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GROWTH PATTERN AND CONDITION FACTOR OF *BAGRUS BAYAD* FROM TWO RIVERS IN SOUTHERN NIGERIA

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ABSTRACT
The growth pattern and condition factor of *Bagrus bayad* from River Niger at Asaba and River Adofi at Ossissa in Southern Nigeria were investigated using length-weight relationship to determine growth conditions for the assurance of food security. A total of 474 *Bagrus bayad* fish species were collected fortnightly for a period of 12 months using set gill nets of mesh sizes 1.0cm, 3.0cm and 5.0cm with net having a length of 25.0m and a depth of 3.0m. Length-weight relationships showed that *B. bayad* sampled from River Niger had b-values of 12.864 and 14.637 and for River Adofi b-values of -0.78 and 4.35 for male and female *B. bayad.* The length-weight relationships in this study had b-values higher than 3 (b > 3) for the growth exponential 'b' (slope of regression) except for male *B. bayad* from Adofi River. This shows that *B. bayad* exhibited positive allometric growth pattern. The mean condition factor of *B. bayad* was 1.30 and 1.28 for male and female fish from River Niger and 0.69 and 0.64 for male and female fish from River Adofi. The higher condition factor observed for male *B. bayad* in the two rivers was not significant different (P>0.05) from that of the female. In the present study, that condition factor 'k' for *B. bayad* from River Niger were 1.30 and 1.28 for male and female fish. These values being above 1 and below 4.28 indicate that the fish species is doing well in the river but not mature. *B. bayad* from River Adofi with condition factor less than 1 may not be doing well as compared with *B. bayad* from River Niger.

KEYWORDS: Growth pattern, condition factor, *Bagrus bayad*, Rivers, Southern Nigeria.

INTRODUCTION

Fisheries management and research often require the use of biometric relationships in order to transform data collected in the field into appropriate indices (Ecoutin and Albareta, 2003). Effective management of any fishery requires considerable knowledge of population parameters such as length-weight, age and growth, mortality and recruitment of the exploited stock. The length-weight relationship (LWR) of fishes are therefore important in fisheries biology and in the study of natural history of fishes because they allow the estimation of the average weight of the fish of a given length group by creating a mathematical relationship between them (Sarker, 2008; Mir, 2012). LWR is also an important factor in fish ecology and in the biological study of fishes, being of prime importance in parameterizing fish yield equations in stock assessments and management (Bagenal, 1978, Nash *et al.*, 2006). LWR can also be used to calculate condition indices, to compare life history and morphology of population belonging to different regions and to study ontogenic allometric changes (Tebiera de Mello, 2006: Sani *et al*., 2010). The mathematical parameter of LWR of fish furnishes further information on the weight variation of individuals in relation to their length (condition factor, k). This factor estimates the general well-being or relative fatness (plumpness) of the individual fish and is usually influenced by age, sex, season and maturity (Anyanwu *et al.*, 2007). Braga (1986) stated that Fulton's condition factor is only adequate for the comparison of fish of the same size, while the allometric condition factor, which occurs when b≠3, is valid for the study of any range of length although at the same stage of development. In the use of allometric condition factor, Vazzoler (1996) reported that Fulton's condition factor be determined and the value of 'b' calculated for reliability of results. The factor is calculated from the relationship between the weight of a fish and its length with the motive of describing the condition of that individual fish (Froese, 2006). The various values of k of a fish reveal the state of sexual maturity, the degree of food sources availability, age of fish, sex of some species (Anibeze, 2000). This study compares the growth patterns and conditions using length-weight relationships and condition factors of *Bagrus bayad* from two rivers in Southern Nigeria.

MATERIALS & METHODS

Description of Study Areas

The study area is River Niger at Asaba in Oshimili South and River Adofi at Ossissa in Ndokwa East Local Government Areas of Delta State (Figure 1). Asaba is the capital of Delta State Delta State and lies on latitude $6^0$433'42.48" E and on longitude $6^0$11' 52.23" N of the Equator. Ossissa is about 57 km away from Asaba.

