Biological Forum – An International Journal **15(1): 540-544(2023)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Morphometric Study, Length-weight Relationship and Condition Factor of *Horabagrus brachysoma* (Günther, 1864), an Endemic Fish in the Rivers of Western Ghats of India

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(Received: 05 December 2022; Revised: 10 January 2023; Accepted: 14 January 2023; Published: 23 January 2023)
(Published by Research Trend)

ABSTRACT: Length-weight relationships and condition factor are of great relevance in fishery assessment studies. The relationship between length and weight is necessary for creating the yield equation and occasionally it may be helpful as a character to distinguish "small taxonomic entities" and the condition factor is useful in identifying fish biological changes. The present study describes selected biological parameters such as Morphometry, Length-Weight relationship and Condition factor of *Horabagrus brachysoma*, an endemic fish in the rivers of Western Ghats of India. A total of ninety four fish specimens were collected from Kodoor River, Puthuppally, Kottayam District, Kerala, India. The length-weight relationship of the collected species was determined and the results obtained showed that *Horabagrus brachysoma* found in Kodoor River has positive allometric growth. The *b* values ranged between 3.3 and 3.9; *b* value was higher in the case of males. The mean values of condition factors were found to be one in both the sexes and this shows a better condition of fishes in this aquatic system.

Keywords: Horabagrus, condition factors, morphometric study, environment, endemic.

INTRODUCTION

Piscian fauna have been interlinked with human cultures in different ways from ancient times. Fisheries sector plays an important role in socio-economic development of a country. Moreover, fish holds an important position in human diet because of its high protein content. More importantly, fishes are known to be the major engineers in aquatic systems, for they help in energy and nutrient recycling thereby maintaining the natural balance.

The morphometric studies, Length-weight relationships (LWR) and Condition factors are crucial in any fishery assessment programs for the reason that it provides information about the growth of fish, the population structure of fish species, phenotypic divergence and adaptive radiations, general wellbeing and fitness in the habitat where it lives. Fishing aquatic biota in larger quantities without authentic scientific information may lead to critical depletion in its population, and threats their sustainability in nature (Pasisingi *et al.*, 2021). Fish populations are drastically declining, according to current studies on fish diversity, as a result of overfishing, climatic changes, habitat loss, and pollution of aquatic ecosystems. Studies pertaining to fish species are currently receiving a lot of interest on a global scale.

The yellow catfish (*Horabagrus brachysoma*) is well known for its taste and also considered as an ornamental species because of its eye-catching yellow colored body. Western Ghats region is home to the endemic *Horabagrus brachysoma* (Gu¨nther), which is of conservation concern (Raghavan and Ali 2013). It is crucial for local and global economies, as well as for people's livelihoods (Raghavan *et al*., 2013, 2016; Prasad *et al.*, 2012; Sreeraj *et al*., 2007). Freshwater fishes have evolved into a taxon that is "living on the edge" as a result of a variety of human-induced stressors, including as habitat alteration and degradation, overfishing, and exotic species introductions. The population of yellow catfish in nature is in gradual decline due to overfishing, destruction of spawning grounds, and habitat fragmentation. Hence, this species is listed by the IUCN as vulnerable (Kurup *et al*., 2004). The values of condition factor generally depend on physiological

features of fish especially maturity, spawning, life-cycle, environmental factors and food availability in a water body (Dudgeon, 2011, Ujjania *et al*., 2012; Dan-Kishiya, 2013). The present study makes an attempt to reveal the, morphometric features, length-weight relationships and condition factor of yellow catfish, *Horabagrus brachysoma*.

MATERIALS AND METHODS

Ninety four (94) adult fish specimens (*Horabagrus brachysoma*) were collected from Kodoor River, Puthuppally (9^o 33.566′ N; 76^o 34.333′E), Kottayam district, Kerala, India.

A. Morphometric studies

The body weight (g) and total length (cm) of each fishes were measured using measuring scale and electronic balance respectively. Measurements were recorded after placing the specimen in white polystyrene sheets. Male and female fishes were identified based on the presence of gonads after dissection. Following measurements such as Total length, Standard length, Fork length, Head length, Peduncle length, Eye Diameter, Snout length, Pre-orbital length, Pre-Dorsal length, Pre-Pelvic length, Pre- Pectoral length, Pre - Anal length and Body depth were recorded.

