any individual was not to a single factor but various factors (Townsend *et al.,* 2003).

The present study on length- weight relationship of *H. acuminatus* showed that the 'b''t' test was done to compare the b values of males and females from the hypothetical value of 3. While the b value of male (2.76) differed significantly from the hypothetical value of 3 ($t = -2.85 < 0.05$), the b value of female (2.85) did not differ significantly from the hypothetical value of 3 ($t = -1.0158 > 0.05$).values of both males and females were less than 3. However differences were found between the regressions of males and females and hence separate regression equations were derived for males and females. It can be concluded that the weight in both sexes of this banner fish species increases in proportion 2.76 for males and 2.85g for females, if not exactly in proportion of 3. Several factors are responsible for the minor difference in b values of males and females, such as differential metabolic rates and growth rates, status of ovarian maturation, reproductive potential, and fullness of stomach or intensity of feeding during analysis, food and feeding habits, biochemical make up, environmental conditions etc.

The previous reports on length weight relationship of ornamental fishes revealed slope value was higher in females where compared to males. Robins (1986) reported the slope value of 2.87 and 2.93 for both the sexes of *Balistes vetula* and *Xanthichthys ringens.* A good correlation between length and weight was consistently observed for *Rhinecanthus rectangulus* by Matsuura (2001). Myers (1991) studied more length gain and recorded a slope value of 2.96 for *R. rectangulus*. The slope of *Odonus niger* was less than 3 for both sexes.

Higher values of 'b' (> 3) were reported in carps (Bhatnagar, 1972; Khan, 1972). While exponential values 'b' less than 3 were reported in major carps (Pathak, 1975; Kulshrestha *et al*., 1993). The length weight relationship shows the values of 'b' was found less than 3 in *Labeo calbasu* and some cyprinid fish and even in the same species from different water bodies (Khan, 1988; Yousuf *et al*., 1992). The variations in the exponential values 'b' might be due to composite culture and certain environmental conditions (Narejo *et al*., 2003). In both the species, it has been observed that the females were found to be slightly in better condition than the male. Similar observations have also been reported by Jhingran (1952) and Dasgupta (1991) in major carp *Tor putitora.*

The total length and body weight relationship showed positive allometric pattern of growth for *Ompok pabda, Wallago attu, Mystus vittatus, Ailia coila* and *Sperata seenghala* (Hossain, 2010; Hossain *et al.,* 2009). Khan *et al.,* (2012) reported negative allometric pattern of growth in the same species from Ganges River. The length-weight relationship of *Puntius denisonii* follows the cube law for isometric development (Grover and Juliano, 1976). Similar isometric growth model has been reported in *Puntius sarana* (Sultansalim and Shamsi, 1981); *Mastacembalus armatus* (Narejo *et al*., 2000); *Nandus nandus* (Somagoswami and Dasgupta, 2004); *Cynoglossus macrostomus* (Rekha, 2007).

Length and weight condition factors for this species is lacking from literature and databases including Fish Base. Therefore the result of this study provides valuable information for the online Fish Base database, as well as provides important baseline data for future studies. Estimated values in the present results fall well within the range of values reported earlier for *H. acuminatus.*

REFERENCES

[1] Abdurahiman, K.P., T. Harishnayak, P.U. Zacharia and K.S. Mohamed, 2004. Length-weight relationship of commercially important marine fishes and shellfishes of the southern coast of Karnataka, India. Naga IC Q., 27(1): 9-14.

[2] Allen, K.R., 1938. Some observations on the biology of the trout (Salmo trutta) in Windermere. J. Anim. Ecol., 7: 333-349.

[3] Bal, D.V. and K.V. Rao, 1984. Marine fisheries. Tata McGraw-Hill Publishing Company, New Delhi, pp: 51-73.

[4] Beverton, R.J.H. and Holt, S.J. 1957. On the dynamics of exploited fish populations. U.K. Min. Agric. Fish., Fish. Invest., 19: 533 p.

[5] Beyer, B.K., 1987. Practical Strategies for the Teaching of Thinking. London: Allyn & Bacon. pp:21

[6] Bhatnagar, G.K., 1972. Maturity, fecundity, spawning season and certain related aspects of Labeo fimbriatus (Bloch) of river Narmada near Hoshangabad; J. Inland Fish. Soc. India, (4)26–37.