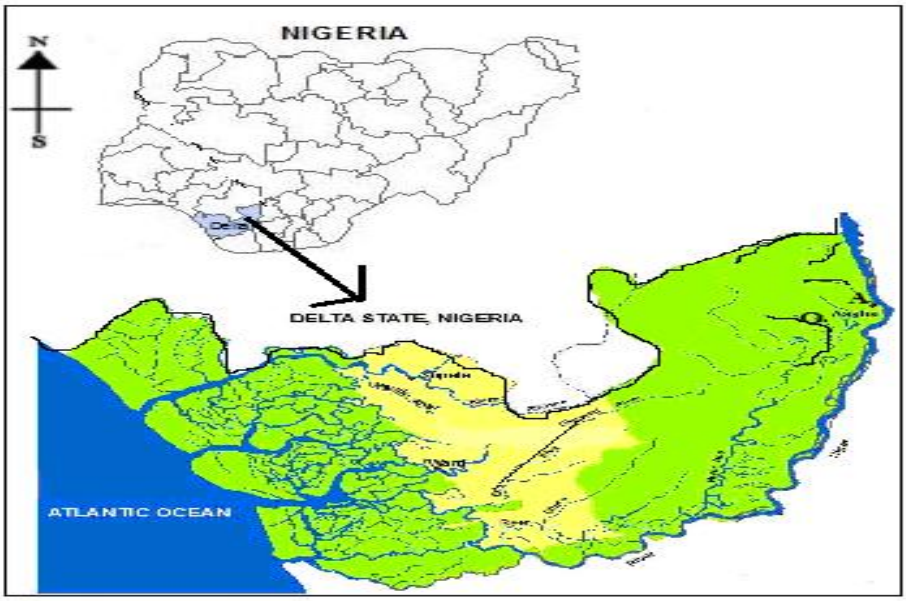

FIGURE 1. Map of Delta State showing sampling locations at River Niger at Asaba (A) and River Adofi at Ossissa (O). (Adapted from Urhobo Historical Society, 2008).

Collection of Fish Samples

Fish samples were collected fortnightly for a period of 12 months from August, 2013 to July, 2014. Fish samples were collected with the assistance of fishermen who used set gill nets of mesh sizes 1.0, 3.0 and 5.0cm with net having a length of 25.0m and a depth of 3.0m. A total of 474 *Bagrus bayad* fish species of average total length of 40.02cm and 36.40cm for male fish and average body weight of 324.92g and 245.76g for female fish were collected from Rivers Niger and Adofi respectively. *Bagrus bayad* numbering 219 were collected from R. Niger while 255 were collected from R. Adofi. All fish samples caught were washed, packaged in Coleman ice-chests and transported to Fisheries and Aquaculture Teaching and Research Laboratory of the Delta State University, Asaba Campus, Asaba, where fish were sorted, counted and measurements taken. Fish samples were identified up to the species level according to Reed *et al.* (1967) and Idodo-Umeh (2003).

Length and Weight Measurement

Measurement such as total length and standard length, body weight, stomach/gut weight were taken and recorded. The total and standard length were measured to the nearest 0.1cm using measuring board, while the weight was determined to the nearest 0.1g using electric beam balance. The LWR was determined from the formula: $W = aL^b$. The parameters a and b in the formula were estimated through logarithmic transformation in the form, Log W = Log a + b Log L

Where,

W = Total body weight of fish

L = Total length of fish (cm)

b = Growth exponent or regression coefficient

Log a= Intercept on the Y-axis

The condition factor of *Bagrus bayad* was calculated from the length and weight relationship. The condition factor (k) was estimated after Le Cren (1951) from the relationship: $K = \frac{100W}{L^3}$

Where K= Condition Factor

L= Standard length of fish (cm)

W= Weight of fish (g)

3.5 Data Analysis

Data obtained from the total length and body weight of *B. bayad* fish sampled were subjected to analysis from the LWR determined from the formula, $W = aL^b$.

RESULTS

The total length of 126 male *B. bayad* sampled from River Niger ranged from 21.0 cm to 38.9 cm while the total length of 93 female *B. bayad* ranged from 18.9 cm to 37.4 cm. The body weight ranged from 105.2 g to 780.0 g for both sexes of *B. bayad* sampled from River Niger. Total length of 90 male *B. bayad* sampled from River Adofi ranged from 21.90cm to 73.40cm while 165 female B. *bayad* sampled from the same river had total length ranged from 15.60cm to 45.20cm. Body weight of *B. bayad* from River Adofi ranged from 152.30g to 407.00g for male and 119.60g to 324.70g for female *B. bayad.* For *B. bayad* sampled from River Niger, the intercept 'a' values for male and female *B. bayad* was -206.924 and -242.752 respectively. The slope of regression 'b' was 12.864 and 14.637 for male and female *B. bayad*. The regression equation of male *Bagrus bayad* was y= -206.924 + 12.864x while that of female *B. bayad* was y= -242.752 + 14.637x. The regression coefficient 'r' for male and female *B. bayad* was 0.764 and 0.777 respectively. Table 1 shows the length-weight relationship and related statistics of *Bagrus bayad* sampled.

