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MORPHOMETRIC RELATIONSHIPS AND RELATIVE CONDITION FACTOR OF *Synodontis eupterus* (Boulenger) FROM RIVER RIMA IN NORTH-WESTERN NIGERIA

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ABSTRACT

Samples of *Synodontis eupterus* (Boulenger) from River Rima in North-Western Nigeria were analysed for morphometric relationships and relative condition factor. A total of 1,610 samples of which 781 were females, 816 males and 13 with unidentified sex (giving a ratio of about 1:0.96 female: male) were examined between November 2005 and December 2008. Morphometric measurements were taken. The samples ranged in total length from 6.00 to 17.50 cm (mean=10.36±1.50cm) and total weight of 2.19 to 72.20g (mean=15.49±1.50g). The b values for the length-length relationships suggested negative allometry. The species exhibited positive allometric growth pattern based on all parameters (b>3) except in dry season, where b=2.917 (isometry). The species were in good condition in the river, with overall Kn of 2.06±0.08SD for females and 2.01±0.08SD for males. In both sexes, larger samples were in better condition (P<0.05) than small ones and samples of rainy season were in better condition (P<0.05) than those of dry season. Samples in stages III, IV, V and VI were in better condition (P<0.05) than those in the maturing and immature stages. The result of this study for *S. eupterus* in River Rima showed that increase in total length would lead to increase in length of all the other length variables in the length-length relationships; the growth pattern is positive allometry and that the species is in good condition in the river.

Keywords: *Synodontis eupterus;* Length-length and Length-weight Relationships; Condition factor.

INTRODUCTION

Synodontis eupterus belongs to the Family Mochokidae and it is commonly referred to as the feather fin, squeaker or the upside down catfish. The species is mostly found in freshwater with a pH range of 6.2-7.5 and temperature of 22-26^{0}C (ScotCat, 1998). Holden and Reed (1972) described *S. eupterus* as a small species, with short to medium scale-less body of about 20cm in length and a bony shield on the head and sides. The colour of the adults of the species is uniformly olive with small round black spots on the body and all the

fins, and the spots are confluent on the tail and form transverse lines, while the juveniles have the spots arranged in an irregular pattern of tiger like stripes (Reed *et al.*, 1967). The species have a magnificent dorsal fin, with each hard ray extending into long filaments which can vary in different individuals, hence the common name, feather fin. The coloration pattern, grace in movement and their extreme toughness make them particularly attractive for aquaria (Holden and Reed, 1972).

Many studies have been conducted on various species of Synodontis, and these include the works of Reed *et al.* (1967) and Olaosebikan and Raji (1998) who reported on the general descriptions and ecology of the *Genus Synodontis.* Other works on various aspects of the biology of *Synodontis spp.* in Nigeria include those of Imevbore and Bakare (1970), Olatunde (1989), Araoye (1999 and 2001), Shinkafi and Ipinjolu (2001), Shinkafi *et al*. (2002), Malami *et al.* (2005) and Shinkafi *et al*. (2010). All these studies notwithstanding, the available scientific investigations on the biology of *S. eupterus* and the other Synodontis species are still inadequate for their propagation and management. This paper therefore presents the results of investigations conducted on the morphometric relationships and relative condition factor of *S. eupterus* with a view to further bridge the gap in knowledge of this species in River Rima.

MATERIALS AND METHODS

Study Area

The fish samples were collected from River Rima, in Sokoto, north-western Nigeria. Sokoto lies between longitudes $4^{o}8$'E and $6^{o}5$'E, and latitudes 12^{o}N and $13^{o}58$'N (Mamman, 2000). The climate of Sokoto is tropical continental, with much of the rains between June and September, while the long dry season is from October to May (Ita *et al.*, 1982). River Rima flows in a south-western direction over 100km and joins the major River Sokoto to form the Sokoto-Rima river system. It is a perennial river, usually over flooding its banks during the rainy season in August and September, and up to October at times (Mock, 1963). River Rima serves as an important source of fish and fisheries to the people of Sokoto State, with much of the fishing activities being carried out along its various landing sites (Figure 1)