B. Length-weight relationship

The length-weight relationship was estimated according to the equations: W = a×Lb and using its logarithmic form:

ln(W)=ln(a)+b ln(L)

where W=Weight (ingrams), L= Length(incm), 'a' and 'b'= Regression coefficient

C. Condition factors

The Fulton's Condition factor (K_F) was calculated by applying the equation (Fulton, 1904):

$K_{F=}100\ W/L^3$

Where: K_F= Fulton's Condition factors, W= Weight of fish sample (in gram), L= Length of fish sample(in cm)

The relative condition factor (K_R) for each sample was calculated with the help of following equation (Le Cren, 1951):

$K_R= W/a\times L^b$

Where K_R=Relative condition factor, W= Weight of fish sample (in gram), L= Length of fish sample (in cm),

'a' and 'b' = Regression coefficient

Moreover, relative weight was determined by the equation of Froese (2006):

$W_R= (W/W_S) \times 100$

Where W_R= Relative weight, W= Weight of fish sample (in gram), $W_S = a\times L^b$ (a and b values are obtained from the relationships between total length (TL) and body weight (BW)

D. Statistical analysis

Statistical analysis were carried out with the help of Microsoft® Excel 2010. Logarithmic transformation of LWR parameters, a-intercept, b-slope and the regression coefficient 'r2' were analysed for both sexes. Minimum and Maximum values, also Mean with standard deviation and CL 95% for total length (TL) and body weight (BW) of both male and female fishes were recorded. This study made an attempt to understand the morphometric differences between male and female fishes. Logarithmic transformation of LWR parameters is needed for finding regression coefficient. It was carried out with help of 'ln' function. The estimate of parameter 'a' and the estimate of parameter 'b' is calculated using data analysis tool in excel. To estimate the parameter of intercept 'a' the function 'exp' is employed.

RESULTS AND DISCUSSION

The present study was focused on the morphometric analysis, length-weight relationship and condition factors of vulnerable fish species *H. brachysoma*. A total of 94 specimens of *H. brachysoma* were analyzed in this study.

Morphometric Analysis of *H. brachysoma.* Fishes are sensitive to environmental changes and are able to alter their physiology as an adaptation to the changing habitat. The morphological characters of fishes show high plasticity in response to differences in environmental conditions, such as food abundance and temperature (Allendorf and Phelps 1987). In general, fishes demonstrate greater variations in morphological and physiological traits both within and between populations than any other vertebrates, and are more susceptible to environmentally induced morphological variations (Allendorf *et al*., 1980). The phenotypic plasticity of fish is very high. They adapt quickly by modifying their physiology and behavior to environmental changes and these modifications ultimately change their morphology (Stearns, 1983). In most of the fish species, more than 80%, female fishes grow larger than male fishes (Pauly, 2019).

The minimum, maximum and mean with standard deviation values of morphometric characters are furnished in Table 1. The mean values of all the morphometric characters in female fishes have higher numerical value when compared to the morphometric characters of male fishes. Similar results were reported by the morphometric studies carried out in *Rutilus frissikuttum*, member of cyprinidae family by Abdolhay *et al*. (2010) and *H. brachysoma* by Ali *et al*. (2008). The female fishes were found larger than male fishes. The maximum total length and body weight for female fishes are 30.2 cm and 310gm respectively. In males 24.7 cm is the largest value for total length and for body weight it is 150gm. The maximum total length and body weight and also all other morphometric features were found higher in female fishes. Moreover the studies carried out in cat fishes *Arius caelatus* and *Arius thalassinus* reported that there were prominent morphometric differences between two sexes (Sawant and Raje 2009). Larger body size in female fish is

advantageous, and gonad weight accurately reflect the relative fecundities of each sex, females benefit more from being large than males, since ovarian weight is a steeply ascending function of body size rather than testicular weight (Conover, 1984). Umesh *et al*. (1996) noted that females had higher body depth, head width, head depth, eye diameter, pre pectoral length and pre anal length than males. These findings clearly coincide with the data obtained in the present study.

Length-weight relationships (LWR) and Condition factor. Length-weight relationship is a powerful tool for fish stock management. Sample size, minimum and maximum values of both total length and body weight, 95% Confidence limit and their mean and standard deviation are shown in Table 2. According to the data analysis, female fishes were found larger than the male fishes in both length and weight. However, the minimum limit of total length and body weight was found smaller in females. This might be due to the fact that male fishes attain sexual maturity earlier than females in *H. brachysoma*. In the present study length-weight relationship and the value of slope-*b* suggest positive allometric growth in *Horabagrus brachysoma* during the study period. The *b* value of length-weight relationship ranged between 3.3 and 3.9, *b* value was higher in case of males. Another study conducted in *Horabagrus brachysoma* from Vembanad Lake by Bindu and Padmakumar 2019) also reported higher b values for male fishes. Findings in the present study are consistent with the findings of Ali *et al.* (2008), where they recorded higher *b* values for males of *H.brachysoma* from Chalakudy and Pamba River. A constant value of the weight exponent *b* helps the adjustment of size variations so that comparisons can be made between samples in which weights are not similar (Elliott and Hurley 1995). It is suggested that, for a fish which maintains its shape throughout its life, the value of regression coefficient will be 3 (Talwar, 1962), other than 3, the value indicates allometric growth. Allen (1938) suggested that the value for *'b'* remains constant at 3.0 for an ideal fish while Tesch (1968) viewed that a value of 3 for the exponent *'b'* indicates that fish growth is isometric. According to Le Cren (1951) the value of *'b'* may change with localities, sex, maturity, metamorphosis and it can also be influenced by environmental factors, food and parasitism.

