Morphometric Measurements Relationships of *Synodontis batensoda* (Rueppell 1832) from Forcados River, Toru-Orua, Bayelsa State, Nigeria

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Abstract- ***The Length Weight Relationship (LWR) and Condition Factor (K) of an IUCN red listed but LC categorized species, Synodontis batensoda, from River Forcados, Sagbama, Bayelsa State was investigated. A total of 50 specimens from two fishing communities using gillnet along the River Forcados, comprising of 20 females and 30 males were sampled and studied between June and July, 2023. Results from combined communities showed Weight (W) for the female fishes ranged from 10.0 g - 46.0 g with mean 26.650 g, while that of the males ranged from 16.0 g - 65.0 g with mean 36.533 g. The Total Length (TL) for female fishes ranged from 10.4cm-16.3cm with mean 13.590cm, while males ranged from 12.4 cm - 18.5 cm with 15.210 cm. The LWR was calculated using the equation*** $W = aL^b$ ***and*** $K = 100(W/L^3)$***. The LWR obtained were the combined communities, Ebedebiri and Angalabiri separately were*** $W = 0.0067L^{3.1565}$***,*** $W = 0.0071L^{3.1357}$***, and*** $W = 0.0067L^{3.1515}$***, with Correlation Coefficient (r) values highly significant at 0.971, 0.968, and 0.979. The K values are, 1.0179, 1.0266, and 1.0073, respectively. Statistically, means of TL, W, and K from both communities were not significantly different (P > 0.05) with P values of 0.195, 0.189, and 0.462. Sampled sexes from Ebedebiri community were significance different (P < 0.005) in TL and W, P = 0.005 and 0.02 respectively, but K value for the sexes were not significantly different (P > 0.05) at P = 0.618. Angalabiri showed similar results to Ebedebiri for both TL and W (P < 0.05), P = 0.00015 and 0.001. Also similar was the K value at P > 0.05 (P = 0.382). Both communities showed a positive allometric growth (b = 3.1565) indicating that Forcados River environmental factors favour the growth of S. batensoda in the study communities during the period of its availability.***

Indexed Terms- ***Upside-down catfish, Condition Factor, Standard Length, Fork Length, Head Length.***

I. INTRODUCTION

Morphometric characteristics of fish are very important feature in the study of the development of living organisms (Jisr *et al.*, 2018) including fishes. In fisheries management, these characteristics are used in estimation of the wellbeing of fish population especially length-weight relationship. It is also useful in the study of relationship between the variation in fish body, shape and environmental changes where the fish live (Williams 1996). Also, Kuriakose (2017), reported the use of morphometric measurement for standard biological changes in fish, he pointed that such studies should be conducted frequently. Hence several authors have emphasized the use of morphometric studies in various aspect of fisheries studies for example in, comparing life history of population from different region, and stock assessment, hence, improving techniques for fisheries management, conservation and in culture fisheries (Ayoade and Ikulala, 2007, Kaur *et al.*, 2019). The relationship of length and weight can be used to determine type of growth (isometric or allometric) and likely differences between distinct unit stocks of the same species (King 2007). The mathematical expression of the relationship is $W = aL^b$, where W is Weight, L is Total Length, a is the intercept on the y-axis and b is the slope or gradient of the line. The value of *a* relates to the condition of a fish (the larger the value of *a*, the larger the fish weight for a given length) and is used in condition indices (King, 2007). According to Kuriakose (2017), the Length is one dimension whereas weight which depends on volume is three dimensions i.e. weight of a fish is proportional

to cube of the length of the fish. Therefore, the cubic relationship that exist between weight and length of a fish for an ideal fish which maintains the same shape is $b = 3$. Though, most species of fish do change their shape as they grow, the cubic relationship between length and weight would hardly be obtained due to several factors. The value of *b* provides information about the type of growth of the fish species, b=3 signifies Isometric growth, b<3 or b>3 signify negative or positive Allometric growth.

The Condition Factor (K) of fish connotes the condition and wellbeing of fish and it is significant in the management and conservation of fish population (Muchlisin *et. al.*, 2010). It is also useful in examining feeding intensity, age, and growth rate of fish (Adaka *et al.*, 2015). The mathematical expression $K = 100\ (W/L^3)$, signifies that the larger the weight of fish for a given length, the larger the K value (King, 2007). According to Muchlisin *et al.* (2010), Condition factor K can be used especially in three cases such as; comparing two or more co-specific populations inhabiting in similar or different conditions, determining period and duration of gonadal maturation, and in observing increase or decrease in fish population due to alteration in food resources. Hence they concluded that it is necessary to conduct stock assessment of important fishes especially if species to be studied are commercially important and happened to be threatened in any body of water. This injunction is the basis for this study of the *Synodontis batensoda* from Forcados River in Sagbama LGA of Bayelsa State. This member of the Mochokidae is under IUCN red listed species.