TABLE 1. Length-weight relationship and related statistics of *Bagrus bayad* from River Niger at Asaba

Sex	N	Mean fish characteristics					Parametric relationships				
		Total length (cm)	Body weight (g)	S.E.	Min.	Max.	a	b	S.E.(b)	r	P value
Both	73	40.04	323.12	0.86571	21.30	54.80	-232.257	13.870	56.723	0.766	0.000
Male	42	39.76	304.53	1.05839	27.00	54.80	-206.924	12.864	1.720	0.764	.005
Female	31	40.44	349.16	1.46841	21.30	54.20	-242.752	14.637	2.4244	0.777	0.014

The intercept 'a' values for male and female *B. bayad* samples from River Adofi was 279.016 and 181.396 respectively. The slope of regression 'b' was -0.777 and 4.347 for male and female *B. bayad*. The regression equation of male *Bagrus bayad* from River Adofi was y= 279.016 - 0.777x while that of female *B. bayad* was y= 181.396 + 4.347x. The regression coefficient 'r' for male and female *B. bayad* was 0.091 and 0.365 respectively. Table 2 shows the length-weight relationship and related statistics of *Bagrus bayad* sampled from River Adofi.

TABLE 2. Length-weight relationship and related statistics of *Bagrus bayad* from River Adofi at Ossissa

Sex	N	Mean fish characteristics		Parametric relationships				
		Total length (cm)	Body weight (g)	A	B	S.E. (b)	r	P value
Male	90	35.85 ± 1.44	253.37± 12.83	279.016	-0.777	2.576	0.091	0.768
Female	165	36.94 ± 0.88	238.15 ± 8.22	181.396	4.347	3.799	0.365	0.519

A test of difference in slope of length-weight relationships carried out for *B. bayad* sampled from River Niger shows that the value of the slope for the male was not significantly different form that of the female fish. The ranges in values of the 126 male *B. bayad* were b = 14.637, F = 55.945 and P = 0.005 while that of 93 female fish were b = 12.864, F = 42.543 and P = 0.014 as shown in Table 3.

TABLE 3. Test of difference in slope of length-weight relationship for *Bagrus bayad* from River Niger

Sex	N	B	Covariance (F)	Analysis (P)
Male	126	14.637	55.947	0.005
Female	93	12.864	42.543	0.014

A test of difference in slope of length-weight relationship carried out for *B. bayad* sampled from River Adofi shows that the value of the slope for the male was significantly different (P<0.05) than that of the female fish. The ranges in values of the 90 male *B. bayad* were b = 0.777, F = 0.091 and P = 0.768 while that of 165 female fish were b = 4.347, F = 0.701 and P = 0.519 as shown in Table 4.

TABLE 4. Test of difference in slope of length-weight relationship for Bagrus bayad from River Adofi

Sex	N	B	Covariance (F)	Analysis (P)
Male	90	-0.777	0.091	0.768
Female	165	4.347	0.701	0.519

The mean condition factor (k) of *Bagrus bayad* sampled from Rivers Niger and Adofi are presented in Table 5. The mean condition factor of male and female *B. bayad* from River Niger was 1.3005 ± 0.07873 and 1.2874 ± 0.09412 respectively. Female *B. bayad* had the lowest value of k while the male had the highest value of k. There was no significant difference (P>0.05) between the mean condition factors of male and female. Condition factor for *B. bayad* from River Adofi were 0.6993 ± 0.10864 for the male fish and 0.6374 ± 0.09776 for the female fish. The condition factor of *B. bayad* sampled from River Niger was observed to be higher than the values obtained for condition factor of *B. bayad* from River Adofi. *B. bayad* from River Niger had significantly (P<0.05) higher condition factor than *B. bayad* from River Adofi (Table 6).

TABLE 5. Mean condition factor (k) in relation to sex of *Bagrus bayad* from Rivers Niger and Adofi

Source of fish	Male k	Female k	Overall K
River Niger	1.3005 ± 0.07873	1.2874 ± 0.09412	1.29395
River Adofi	0.6993 ± 0.10864	0.6374 ± 0.09776	0.66835

TABLE 6. Mean comparison of condition factor 'k' of *B. bayad* from Rivers Niger and Adofi using paired sample't' test statistics

Pairs	Mean ± S.E.M	T	Sig. (2-tailed)
R. Niger male k and R. Adofi male k	0.60733 ± 0.15108	4.020	0.000
R. Niger female k and R. Adofi female k	0.53903 ± 0.16934	3.183	0.003