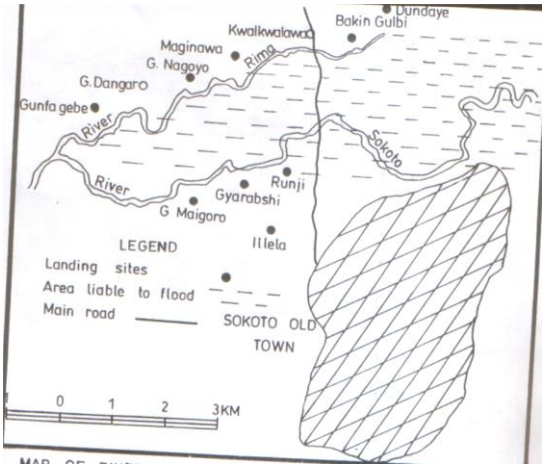

Figure 1: Map of River Rima showing the various fish landing sites of *S. eupterus* used in this study

Fish Samples

Samples were collected on monthly basis for 36 months (November 2005 to December 2008). The samples were examined fresh in the laboratory immediately after collection. On each sample, the total length (cm) and total weight (g) were measured. The female samples were 781 in number, while 816 males were analyzed, giving a ratio of about 1:1. The sex of 13 samples could not be identified, making a total of 1,610. The samples ranged from 6.00 to 17.50cm in total length, with overall mean of 10.36±1.50cm and 2.19 to 72.20g with a mean of 15.49±1.50g in total weight. The proportions of the samples based on sex and size are presented in Table 1.

Table 1: Size distribution of *S. eupterus* samples from River Rima, Nigeria

Parameter	No. of samples	Proportion (%)
Overall	1610	100.0
Sex		
Female	781	48.5
Male	816	50.7
Unidentified	13	0.8
Size class (cm)		
<10	661	41.1
≥10	949	58.9

Data Analysis

Length –length relationship

Several studies have shown linear relationships between total length-standard length, total length-fork length and total length-head length of some fish species (Ipinjolu *et al.*, 1988; Zorica and Sinovcic, 2008; Subba *et al*., 2009; Hajjej *et al*., 2011). As such, linear

regression analysis was used to compute the equations of these relationships. The linear relationship was represented by the equation:

$$Y = a + bX$$ (Steel and Tourrie, 1980; Ipinjolu *et al.*, 1988)

Where: Y = fish gutted weight (g) or standard length (cm); X = fish total weight (g) or total length (cm); a = constant and b = exponent

Length-weight relationship

The relationship between the total length (TL) and total weight (TW) was calculated by a logarithmically transformation equation of length-weight relationship to give a linear one as:

$$\text{Log TW} = \text{Log a} + \text{b Log TL}$$ (Bagenal and Tesch, 1978).

Where: W = Weight of fish (g); L = Length of fish (cm); a = constant; b = exponent.
The values of 'a' and 'b' were estimated by least squares regression analysis (Steel and Tourrie, 1980).

Condition factor

The relative condition factor or Kn (Weatherly and Rogers, 1978), was calculated using the equation:

$$Kn = \frac{100W}{aL^b}$$

Where: Kn = Relative condition factor; W= total weight (g); L = total length (cm);
b = coefficient obtained from LWR and a = constant.

Analyses of the length-weight relationship and relative condition factor were carried out based on sex, two size classes (<10cm and ≥10cm total length), and seasons. For the relative condition factor, gonad maturation stages were also used in the analysis. SPSS computer package, version 11, was employed for the regression and correlation analyses for the length-length and length-weight relationships and mean separation was by Duncan's Multiple Range Test at 95% significance level.

RESULTS

Length-Frequency Distribution

Figure 1 present the length-frequency distribution of the fish samples. The highest proportions of the samples were in the 10cm total length. Most of the samples were within 9.5 and 11cm total length. Samples less than 7.0cm and those above 14.5cm were relatively few.