Synodontis batensoda, the upside-down catfish belongs to the family, Mochokidae, its specific name is translated to "black belly" in Arabic (IUCN, 2020). The fish has a distinct physical appearance that makes it dual commercially important (food and aquarium fish). A nocturnal and omnivorous fish (Idodo-Umeh, 2003) that feeds from a wide range of phytoplankton to zooplankton, insects, molluscs, crustaceans, fish, worms, etc (Akombo *et al.*, 2013). IUCN red list assessment of threatened species released in 2020, indicated that the species is red listed but categorized under Least Concern (LC). This implies that the species has an extensive distribution with no known major widespread threats, although in North Africa the species is regionally extinct, while in Cairo, it is found during flood-time (IUCN, 2020). Population-wise, *S. batensoda* in the past is less abundant compared to other species of the Synodontis genus (Akombo *et al.*, 2014a), with 0.27% abundance of the sixteen identified Synodontis species. Recently, in River Forcados, Sagbama LGA, Bayelsa State, the species population is diminishing gradually even in its period of abundance, between May and July. This calls for serious attention on the management and conservation of the species, hence, the reason for the morphometric measurements and condition factor study of the species.

II. MATERIALS AND METHODS

- Study Area

This study was conducted along the Forcados River using two sample stations Ebedebiri and Angalabiri, located in Sagbama LGA, Bayelsa State. Nigeria. River Forcados is a distributary of the River Niger which starts from the bifurcation of River Niger at Aboh and flows through the Forcados Estuary into the Atlantic Ocean. The river is one of the most used lotic system in Bayelsa State. The communities used for sampling are 9.4 Km apart and intersected by Toru-Orua community. Ebedebiri lies between Latitude 5.1298º N and Longitude 6.0944º E, while Angalabiri is between Latitude 5.0835º N and Longitude 6.0573º E. Residents of communities use the river for fishing, bathing, washing, etc. Other usage are trading routes, logs transportation, movement of people to and fro communities in Delta State aside its other anthropogenic activities.

- Sample Collection

Fish specimens were collected at landing site from artisanal fishers using gill net, seine net and cast net of diverse mesh sizes along the River Forcados at Ebedebiri and Angalabiri between May and July. Samples of *S. batensoda* were comllected from each sampling station weekly for five weeks. Sampling was carried out between 7.00 hrs to 8.00 hrs on the sampling days and biometric measurements were taken immediately on arriving at the Biology laboratory of the University of Africa, Toru-Orua. Sexing was by observing the gonads of each specimen to separate males from females, then followed by morphometric measurement of; Total Length (TL),

Standard Length (SL), Head Length (HL), and Fork Length (FL), measured to the nearest 0.1cm using measuring board. Weight of each fish was measured 0.1g using sensitive weighing scale.

III. DATA ANALYSIS

- Length-weight Relationship (LWR)

The morphometric relationship (LWR) for combined and each community was determined using the mathematical expression $W = aL^b$. The intercept a and slope of the line b were estimated using the logarithmic transformation of the LWR power curve equation to a linear relationship of $Log\ W = Log\ a + b\ Log\ L$ (Kuriakose, 2017).

- Condition factor (K)

K model was used to determine wellbeing of the sampled fishes using the relationship, $K = 100(W/L^3)$. Where K = Condition Factor/Wellbeing of fish, L = Length of fish, and W = Weight of fish. Fishes with K value ≥ 1 are adjudged to be living in an environment with better conditions, while species with K value < 1 implies low environmental conditions (Kuriakose, 2017).

- Statistical Analysis

The morphometric data were subjected to statistical analyses using Excel and SPSS version 23. Significance of LWR and K data were tested using Independent Sample Test and descriptive statistics to compare means for combine communities of Ebedebiri and Angalabiri at 5% significant level ($p < 0.05$).

