GROWTH PATTERN AND CONDITION FACTOR OF THREE IMPORTANT FISH SPECIES OF CHALLAWA GORGE RESERVOIR, KANO STATE, NIGERIA

Supported by tetfund TERTIARY EDUCATION TRUST FUND

A. M. Ali[1], B. I. Usman[2]* and K. M. Umar[3]
[1]Department of Biological Sciences, Bayero University Kano, Kano State, Nigeria
[2]Department of Fisheries and Aquaculture, Bayero University Kano, Kano State, Nigeria
[3]Centre for Dryland Agriculture, Bayero University Kano, Kano State, Nigeria

*Corresponding author: biusman.faq@buk.edu.ng

Received: September 21, 2022 **Accepted:** November 12, 2022

Abstract: This study was conducted at the Challawa Gorge Reservoir, Kano, with the aim of assessing the growth pattern and condition factor of three fish species namely; *Auchenoglanis occidentalis*, *Bagrus bayad* and *Schilbe mystus* were examined using standard morhological data. A total of 209 samples of fish were obtained from local fishermen in the study area. The length-weight relationship revealed positive allometric growth pattern for *A. occidentalis* (b = 3.810, R^2 = 0.919) and negative allometric growth for *B. bayad* (b = 2.306, R^2 = 0.923) and *S. mystus* (b = 1.139, R^2 = 0.916). The condition factor revealed that the average values obtained are ≥1 in all the fish species studied, thus indicating that the environment is good. This information is very useful for the development of management strategies that aimed at conserving these fish species.

Keywords: Challawa Gorge, condition factor, fish species, growth pattern, Kano state, Nigeria, reservoir

Introduction

Length weight relationship (LWR) of fish is widely recognized as an important tool in fisheries science, especially in ecology population dynamic and stock management. This is so because the relationship permits estimating the weight of a specimen easily when total length is known and the relationship estimates condition factor of the fish species and fish biomass through length frequency (Getso *et al*., 2017; Usman *et al*., 2016). The relationship between length and weight can be used to assess the wellbeing of individual and to determine possible differences between separate unit stocks of the same species. LWR is also important in fisheries management for growth comparative studies and fishery assessments (Adaka *et al*., 2015). Length and weight measurements in conjunction with age data can give information on the fish stock, age maturity, life span, mortality, growth and reproduction (Getso *et al*., 2017). Ude *et al*. (2011) asserted that LWR has a number of important applications in fish stock assessment, among which are estimating the standing stock biomass and comparing ontogeny of fish population from different regions. This information improves management, conservation and culture of these species, further allowing comparisons between populations of the same species. LWR is also useful in local and interregional, morphological and life historical comparisons in species and populations (Khan *et al*., 2012; Amin *et al*., 2016). LWR provides valuable information on the habitat where the fish live. So also, for proper exploitation and management of the population of fish species, the length-weight relationship is very important (Adaka *et al*., 2015).

Condition factor is an expression of relativeness fatness of fish which shows the degree of wellbeing of fish in their habitat which is expressed by 'coefficient of condition', also known as the length-weight factor (Lizama *et al*., 2002; Kachari *et al*., 2017). This factor is a measure of various ecological and biological factors such as degree of fitness, gonad development and the suitability of the environment with regard to the feeding condition (Nehemia *et al*., 2012). Challawa Gorge reservoir was constructed with hydropower potential of around 3MW as well as activities like irrigation, fishing and township water supply. Challawa reservoir is known for its production of a large yield of exotic species, with *Bagrus bayad Macopterus*, *Auchenoglanis occidentalis*, and *Schilbe mystus* accounting for 5.67%, 2.87% and 5.88% respectively (Suleiman *et al*., 2018). This study was carried out to estimate the LWR and condition factor of the three different fish species used.

Materials and Methods

Study Area and Sampling Sites

The study was conducted in Challawa Gorge Reservoir. The Reservoir is located in Karaye local government area of Kano State, Nigeria. It is located 90km southwest of Kano city at 8°06′58.04″E latitude 11°41′21.95″N longitude, with total area of 479km² (185sq m). It is a major reservoir on the Challawa River, a tributary of the Kano River. Three landing sites (Turawa, Tinkis and Maa) were used for fish sampling (Fig. 1).