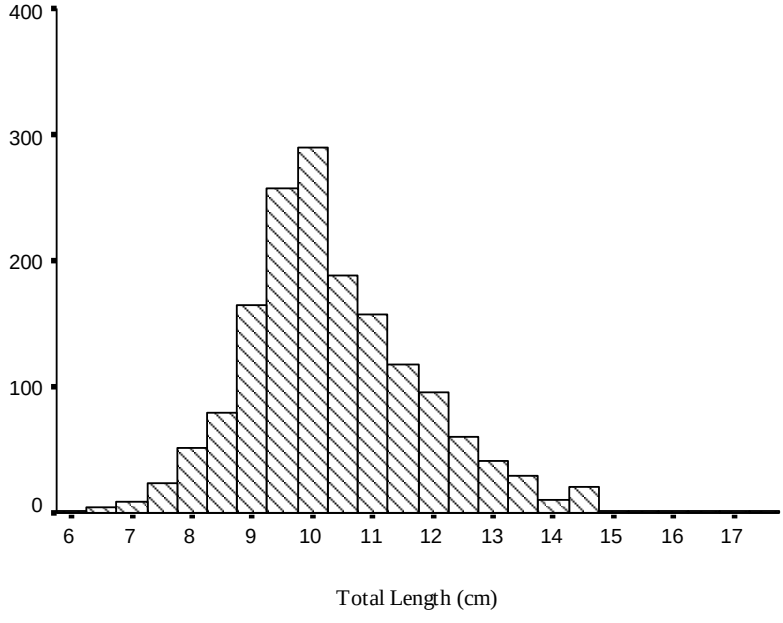

Figure 2: Length- Frequency Distribution of S. eupterus Samples

Morphometric Features

Table 2 shows the range of the body lengths and weights measured. The maximum total length (TL) ranged from 6.00 to 17.50cm in total length, with overall mean of 10.36±1.50cm. Total weight ranged from 2.19 to 72.20g, with a mean of 15.49±1.50g. The minimum, maximum and mean values of all the other growth parameters (SL, FL, HL, GTH, and GW) are presented in the table.

Table 2: Morphometric measurements of *S. eupterus* samples from River Rima, Nigeria

Parameter	No. of samples	Minimum	Maximum	Mean	SD
Total length (cm)	1610	6.00	17.50	10.36	1.50
Standard length (cm)	1610	4.80	13.00	8.03	1.14
Fork length (cm)	1610	5.40	15.00	9.03	1.25
Head length (cm)	1610	1.40	4.50	2.37	0.38
Girth (cm)	1610	0.80	3.80	1.84	0.39
Total weight (g)	1610	2.19	72.20	15.49	8.17
Gutted weight (g)	1610	1.41	56.90	12.89	6.45

Length-Length Relationship

The results of the regression analyses of all the length-length relationships are presented in Table 3. For the total length (TL)-standard length (SL) relationship, the b value was 0.731, indicating negative allometry. The negative allometry suggests that the overall increase in total length was slightly faster than increase in the standard length. The coefficient of the regression equation for the total length (TL) and head length (HL), and total length (TL) and girth (GTH) were 0.213 and 0.203, respectively. The low b values, showing negative allometry, suggest that the head length and girth grow at a slower rate than the overall total length. The coefficient of head length-girth relationship was 0.779, indicating negative allometry, which suggests that the girth increases at a slightly faster rate than the head length. The correlation coefficients in all the length-length relationships were highly significant ($P<0.01$), with r values almost equal to 1 for SL-TL, FL-TL and GTH-HL relationships, and lower for the other relationships.

Length-Weight Relationship

The coefficients of the length-weight relationships (Table 4) indicate positive allometric growth pattern for female and male samples with values of b=3.129 and 3.181 respectively. The coefficients for the two size classes (<10cm and ≥10cm) were also the same, being 3.161 and 3.143, respectively, suggesting allometric growth pattern. For the seasons however, samples in the rainy season indicated positive allometry (b=3.233), while those of the dry season exhibited isometric growth pattern (b=2.917). In all the cases, the parameters were highly correlated, with the highest values obtained in the females (r=0.952) and the least (r=0.798) in size class <10cm. All equations were highly significant ($P<0.05$).