IV. RESULTS

- Length-weight relationship

Summary of the Length-Weight Relationship and Condition Factor for *Synodontis batensoda* are presented in Table 3. The calculated TL, W, and K pooled for Ebedebiri and Angalabiri are presented in Table 1 and 3. The pooled communities' results showed Weight (W) ranged from 10.0g-65.0g with mean value of 32.53 ± 1.53, while the values for Length (L) ranged from 10.4cm-18.5cm with mean of 14.56 ± 1.57 (Table 1). Of the 50 specimens collected, 20 were females and their weight ranged from 10.0 g - 46.0 g with mean 26.65 ± 8.11 g, while 30 specimens were males ranged from 16.0 g - 65.0 g with mean 36.53 ± 10.68 g. The Total Length (TL) for female fishes ranged from 10.4 cm - 16.3 cm with mean 13.59 ± 1.27 cm, while male fishes ranged from 12.4 cm - 18.5 cm with 15.21 ± 1.42 cm (Table 3). The mean results on other length measurements such as HL, SL, and FL, for the pooled communities were 3.77 ± 0.79, 11.04 ± 1.20, and 13.04 ± 1.62, respectively (Table 2).

Table 1: Analysis of TL, W, and K of Pooled, Samples for Ebedebiri and Angalabiri Communities *Synodontis batensoda* in River Focardos.

Community	N	Mean TL ± SD	Mean W ± SD	Mean K ± SD	r
Pooled Community	50	14.56±1.57	32.58 ± 1.53	1.02 ± 0.09	0.971**
Ebedebiri	25	14.85±1.42	34.56 ± 10.80	1.03 ± 0.10	0.968**
Angalabiri	25	14.27±1.69	30.60 ± 10.81	1.01 ± 0.09	0.979**

**Correlation is highly significant

Table 2: Descriptive Statistics of Pooled Communities HL, SL, and FL of *Synodontis batensoda* in River Focardos.

Parameters	N	Range	Mean ± SD	R	*a*	*b*	LWR Equation
HL	50	1.8 – 5.6	3.77 ± 0.79	0.902**	0.0255	1.85887	TL=0.025 HL^1.8587
SL	50	7.9 – 14.2	11.04 ± 1.20	0.955**	0.8666	0.95022	TL=0.8662SL^0.9502
FL	50	9.3 – 16.1	13.04 ± 1.62	0.971**	0.6661	1.1113	TL=0.661 HL^1.113

**Correlation is highly significant

The LWR equation for *S. batendoda* was determined through the estimated parameters of *a* and *b*. Correlation Coefficient (r) values were highly significant ($P < 0.05$) at 0.971, 0.968, and 0.979 for pooled, Ebedebiri and Angalabiri communities, with K values of 1.02 ± 0.09, 1.03 ± 0.1, and 1.01 ± 0.08, respectively, Table 1. Statistically, mean values of TL, W, and K between communities were not significantly different ($P > 0.05$) as shown by their P values of 0.195, 0.189, and 0.462 (Table 3). Analysis of fish sexes from Ebedebiri community were significantly different ($P < 0.005$) in TL and W, P = 0.005 and 0.021 respectively, but K value for both sexes were not significantly different ($P > 0.05$) at P = 0.618. Angalabiri showed similar results to Ebedebiri for both TL and W ($P < 0.05$), P = 0.016 and 0.030 (Table 3). Also similar was the K value at $P > 0.05$ (P = 0.415). Pooled communities analysis on TL and W of the sexes were significantly different ($P < 0.05$), at P = 0.001 and 0.0001, while the K analysis were not significantly different ($P > 0.05$) at P = 0.382 (Table 3). Results on growth pattern showed a positive allometric growth ($b > 3.0$) for all the sampled fishes, Table 3. Statistically, *b* and *a* values for between communities and sexes of pooled communities were significantly different ($P < 0.05$). While r^2 were not significantly different ($P > 0.05$) for both communities. Analysis on *a*, *b* and r^2 for sexes within both communities were significantly not different ($P > 0.05$), Table 3. Graphically, the LWR for Pooled Samples, Ebedebiri, and Angalabiri communities and their sexes are shown in Fig 1- 6.