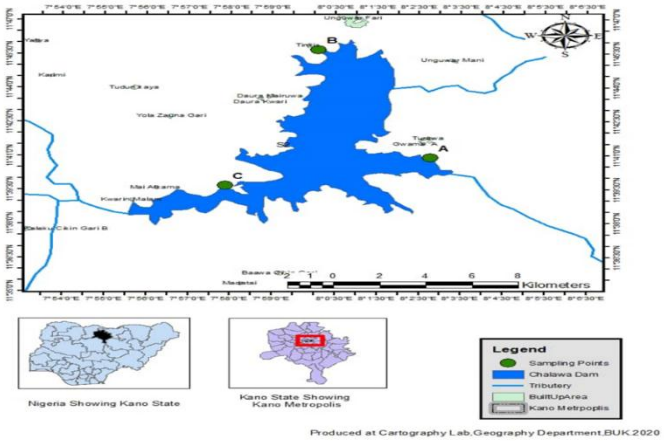

Fig. 1: Map of study area showing the sampling sites

Sample Collection and Measurements

Samples of fish were collected with the help of artisanal fishermen at each of the landing sites, with the use of various fishing gears. Fish samples were transported to the Laboratory for morphometric measurements. The total and standard lengths of the fish were measured in centimeter (cm) using measuring board. Total length was measured from the snout to the extreme end of the caudal fin; standard length was measured from the snout to the starting point of caudal fin. The weight of the fish was measured in gram (g) using digital weighing balance (Simon TH-5000).

Data Analysis

The equation $W = aL^b$ (Le Cren, 1951) where W= wet weight in g, L= total length in cm, a = constant and b = relative growth coefficient was used to estimate the length-weight relationships. Logarithmic transformation of the formula (W = aLb) into Log W = Log a + b Log TL was done, while each value of 'a' and 'b' was determined empirically employing common statistics.

Condition factor is calculated using the following formula:

$$CF = \frac{W}{L^3} \times 100 \quad \text{.....(1)}$$

Where: CF= Condition factor, W= Body Weight (g), TL = Total Length (cm) (Amin, 2001; Zorica *et al*., 2006). All statistical analyses were performed using Microsoft Excel, MINITAB version 17 and SPSS version 22 statistics software.

Growth Pattern

Growth pattern for the fish was based on the LWR (Figs. 2,3 and 4). The LWR parameters 'a', 'b', coefficient of determination (R^2) and growth pattern of the studied fish are presented in Table 2. The estimated allometric coefficient values (b) were 3.810, 1.139 and 2.306 for *A. occidentalis*, *S. mystus* and *B. bayad* respectively. The b-values indicated that

Results

Size Composition

The parameters of total length-body weight relationships of the studied fishes are presented in Table 1. A total number of two hundred and nine specimens were collected for this investigation. *A. occidentalis* ranged in total length from 10.20 to 25.30 cm (mean 16.36±3.66); standard length 8.50 to 21.20 cm (mean 13.15±3.07) and body weight from 5.00 to 200.00 g (mean 54.40±5.81). The total length of *S. mystus* ranged between 8.30 to 22.30 cm (mean 14.58±3.87); standard length 6.70 to 19.60 cm (mean 12.26±3.37) and body weight from 5.00 to 60.00 g (mean 19.84±1.33). Whereas the total length of *B. bayad* ranged between 13.10 to 37.00 cm (mean 22.80±5.25); standard length 10.20 to 30.00 cm (mean 18.25±4.34) and body weight from 20.00 to 200.00 g (mean 69.33±4.43).

Table 1: Summary of the statistical analyses of body measurements of the fishes studied

	A. occidentalis (N = 42)		*S. mystus* (N = 85)		*B. bayad* (N = 82)		F	P
	Range	**Mean ± SD**	**Range (cm)**	**Mean ± SD**	**Range (cm)**	**Mean ± SD**		
TL (cm)	10.20 - 25.30	16.36^{b}±3.66	8.30 - 22.30	14.58^{c}±3.87	13.10 - 37.00	22.80^{a}±5.25	76.21	0.000**
SL (cm)	8.50 - 21.20	13.15^{b}±3.07	6.70 - 19.60	12.26^{b}±3.37	10.20 - 30.00	18.25^{a}±4.34	58.89	0.000**
W (g)	5.00 - 200.00	54.40^{b}±5.81	5.00 - 60.00	19.84^{c}±.33	20.00 - 200.00	69.33^{a} 4.43	43.78	0.000**

Means with the same superscript are not significantly different (P>0.05); **highly significant (P<0.001); TL = Total Length; SL = Standard Length; BW = Weight

A. occidentalis has positive allometric growth pattern, while both *S. mystus* and *B. bayad* exhibited a negative allometric growth pattern. The value of (R^2) varied from 0.916 to 0.923.The LWR equations were established as Log W=3.810 LogTL- 3.010 for *A. occidentalis*, Log W=1.139 LogTL - 0.125 for *S. mystus* and Log W = 2.306 LogTL - 1.329 *B. bayad*.