Table 3: Length-length relationships of *S. eupterus* samples from River Rima, Nigeria

Relationship	A	B	SE of b	R
SL = a+b TL	0.512	0.731	0.005	0.960
FL = a+b TL	0.700	0.803	0.006	0.963
HL = a+b TL	0.159	0.213	0.003	0.850
GTH = a+b TL	-0.267	0.203	0.004	0.795
GTH = a+b HL	-0.003	0.779	0.010	0.763

All equations are significant ($P<0.01$)

Table 4: Total length-total weight relationship of *S. eupterus* samples from River Rima, Nigeria

Parameter	No. of samples	A	B	SE of b	R
All samples	1610	-2.071	3.174	0.032	0.928
Sex					
Female	781	-1.997	3.129	0.039	0.944
Male	816	-2.006	3.181	0.050	0.908
Size class (cm)					
<10	661	-2.060	3.161	0.093	0.798
≥10	949	-2.038	3.143	0.053	0.881
Season					
Dry	216	-1.784	2.917	0.078	0.932
Rainy	1394	-2.135	3.233	0.035	0.928

All equations are significant (P<0.01); Equation: Log TW = a + b Log TL

Relative Condition Factor

Table 5 shows the relative condition factor (Kn) for female and male samples based on size, season and gonad maturation stages. The overall Kn for female was 2.06±0.08SD which was higher than that of the male (2.01±0.08SD). In both sexes, larger sizes (≥10cm) had significantly (P<0.05) higher Kn than smaller ones (<10cm). In both sexes, samples in the rainy season were in better condition than in the dry season. Based on gonad maturity stages of the female samples, the highest Kn was obtained in the resting stage, followed by mature stage, while the least Kn values were found in the immature and maturing stages. All these differences were highly significant (P<0.05). In male samples, the highest (P<0.05) Kn values were obtained in the spent and resting stages, while the least were obtained in the immature and maturing stages.

Table 5: Relative condition factor of *S. eupterus* from River Rima, Nigeria

Parameter	Female			Male		
	No. of samples	Mean	SD	No. of samples	Mean	SD
Overall Sex	781	2.06	0.08	816	2.01	0.08
Size class(cm)						
<10	265	1.98[b]	0.07	374	1.96[b]	0.07
≥10	516	2.10[a]	0.05	442	2.06[a]	0.05
Season						
Dry	110	2.09[a]	0.07	91	2.04[a]	0.08
Rainy	671	2.06[b]	0.08	725	2.01[b]	0.08
Maturity stage						
Immature	118	2.03[d]	0.12	86	1.97[c]	0.13
Maturing	94	2.02[d]	0.09	171	1.97[c]	0.08
Mature	221	2.09[b]	0.07	494	2.03[b]	0.06
Ripe and running	285	2.06[c]	0.07	47	2.04[b]	0.07
Spent	53	2.05[c]	0.07	10	2.19[a]	0.07
Resting	10	2.14[a]	0.05	08	2.10[a]	0.04

Means in column with same letter are not significantly different (P>0.05).

DISCUSSION

The length-frequency distribution of the samples (Figure 2) revealed several modes, with no marked demarcation between the different modal groups, suggesting that the several modes represent different spawnings, though they may not be representatives of definite year-classes. Similar findings of several modes were reported for *Pellonula afzeliusi* (Balogun, 1987) and *Chrysichthys auratus* (Ikomi and Odum, 1998). This length-frequency distribution may be used to estimate the age and growth of *S. eupterus* in River

Rima by fitting them into the Von Bertalanffy growth formula (Almatar, 1993) in order to assess the stock.