[7] Bolger, T. and P.L. Connolly, 1989. The selection of suitable indices for the measurement and analysis of fish condition. J. Fish. Biol., 34: 171-182.

[8] Carlander, K.D., 1969. Handbook of Freshwater Fishery Biology. Vol. 1. The Iowa State University Press, Ames, Iowa, pp: 752.

[9] Das, N.G., A. Majumder and S.M.M. Sarwar, 1997. Length-weight relationship and condition factor of catfish, Arius tenuispinis Day, 1877. Indian J. Fish., 44: 81-85.

[10] Dasgupta, M., 1991. Length-weight relationship and condition factor (K-value) of Tor putitora (Ham.) from Garo Hills, Meghalaya. Indian J. Fish., 38 (1): 35-38.

[11] Ecoutin, J.M., Albaret, J.J. and Trape, S. 2005. Length-weight relationships for fish populations of a relatively undisturbed tropical estuary: The Gambia. Fish. Res., 72:347–351.

[12] Fagade, S., 1983: The biology of chromido Tilapia guntheri from a small lake. Arch. Hydobil., 97:60-72.

[13] Froese, R. and D. Pauly, 2012. Fish base. World Wide Web Electronic Publication. Online version (publication. www.fishbase.org, version (04/2012).

[14] Frosta, I.O., P.A.S. Costa and A.C. Braga, 2004. Length-weight relationships of marine fishes from the Central Brazilian Coast Naga. World fish centre Quarterly, 27(182): 20-26.

[15] Grover, J.H. and R.O. Juliano, 1976. Length-weight relationship of pond-raised milkfish in the Philippines. Aquaculture 7:339-346.

[16] Hossain, M.Y., 2010. Length-Weight, Length-Length Relationships and Condition Factors of Three Schibid Catfishes from the Padma River, Northwestern Bangladesh. Asian Fisheries Science, 23,329-339.

[17] J.N. Rekha, 2007. Flatfish fishery off Cochin and some aspects of the biology and stock of Malabar sole Cynoglossus macrostomus (Norman). Indian J. Fish., 54(1): 45-49.

[18] Jhingran, A.G., 1968. The length-weight relationship and K factor of Gudusia chapra (Ham) from the Ganga river system. Proceedings of the National Academy of Sciences India 88B, 249- 263.

[19] Jhingran, V. G., General length-weight relationship of three major carps of India. Proc. Nat. Inst. Sci. India, 18: 449-460., (1952).

[20] Khan, R.A., 1972. Studies on the biology of some important major carps; Ph.D., Thesis, Aligarh Muslim University, Aligarh.

[21] Khan, M.A., 1988. Biology of Labeo calbasu (Ham.) from Tilaiya reservoir Bihar, Length weight relationship, condition index and feeding habits. Proc. Nat. Acad. Sci. India, 58 B (1): 41-47.

[22] Khan, M.A., S. Khan & K. Miyan, 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.

[23] King, R.P., 1996. Length-weight relationships of Nigerian coastal water fishes. Fiesbyte, 19: 53-58.

[24] King, R.P., 1996. Length-Weight relationships of Nigerian freshwater fishes. Naga, ICLARM. Q., 19: 45-52.

[25] Kulbicki, M., G.M. Tham, P. Thollot and L. Wantiez, 1993. Length-weight relationships of fish from the lagoon of New Caledonia. Naga ICLARM Quart., 16: 26-30.

[26] Kulshrestha, S. K., Srivastava, M., George, M. P., Saxena, R. and Tiwari, A., 1993. 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 Publishing House, Delhi., 329-332p.

[27] Le Cren, E.D., 1951. The length-weight relationship and seasonal cycle in gonad weight and condition in the Perch (Perca fluviatilis). J. Anim. Ecol., 20: 201-219.

[28] M.Y. Hossain, S. Jasmine, A.H.M. Ibrahim, Z.F. Ahmed, M.M. Rahman and J. Ohtomi, 2009.Length–weight and length–length relationships of 10 small fish species from the Ganges, Bangladesh. J. Appl. Ichthyol., 25, 117–119.