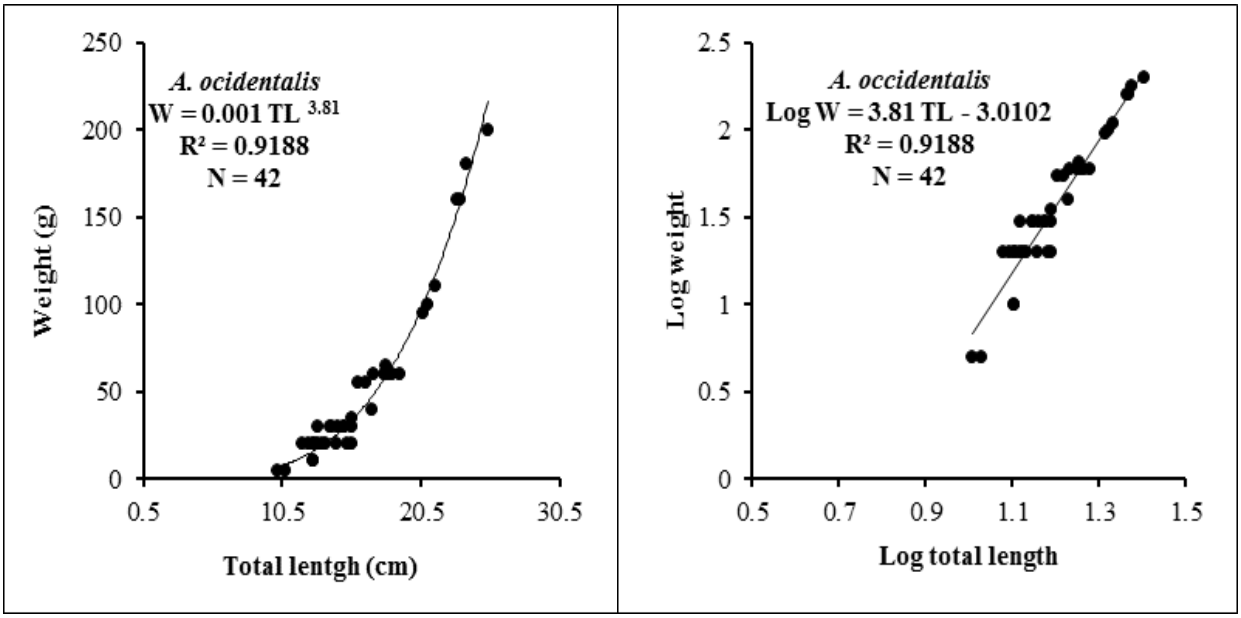

Fig. 2: Length-weight relationship of *A. occidentalis* (logarithmic and arithmetic Scale)