V. DISCUSSION

This study estimated the length weight relationships of *Syndontis batensoda* of Forcados River using two communities along the river as sample stations. A strong positive relationship was established and can be used to make inference on the living condition of the fish in Forcados River. The simple power equation of the L-W intercept and slope ranges between 0.0046 - 0.0071 and 3.14 - 3.36, respectively. The estimated values of *b* for pooled communities, each community, sexes of pooled communities, and sexes of each community, indicated positive allometric type of growth in their season of abundance (June-July). The estimated value of *b* is in contrast to the values obtained by other studies on Synodontis spp; Akombo *et.al*. (2014ab) observed a negative allometric growth for *Synodontis clarias* in lower Benue, Midhat *et.al*. (2012), Dambo and Solomon (2021), Hart and Abowei (2007), and Olowo *et.al*. (2022), but agrees with the findings of Arame *et.al*. (2020) for *Synodontis clarias* ($b > 3$). According to Deekae and Abowei (2010), when $b > 3$ it signifies a more weighty body as length increases. Result on sampled sexes revealed that males were more than females, this is in contrast to the study of Dambo and Solomon (2021) and Akombo *et.al*. (2016), where the only sampled fishes were females, but consistent with the work of Akombo *et.al*. (2014) where more males were sampled. According to Ozcan and Bulk (2009), the discrepancies in various studies for *b* value may be attributed to several factors that impact fish growth such as habitat, food availability, sexual dimorphism, gonadal maturation, and general health of fish species.

Condition Factors (K) of *S. batensoda* sampled for between communities, sexes within/between communities range between 0.99 - 1.04 and were not significantly different ($P > 0.05$) for fishes within/between communities and sexes of fish within/between communities. The results on K values reveal that *S. batensoda* of Forcados River living condition favoured the growth of the fish during the period of this study.

Table 3: Length Weight Relationships and Condition Factors of *Synodontis batensoda* of River Forcados.

	Location /Sex	N	W		TL		*a*	*b*	r^2	K	LWR Equation	P-Value		
			Range	Mean ± SD	Range	Mean ± SD				Mean ± SD		W	TL	K
Pooled Communities	Ebedebiri & Angalabiri	50	10.0 – 65.0	32.58 ± 1.53	10.4 - 18.5	14.56±1.57	0.0067	3.16	0.9289	1.02 ± 0.09	W=0.0067L^3.1565			
Between communities	Ebedebiri	25	16.0 – 65.0	34.56 ±10.80	13.0 - 18.5	14.85±1.42	0.0071	3.14	0.8924	1.03±0.10	W=0.0071L^3.1357	0.195*	0.189*	0.462*
	Angalabiri	25	10.0 - 48.0	30.60 ± 10.81	10.0 – 17,1	14.27±1.69	0.0067	3.15	0.9471	1.01±0.09	W=0.0067L^3.1515			
	P-Value						0.016	0.003	0.854					
Both sexes of Pooled Communities	Male	30	16.0 - 65.0	36.53 ±10.68	12.4 - 18.5	15.21±1.42	0.0048	3.28	0.9405	1.01±0.08	W=0.0048L^3.2750	0.0001**	0.001**	0.382*
	Female	20	10.0 - 46.0	26.65 ± 8.11	10.4 – 16.3	13.59±1.27	0.0051	3.27	0.8824	1.03±0.11	W=0.0051L^3.2711			
	P-Value						0.020	0.003	0.855					
Sexes Within Ebedebiri Community	Male	16	23.0 – 65.0	38.25 ±10.59	13.5 – 18.5	15.4 ± 1.30	0.0054	3.23	0.9457	1.02±0.07	W=0.0054L^3.2311	0.02**	0.005**	0.618*
	Female	9	16.0 – 46.0	28.11 ± 8.12	13.0 - 16.3	13.8 ± 1.04	0.0046	3.30	0.7116	1.04±0.14	W=0.0046L^3.3042			
	P-Value						0.925	0.409	0.430					
Sexes Within Angalabiri Community	Male	14	16.0 – 48.0	34.57 ±10.82	12.4 - 17.1	14.97±1.57	0.0047	3.28	0.9348	0.99±0.09	W=0.0047L^3.2769	0.030**	0.016**	0.415*
	Female	11	10.0 – 38.0	25.45 ± 8.29	10.4 – 15.6	13.3 ± 1.45	0.0052	3.36	0.9527	1.02±0.09	W=0.0052L^3.3610			
	P-Value						0.927	0.411	0.505					

** Highly significant * not significant

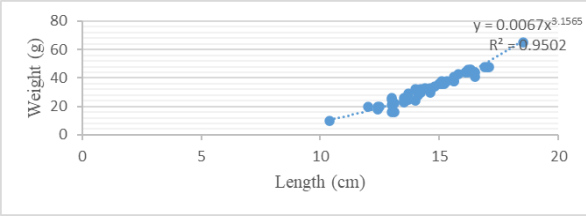

Fig 1: LWR of *S. batensoda* of Pooled Communities.