[29] Matsuura, K., 2001. Balistidae. Trigger fishes. In: K.E. Carpenter and V. Niem (Eds.) FAO species identification guide for fishery purposes. The living marine resources of the Western Central Pacific. Vol. 6. Bony fishes part 4 (Labridae to Latimeriidae), estuarine crocodiles. FAO, Rome. pp. 3911-3928.

[30] Morato, T., P. Afonso, P. Lourinho, J.P. Barreiros, R.S. Santos and R.D.M. Nash, 2001. Length-weight relationships for 21 coastal fish species of the Azores, North-Eastern Atlantic. Fish. Res., 50: 297-302.

[31] Myers, R.F., 1991. Micronesian reef fishes. Second Edd., Coral Graphics, Barrigada, Guam, p. 298.

[32] N.T. Narejo, S.I.H. Jafri and S.A. Shaikh, 2000. Studies on the age and growth of palri, Gudusia chapra (Clupeidae: Teleostei) from the Keenjhar Lake (District: Thatta), Sindh, Pakistan. Pakistan J. Zool., 32(4): 307-312.

[33] Narejo, N. T., Rahmatullah, S. M. and Rashid, M. M., 2003. Length-weight relationship and relative condition factor (Kn) of a freshwater spiny eel, Mastacembalus armatus (Lacepede) from Mymensingh, Bangladesh. Indian J. Fish., 50 (1): 81-87.

[34] Oni, S.K., J.Y. Olayemi and J.D. Adegboye, 1983. The comparative physiology of three ecologically (Rupel). Synodonts schall. Block and Schneider and Tilapia zilli (Gervais). J. Fish. Biol., 22: 105-109.

[35] Pathak, S. C., Length-weight relationship, condition factor and study of Labeo calbasu (Ham.) from Loni reservoir (M.P.). J. Inland Fish. Soc. India, 8:58-64.

[36] Pauly, D., 1993. Fish byte section editorial. ICLARM Q. Naga, 16: 26-27.

[37] Petrakis, G. and K.I. Stergiou, 1995. Weight-length relationships for 33 fish species in Greek waters. Fish. Res., 21: 465-469.

[38] Qasim, S.Z., 1973a. An appraisal of the studies on maturation and spawning in marine teleosts from the Indian waters. Indian J. Fish., 20: 166-181.

[39] Robins, C.R., and G.C. Ray, 1986. A field guide to Atlantic coast fishes of North America. Houghton Mifflin Company, Boston, U.S.A. p. 354.

[40] Schneider, S., D. Roessli and L. Excoffier. 2000. “Arlequin: software for population genetics data analysis. Genetics and Biometry Lab, Dept. of Anthropology, University of Geneva., pp: 48

[41] Snedecor, G.W. and W.G. Cochran, 1967. Statistical Methods. Oxford and IBH Publishing Co., Calcutta, India, Pages: 593.

[42] Snedecor, G.W., 1956. Statistical Methods. 6th Edn., Oxford and IBH Publishing Co., New Delhi, India.

[43] Somagoswami and M. Dasgupta, Biology of Nandus nandus (Hamilton) from fish genetic resources center at new aluvial zone of west Bengal and its natural habitat. Ind. J. Fisher., 51(2) (2004): 193-198.

[44] Sultan salim and M.J.K. Shamsi, Morphometric study of Puntius sarana (Ham.) of the River kali. Geobios., 8(1981): 17-21.

[45] Tesch, F.W., 1968. Age and Growth. In: Methods for Assessment of Fish Production in Freshwaters. Ricker, W.E. (Ed.). IBP Handbook No. 3, Blackwell Scientific Publication, Oxford and Edinburgh, pp: 93-123.

[46] Townsend, C.R., Silva L.V.F, Baldisserotto, B., 2003. Growth and survival of Rhamdia quelen (Siluriformes, Pimelodidae) larvae exposed to different levels of water hardness. Aquaculture 215, 103-108.

[47] Yousuf, A.R., Firdous, G. Bhalki, M.H. and Pandit, A.K. 1992. Studies on length-weight relationship in some cyprinid fish in Manasbal Lake, Kashmir,:. In: A. F. Yousuf, M. K. Raina, and M. Y. Qadri, (Ed.) Current trend in fish and fishery biology and aquatic ecology. Univ. of Kashmir, Srinagar, India. 185-189.