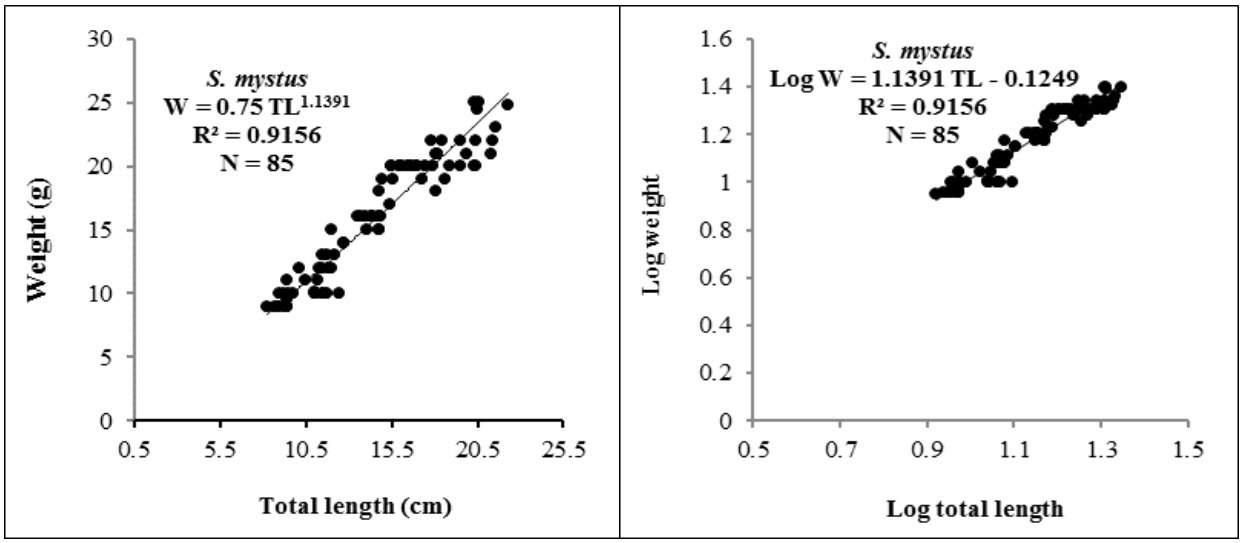

Fig. 3: Length-weight relationship of *S. mystus* (logarithmic and arithmetic scale)

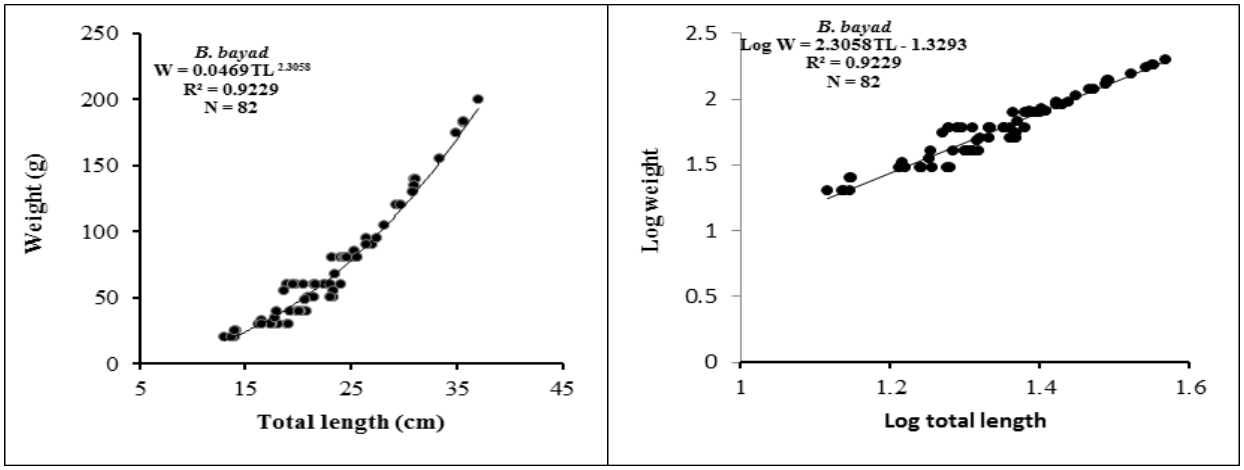

Fig. 4: Length-weight relationship of *B. bayad* (logarithmic and arithmetic scale)

Table 2: Computed parameters of length-weight relationship parameters of the three different fishes used in the study

Fish Species	N	a	b	R^2	Growth type	LWR equation
A. occidentalis	42	0.001	3.810	0.919	Allometric (+)	Log W = 3.810 LogTL - 3.010
S. mystus	85	0.750	1.139	0.916	Allometric (-)	Log W = 1.139 LogTL - 0.125
B. bayad	82	0.047	2.306	0.923	Allometric (-)	Log W = 2.306 LogTL - 1.329

N = number of individuals; a = intercept; b = slope; R^2, coefficient of determination; LWR = length weight relationship.

Table 3: Computed parameters of condition factor of the three different fishes used in the study

Fish Species	N	Mean±SD	95% Confidence Interval for Mean		Minimum	Maximum
			Lower Bound	Upper Bound		
B. bayad	82	1.011[a]±0.15599	0.9762	1.0448	0.71	1.44
A. occidentalis	42	1.006[a]±0.24519	0.9297	1.0825	0.58	1.66
S. mystus	85	1.004[a]±0.09297	0.9843	1.0244	0.75	1.18

Means with the same superscript are not significantly different (P>0.05); N = number of individuals

Condition factor

The condition factors of the three different fishes used in the study are presented in Table 3. From the results, there was similar trend of fluctuation in the condition factor values among the fishes. The condition factor ranged from 1.004 to 1.011 and there was no significant difference condition between the fishes (P<0.05).