Minimum and maximum values of total length (TL) in males are 14.5cm and 24.7cm respectively; for females the minimum and maximum value of total length (TL) are 12.2cm and 30.2cm respectively. Similarly, minimum and maximum values of body weight (BD); for males minimum body weight is 20g and maximum body weight is 150g and for females it is 15g and 310g (Table 2). Mean value with standard deviation of total length (TL) of male fishes were recorded as 19.84±2.13; for females it is 22.14±4.18. Mean value

The nutritional and physiological status of the fish can be determined by fulton values and the relative condition factor of the fish (Adeogun *et al*., 2016; with standard deviation of body weight (BW) of male fishes found to be 84±32.33; for females it is 123.67±71.46 (Table 2). 95% Confidence limit for females is 20.58-23.7 (Total length) and 96.98-150.35 (Body weight).95% Confidence limit for males is 19.04-20.64(total length) and for body weights it is 71.92-96.07 (Table 2).

Regression co-efficient 'r2', growth type, a-intercept, b – slope are given in Table 3. The value of regression co-efficient 'r2 'is close to 1(r<1) shows a good linear relationship between length and weight in both sexes. Male and female fishes recorded a value of 0.96 in the case of regression co-efficient (Table 3). In the present study b-slope is higher than 3 for male and female fishes; both shows positive allometric growth pattern (Table 3).

The condition factor have immense application in the field of fisheries and aquatic biology because it gives information about the growth, well-being, feeding intensity, gonad maturation, habitat, food abundance and physiological changes that are related to fish populations. Fishes can be used as pollution indicators; any disturbance in their living environment may bring changes in their physiology. Hence, by studying the condition factor of the fish species, we will be able to know about the pollution rate in a particular aquatic environment. The minimum and maximum values, Mean± SD of each of the condition factors (KF and KR) and relative weight (WR) of *H. brachysoma* are shown in Table 4. The investigation of condition factors of *H. brachysoma* revealed that, minimum and maximum values of KF in the case of male are 0.7 and 1.3 respectively with a mean value of 1.02±0.12 and for females minimum and maximum values are 0.8 and 1.4 respectively with a mean value of 1±0.15 (Table-4).The value of Fulton's condition factor (KF) 1 indicate a "normal" fish in good condition. The mean values of Relative condition factor (KR) were 1.01±0.08 and 1.02±0.1 5 for male and female respectively (Table 4). The WR values are higher in females with a mean value of 101.86.These parameters are considered important for the proper management of fish stocks. The length-weight relationship can be used in the estimation of condition factor (K) of fish species (Dan-Kishiya, 2013). In the present study both Fulton's condition factor and Relative condition factor were found to be 1 in the case of both the sexes (Table 4) whereas in another study carried out in *Horabagrus brachysoma* by Bindhu and Padmakumar (2019) the condition factor reported was higher than 1. In the same way higher values of K were reported in *Labeorohita* by Pandey and Sharma (1998). On the other hand, the condition factor of a large predatory catfish, *Wallagoattu* was lower than unity (Rufus *et al*., 2015). Sarkar *et al.* (2013) noted that condition factor is not constant for a species or population.

Panicker and Katchi 2021). Values above one in this calculation (>1 according to Fulton, 1905) could suggest favourable conditions for growth. However, a

variety of elements, such as fish's habitat, activity, and environment as well as their reproductive cycles and food availability, affect fish's ability to grow (Edah *et al*., 2010; Muchlisin *et al*., 2017; Jisr *et al*., 2018). The condition factor can be applied to comparative studies of the same fish species but living in two different habitats since it is strongly influenced by environmental conditions (Anene, 2005). The condition factor reflects the well-being of fish (Abowei, 2010) and is rooted on the hypothesis that heavier fish of a given length are in better condition (Bagenal and Tesch 1978). It is also considered as a quantitative parameter of the state of well-being of the fish population that determines present and future population success because of its influence on growth, reproduction and survival (Richter, 2007). The relative weight (W_R) is considered as one of the several noninvasive condition measures that are applied in the field of fisheries. It can act as an aid for estimating fish body composition, as a measure of fish health, and to assess prey abundance, fish stockings, and management actions (Blackwell *et al*., 2000). Most of the works substantiate that, there exist a strong relation between the relative weight and energy reserves especially the fat deposition (Murphy and Willis 1991). The optimum range of W_R is 95 to 105 according to Anderson and Gutreuter (1983) which shows similarity to the results of the present study in which the relative weight with a value of 100.91 and 101.86 for males and females respectively (Table 4). The present study will be an effective tool for the successful management and conservation of this species.