DISCUSSION

B. bayad ranged in length from 21.0cm to 38.9cm and from 21.9cm to73.4cm in Rivers Niger and Adofi. These ranges in length show that most of the fish sampled were not mature yet. Olaosebikan and Raji (2004) reported a maximum size of 57.5cm from upper and lower River Niger. The length-weight relationships in this study had b-values higher than 3 (b > 3) for the growth exponential 'b' (slope of regression) which shows that *B. bayad* exhibited positive allometric growth pattern. Ogbe and Fagade (2006) also reported positive allometric growth pattern for *B. bayad* from lower River Benue. The values of 'b' obtained from this study were 12.864 and 14.637 for *B. bayad* from River Niger. These values are similar to those obtained by Entsua-mensah (1995) who reported b-values of 10.28 and 14.47 for bagrids from River Volta. The high values of the growth exponential 'b' obtained for *B. bayad* from River Niger is an indication of a strong association between length and weight *B. bayad* studied. This means that *B. bayad* tends to grow fatter as the length of *B. bayad* increases. The results obtained from this study shows how successful the fish population has exploited and utilized the available food materials in their habitat. The fact that the weight of fish increased faster than the total length of the fish could also be due to sufficient space area which may have also contributed to the increase in the weight of the fish than in the length of fish studied. *B. bayad* from River Adofi had lower values of 'b' (0.777 and 4.347) which is in agreement with the works of King (1996a) who reported low values of 'b' of 2.911 and 2.794 for *Clarias gariepinus*. Lower values of 'b' were obtained for *B. bayad* from River Adofi. Low b-value, when 'b' < 3, is indicative of negative allometry in growth pattern. Male *B. bayad* from River Adofi had b-value of 0.777 which is less than 3 indicating negative allometry in growth pattern. This means that male *B. bayad* from River Adofi does not grow fatter the length of the fish increases. Negative allometry in growth pattern has been reported for juvenile cichlids, *Chromidoptilapia guntheri* and *Hemichromis fasciatus* in Lake Eleiyele, Ibadan Southern Nigeria (Zelibe, 1982), *Clarias gariepimus* (King, 1996a), Illesha Africana and *Heterobranchus longifilis* from River Idodo, Nigeria (Anibeze, 2000). Weatherly and Gill (1987) reported that allometric growth pattern could be negative or positive and that in "isometric growth pattern", when the growth exponent 'b'= 3, the body form maintains a constant proportion to length but when 'b' ≠ 3 a positive or negative allometry is indicated with 'b' < 3 as negative and 'b' > as positive allometry. This study follows the cube law which according to Froese (2006) uses the Fulton's Condition Factor and attributes of length-weight exponential of b-value of 3 for isometric fish growth. The mean condition factor of fish in this study was observed to be favorably comparable with the condition of different tropical fish species investigated and reported by (Saliu, 2001) in *Bryanus nurse* from Asa Reservoir, Ilorin, Nigeria. The value of K in the present study was 1.30 and 1.28 for male and female and 1.29 both sexes of *B. bayad* sourced from River Niger. For *B. bayad* sourced from River Adofi condition factors of 0.69, 0.63 and 0.67 were observed for male, female and both sexes of fish. Factors known to influence condition factor include prevailing environmental condition, availability of food, feeding intensity, density or population changes, the period and duration of gonadal maturation among others. Anyanwu *et al.* (2007) noted that condition factor which is an estimate of the general well-being or relative fatness (plumpness) of the individual fish may be influenced by age, sex season and maturity. It was observed in the present study, that condition factor for *B. bayad* from River Niger had 'k' values of 1 and above which indicate that fish species are doing well in the river. When k is greater than unity, the fish species is healthy. However, Bagenal (1978) reported that condition factor for mature fresh water fish ought to be in the range of 2.9 to 4.8.

CONCLUSION

The length-weight relationship of *B. bayad* in this study shows that *B. bayad* sourced from River Niger had b-values higher than 3 which show positive allometry. Lower values of 'b' were obtained for *B. bayad* from River Adofi, with female *B. bayad* having a b-value of 4.347 also exhibiting positive allometry but male *B. bayad* having b-value of -0.777 which is less than 3 indicating negative allometry in growth pattern. This means that male *B. bayad* from River Adofi does not grow fatter as the length of the fish increases. The value of k in this study were 1.30 and 1.28 for male and female for *B. bayad* sourced from River Niger while k values were 0.69 and 0.63 for male and female fish from River Adofi. This may be an indication that *B. bayad* from River Niger may not be mature fishes and that *B. bayad* from River Adofi with condition factor less than 1 may not be doing well as compared with *B. bayad* from River Niger.

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