Discussion

Somy Kuriakose (2014) deduced that the relationship between length and weight in fishes take the form W = aLb, where a and b are usually termed as length-weight parameters. When 'b' is equal to 3 or close to 3, growth in fish is said to be isometric (fish becomes more robust with increasing length). When 'b' is far less or greater than 3, growth in fish is said to be allometric (fish becomes thinner with increasing length) (Ude *et al*., 2011). The LWR of the 3 fish species *A. occidentalis, S. mystus, B. bayad* revealed values of b to be 3.810, 1.139 and 2.306 respectively, indicating positive allometric growth (*A. occidentalis*) and negative allometric growth (*S. mystus* and *B. bayad*) with R^2 values greater than 0.90. This finding was almost in accordance with that of Getso *et al*. (2017) which indicated that all the fish species had negative allometric growth with 8% of the species having R^2 values greater than 0.90 while the rest have R^2 value less than 0.90. It was observed that the two sampled species neither showed isometric nor positive allometric growth patterns, but rather showed negative allometric growth. The value of b becomes greater than 3 as the fish becomes fatter and the fish becomes slimmer when b value is lower than 3. When b is equal to 3 the fish grows isometrically, resulting in ideal shape (Ude *et al*., 2011, Usman *et al*., 2016). The length weight relationship of *Oreochromis niloticus, Schilbe mystus, Silurandon auritius, Tilapia dageti* and *Hemichromis fasciatus* from Ebonyi River showed isometric b values (Ude *et al*., 2011). These findings thus differed from the findings in this present study. In another study by Godwin *et al*., 2015, the b values obtained in the nine studied species ranged from 1.830 to 5.670 with most of the fishes indicating negative allometric growth pattern with the exception of *Papyrocranus afer*, which shows positive allometric pattern, and this is nearly similar to the growth pattern of the species in this present study. In fish, b values were reported to vary between 2 and 4, but values ranging from 2.5 to 3.5 are more common (Gupta and Banerjee, 2015).

The condition factor values of the 3 species studied ranged from 0.583 to 1.661 in *A. occidentalis*, 0.751 to 1.180 in *S. mystus* and 0.711 to 1.440 in *B. bayad*, with no significant difference in K between the fish species. All the fish species sampled had maximum condition factors greater than 1 and were within normal ranges, as recommended by Ujjania *et al*. (2012), who revealed that condition factor greater or equal to 1 is good, indicating a good level of feeding and proper environmental condition. The condition factor gives information on the physiological condition of fish in relation to its welfare. However in this study, with K value greater than 1, the fish species found in Challawa reservoir are said to be in a good state of well-being. Mean condition factor for A. *occidentalis*, as reported by Ikongbeh *et al*. (2013) were found to be greater than 1, indicating that fish species are doing well in the lake (increase in length brought about proportional increase in weight). This finding was in accordance with the finding of this present study and another finding by Abd Hamid *et al*. (2015) with K greater than 1 except for *O. anamalura* and *L. leptocheilus*. Nehemia *et al*. (2012), reported that the condition factor for *T. zillii* and *O. urolepis urolepis* in full strength seawater was less than 1 (0.74 and 0.53 respectively) and the K value obtained for *T. zillii* in freshwater was greater than 1 and that of *O. urolepis urolepis*. The value of the condition factor for *Chrysichthys auratus* was less than 1 (indicating a bad state of wellbeing of the fish) while the rest of the species were more than 1 as reported by Adaka *et al.* (2015). This is contrary to the finding of this present study, with K value greater than 1. However, fish condition can be affected by many factors such as sex, age, state of maturity, size, state of stomach, illness, sampling methods, sample sizes and environmental condition.

Conclusion and Recommendation

The LWR results indicated a high relationship between these species with *A. occidentalis* having a positive allometric growth and *B. bayad* and *S. mystus* having negative allometric growth. The condition of living as revealed by the condition factor for the specie indicated that that reservoir has a proper environmental condition as well as a good level of feeding. The Challawa reservoir environment has a significant impact on the growth of fishes, with a good condition of wellbeing, it is therefore recommended that LWR and condition factor should be studied further for these same species as well as other species so as to lay more emphasis on the condition of the fishes in the Reservoir

Conflict of Interest

Authors declare there is no conflict of interest related to this research.