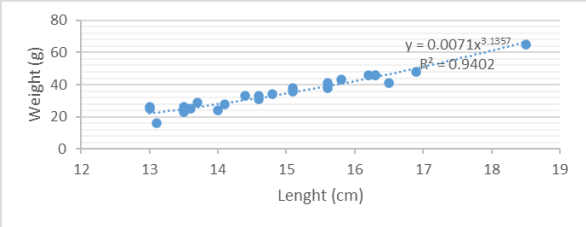

Fig 2: LWR of *S. batensoda* of both Ebedebiri Community.

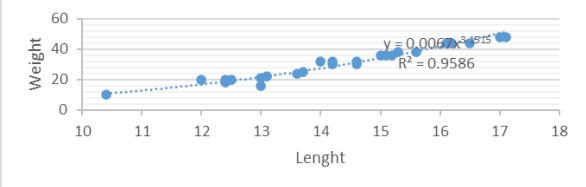

Fig 3: LWR of *S. batensoda* of Angalabiri Community.

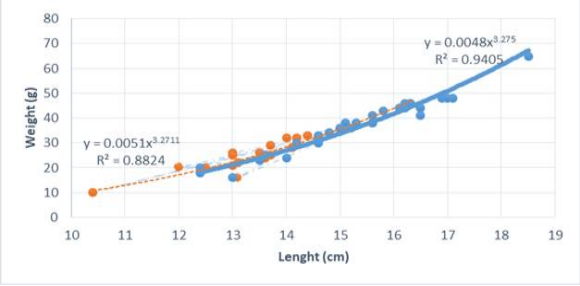

Fig 4: LWR of Male (blue line) and Female (orange line) *S. batensoda* of Pooled Communities.

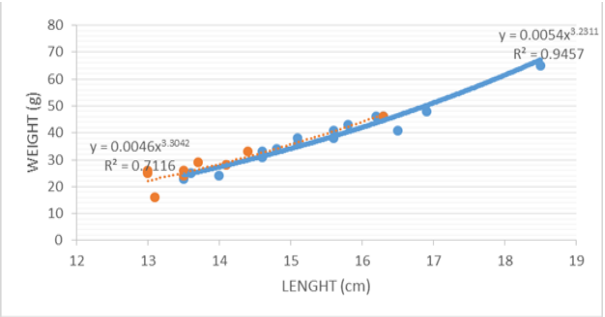

Fig 5: LWR of Male (blue line) and Female (orange line) *S. batensoda* of Ebedebiri Community.

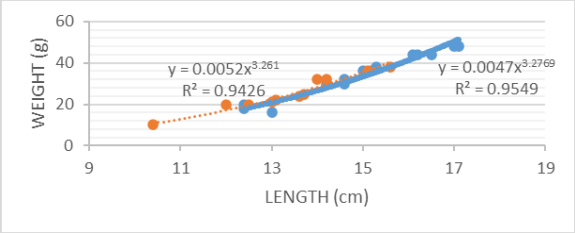

Fig 6: LWR of Male (blue line) and Female (orange line) *S. batensoda* of Angalabiri Community.

Dienye *et.al*. (2020) observed a range of 1.09-1.42 in their study of *Brycinus nurse* from New Calabar River. In this study, females had slightly higher K values than the male but were not significantly different within/between communities (P>0.05). This agrees with the findings of Akombo *et.al.* (2014) in their study of *S. schall* in River Benue but in contrast with Midhat *et.al*. (2012) who reported male in their study of S. schall of River Nile had better condition factors. Komolafe and Arawomo (2011) stated that K value greater than 1 signifies that the current habitat of fish population are in good condition.

CONCLUSION

The length-weight relationship of *S. batensoda* of River Forcados was estimated, an important tool for fisheries management especially for species that are red listed under the IUCN list of threatened species. The findings of this study also provides necessary information on *S. batensoda* well-being in Forcados River as indicated by the condition factor which was above 1 (K>1), signifying a good habitat condition for the fish. A positive allometric growth pattern was obtained with a very strong length and weight relationship. This study will be useful to fisheries scientists and conservationists in the management, production, sustainability and conservation of the fish that is already red listed as Least Concern (LC) in IUCN list. This study is the first of *S. batensoda* in River Forcados, therefore, there is need for further study to be conducted during dry period in order to provide an ample information on the fish biology.

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