The maximum total length of the samples used in this study was smaller than the maximum lengths of the species earlier reported from water bodies in Nigeria (Reed *et al*., 1967; Olaosebikan and Raji, 1998). This may probably be due to depletion of the stock, as a result of over-exploitation, which is a common phenomenon in Africa, as in many parts of the world (Khan *et al*., 2004), due to poor implementation of fishing regulations in River Rima.

Linear relationships and high correlation values were established between the length parameters (Table 3). The results suggests that increase in total length would lead to increase in length of all the other length variables and thus, all the length parameters can easily be predicted from total length using linear regression models. Zorica and Sinovcic (2008) reported similar findings with Atlantic bonito (*Sarda Sarda)*. The coefficients obtained for the total length-fork length relationships were higher than those for total length-standard length. This may be due to the closer relationship between the former than the latter parameters, as revealed by the r values. This may probably suggest that fork length can be used in place of standard length in estimating the total length of the species, with better precision. The b values obtained in this type of linear relationships are required to enable sizes to be standardized in the case of converting one length or weight parameter to another, where different kinds of measurements were taken (Broadhurst *et al*., 2009). Cucalon-Zenck (1999) converted fork length of the Pacific mackerel (*Scomber japonicus*) to total length for the purpose of estimating the growth pattern of this species in the Gulf of Guayaquil, Ecuador. The b and r values of the total length-standard length relationship were higher than those of the total length-head length and total length-girth relationships, indicating that standard length increase faster with total length than does head length and girth with total length. This type of information especially that of girth may enable appropriate mesh sizes to be estimated for fishing gears in the exploitation of the species in the wild. The total length-girth relationship was used by Santos *et al*. (1995) to predict gillnet selectivity of *Pagellus acarne* and *P.erythrinus* in Algarve, Southern Portugal.

The positive allometric growth pattern (b=3.174) of *S. eupterus* suggests that increase in weight was more or faster than increase in length. Same pattern was also exhibited by the small and large sized samples, as well as the females and males (Table 4). Shinkafi *et al*. (2002) also reported positive allometry in the small and large sized samples of *S. clarias* from River Rima. This may probably suggest that the pattern of growth from juvenile to adulthood in these two species is not affected by increase in size. On the other hand, Laleye *et al*. (2006) reported negative allometry for *S. schall* and *S. nigrita* from Oueme River. This may be due to species differences and varying ecological conditions of the two water bodies. The isometric growth pattern exhibited by the samples in the dry season may be due to less food availability or immature gonads of the samples which reduced the weight of the samples during that season.

The results of the relative condition factor (Kn) of about 2 indicated that the species was in good condition in River Rima, meaning that increase in length brought about more proportional increase in weight. Magawata (2008) also reported good condition for about ten species of fishes from the same water body. Higher Kn in females than in males may be attributable to heavier weight of gonads in the females. The higher Kn recorded during the rains may also be due to more food availability and gonadal development. Higher Kn during rainy season was reported for *Heterobranchus longifilis* from Idodo River (Anibeze

2000). Likewise, that the large sized samples were in better condition than the smaller samples may probably be due to better foraging ability and conservation of stored food energy in the adults, or possibly due to increasing weight of maturing gonads in the larger samples. Ikomi and Sikoki (2003) also reported higher Kn values for larger samples than smaller sizes of *Brycinnus longipinnis* from Jamieson River.

Based on gonad maturation stages, the highest Kn values were obtained in the mature, ripe and running, spent and resting stages, while the lowest were recorded in the immature and maturing stages in both sexes due to the heavier weight of the gonads in the mature stages. Fish populations often display considerable changes in average condition, reflecting normal seasonal fluctuations in their metabolic balance and in the pattern of gonad maturation and subsequent release of reproductive products, and also the state of fullness of alimentary canal may influence condition and thus, in many fish species, significant permanent differences occur after maturity (Weatherly, 1972).

The results of this study showed that increase in total length would lead to increase in length of all the other length variables of *S. eupterus* in River Rima. The species exhibited positive allometric growth pattern and was also in good condition in the river. This kind of information is important as it can be utilized in the development of models for the management of the species in the wild and in captivity.

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