References

Abd Hamid M, Mansor M & Mohd Nor SA 2015. Length-Weight Relationship and Condition factor of fish populations in Temengor Reservoir: Indication of Environmental Health. *Sains Malaysiana*. 44(1):61-66.

Adaka G, Ndukwe E & Nlewadim A 2015. Length-weight relationship of some fish species in a tropical rainforest river in South-East Nigeria. *Transylvanian Review of Systematical and Ecological Research*, 17(2): 73-78.

Amin SM., Babatunde TA, Ihab MMM, Usman, BI & Ara, R 2016. Morphometric variations among three different populations of Cobia, *Rachycentron canadum* (Linnaeus 1766) in Peninsular Malaysia. *Sains Malaysiana*, 45(6): 891-898.

Amin SMN 2001. Studies on age and growth, VPA analysis and relative condition factor of *Harpodon nehereus* (Ham-Buch) from the neritic water of Bangladesh. *Online Journal of Biological Sciences*, 1: 192-194.

Getso BU, Abdullahi JM & Yola IA 2017. Length-weight relationship and condition factor of *clarias gariepinus* and *oreochromis niloticus* of Wudil River, Kano,Nigeria. *Journal of tropical aquaculture, food, environment and extension*, 16(1): 1-4.

Gupta S and Banerjee S 2015. Length-weight relationship of *Mystus tengara* (Ham.-Buch., 1822), a freshwater catfish of Indian subcontinent. *International Journal of Aquatic Biology*, 3(2), 114-118.

Ikongbeh OA, Ogbe FG & Solomon SG 2013. Length-weight relationship and condition factor of *Auchenoglanis occidentalis* (Valenciennes, 1775) from Lake Akata, Benue State, Nigeria. *Journal of Agriculture and Veterinary Science*, 3(6):11-17.

Kachari A, Abujam S & Das DN 2017. Length-weight relationship (LWR) and condition factor of *Amblyceps apangi* Nath & Dey from Arunachal Pradesh, India. *Journal of Aquacultural Engineering and Fisheries Research*, 3(3): 97-107.

Khan MA, Miyan K, Khan S, Patel DK & Ansari NG 2012. Studies on the elemental profile of otoliths and Truss network analysis for stock discrimination of the threatened stinging catfish *Heteropneuses fossilis* (bloch 1794) from the Ganga River and its distributaries. *Zoological Studies*, 51(7):1195-1206.

Le Cren ED 1951. The Length-weight relationship and seasonal cycle in gonad weight and condition in the Perch (*Perca fluviatilis*). *The Journal of Animal Ecology*, 20: 201-219.

Lizama M. De Los AP & Ambrosio AM 2002. Condition factor on nine species of fish of the Characidae family in the Upper Parana River Floodplain, Brazil. *Brazil Journal of Biology*, 62(1): 113-124.

Nehemia A, Maganira JD 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.

Suleiman N, Yola IA & Ahmed IM 2018. Biodiversity and condition factor of fish species from Challawa Gorge Dam. *International Journal of Fisheries and Aquatic Studies*, 6(3): 112-117.

Ude EF, Ugwu LLC, Mgbenka BO & Nwani CD 2011. Evaluation of lengh-weight relationship of fish species of Ebonyi River, Nigeria. *Nigerian Journal of Fisheries*. 8(1): 136-144.

Ujjania NC, Sharma, LL & Balai VK 2013. Length-weight relationship and condition factor of indian major carp (*Labeo rohita* Ham., 1822) from southern Rajasthan, India. *Applied Biological Research*, 15(2), 1-5.

Usman BI, Amin SMN Arshad A & Kamarudin IS 2016. Morphometric relations in the Grey-eel catfish *Plotosus canius* in the coastal waters of Port Dickson, Peninsular Malaysia. *Journal of Environmental Biology*, 37(4): 573-578.

Zorica B, Sinovčić G Pallaoro A and Čikeš Keč V 2006. Reproductive biology and length–weight relationship of painted comber, *Serranus scriba* (Linnaeus, 1758), in the Trogir Bay area (middle-eastern Adriatic). *Journal of Applied Ichthyology*, 22(4): 260-263.