Table 1: Morphometric Analysis of *Horabagrus brachysoma*

	Total length (in cm)	Standard length(in m)	Pre-dorsal length(in cm)	Snoutength (in cm)	Pre-orbital length(in cm)	Pre-ectoral length(in cm)	Head length (in cm)	Pre-pelvic length(in cm)	Pre-anal length(in cm)	Fork length (in cm)	Peduncle length(in cm)	Eyeiameter (in cm)	Body depth (in cm)	Bodyw eight (in g rams)
Female														
Minimum	12.2	10.5	3.9	0.8	1.3	2.8	3.3	5.5	7.5	11.4	1.3	0.6	2.4	15
Maximum	30.2	28	9.9	2.6	2.7	6.1	6.8	13.2	18	30	3	1.2	9.5	31
Mean ±SD	22.14 ±4.18	18.35 ±3.55	6.69 ±1.37	1.78± 0.41	2.11 ± 0.36	4.79± 0.87	5.28 ± 0.95	9.79 ± 1.93	12.31± 2.45	19.86 ± 3.90	2.05 ± 0.36	0.88 ±0 .14	5.04± 1.37	123.67 ± 71.46
Male														
Minimum	14.5	11.6	4.5	1.2	1.2	3.2	3.4	6.8	8.3	12.6	1.4	0.7	2.9	20
Maximum	24.7	20.2	7.3	1.9	2.3	5.6	6	10.9	13.8	21.9	2.3	0.9	5.3	150
Mean ±SD	19.84 ±2.13	16.62 ±1.85	6.08± 0.65	1.41± 0.18	1.78 ± 0.33	4.13± 0.81	4.68 ± 0.77	8.86 ± 1.17	11.04± 1.32	17.75 ± 1.77	2±0. 19	0.79 ± 0.04	4.18± 0.41	84±3 2.33

Table 2: Descriptive statistics of length and weight measurements of *Horabagrus brachysoma.*

Measurements	n	Minimum	Maximum	Mean±SD	$CL_{95\%}$
Male	46				
TL(in cm)		14.5	24.7	19.84±2.13	19.04-20.64
BW (in gm.)		20	150	84±32.33	71.92-96.07
Female	48				
TL(in cm)		12.2	30.2	22.14±4.18	20.58-23.7
BW (in gm.)		15	310	123.67±71.46	96.98-150.35

TL: Total length, BW: Body weight, n:samplesize, SD: Standard deviation, CL: Confidence limit for Mean values

Table 3: Sexwise length-weight parameters and growth type of *Horabagrus brachysoma.*

Sexes	Intercept 'a'	Slope 'b'	Regression coefficient'r^2'	Growth type
Male	-7.29	3.9	0.96	A+
Female	-5.64	3.30	0.96	A+

Table 4: Condition factors of the *Horabagrus brachysoma* in the Kodoor River.

Condition factors	Minimum	Maximum	Mean ± SD	$CL_{95\%}$
K_f				
Male	0.7	1.3	1.02 ± 0.12	0.97-1.06
Female	0.8	1.4	1 ± 0.15	0.95-1.05
K_R				
Male	0.81	1.15	1.01 ± 0.08	0.99-1.04
Female	0.84	1.38	1.02 ± 0.15	0.96-1.07
W_R				
Male	81.08	114.61	100.91 ± 8.30	97.8-104
Female	83.71	137.6	101.86 ± 14.56	96.4-107.3

SD: Standard deviation, CL: Confidence limit for mean values, K_f: Fulton's Condition Factor, K_R: Relative Condition Factor, W_R: Relative weight

CONCLUSION

The results of the present investigation on morphometric study, length –weight relationship and condition factor revealed a good level of feeding and proper environmental condition and it also provide information for the management and maintenance of the biological equilibrium of their ecosystem. The results of the current investigation's morphometric study, length-weight relationship, and condition factor showed that the animals were receiving adequate nutrition and living in a suitable environment. They also provided information for managing and maintaining the biological equilibrium of their ecosystem.

FUTURE SCOPE

The morphometric study of fishes in specific environments is an indicator of the conditions pertaining in that area. The prediction of environmental conditions is also closely related with the climate change.

Acknowledgements. We thank the Principal and authorities of University College for extending the facilities to carry out the work in the college.
Conflict of interest. None.

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How to cite this article: Kavya U.M., Nandini N.J. and Siny G. Benjamin (2023). Morphometric Study, Length-weight Relationship and Condition Factor of *Horabagrus brachysoma* (Günther, 1864), an Endemic Fish in the Rivers of Western Ghats of India. *Biological Forum – An International Journal*, *15*(1): 540-544.