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Length-Weight Relationship of the Reed Fish, Erpetoicthys Calabaricus (Smith, 1866) In Ibikpe Creek

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ABSTRACT

Background and Objective: *Considering the "near threatened" status of E. calabaricus, consequent upon habitat degradation from anthropogenic perturbations, and total lacuna of literature and data on the growth and reproductive biology of the species, there was dire need to research on aspects of its ecology. Thus, this study was carried out in other to compute data on length weight relationship the species.* **Materials and Methods**: *Six hundred and thirty four specimens were analyzed. Fish samples were obtained by sampling bi-monthly between April, 2013 and March, 2014. Samples were immediately preserved in 10 % formalin solution for laboratory analysis. Specimens were measured with a measuring board (scaled to ± 1 mm) to the nearest 0.1 cm to obtain total length (TL) and standard length (SL) and weighed on a top loading electronic meter balance (scaled to ± 0.01 g) to the nearest 0.00l g to obtain total weight (TW). The length-weight relationship was computed using the formular (TW = a (TL) ^{b}. Values of a and b were estimated by least square linear regression analysis using double-log transformed on length and weight data according to the formular: Log TW = log a + b log TL. Parameters of this relationship were computed for each sex, month and season.*

Results: *Regression analysis showed positive correlation between total length and total weight ($r = 0.8931$, $p < 0.001$) with an exponential relationship thus: TW = 0.004645 TL $^{2.6903}$accounting for variation (r^2) in weight. The value of the length exponent (2.6903) in the length-weight regression which was different from the standard cube (3) value indicated negative allometric growth.*

Conclusion: *Findings suggests that as the fish increases in length, the body shape becomes "thinner" due to the negative impact on its environment.*

Keywords: *Length-weight, regression, allometric, relationship, seasonal, analysis*

INTRODUCTION

Fishes of tropical water systems are known to experience growth fluctuations due to the physical and chemical properties of the aquatic medium[1, 2]. Growth in fish could be measured in length as well as in weight[3]. Fish growth has also been described as the change in absolute weight (energy content) or length of fish over time[4], while[1] summarized growth as a function of fish size. Length-weight relationship of fish also known as growth index is an important management tool used in estimating the average weight at a given length growth[5]. It is widely used in fisheries biology for several purposes such as estimating the mean weight of fish based on known length[6, 7]. Growth in fishes can be evaluated from morphometric parameters relative to total length and length-weight relationship which are used in inter-specific and intra-specific population comparisons to assess index of well-being of the fish populace[8].

Comprehensive knowledge of growth and reproduction of fish populations is important for increased fish production in natural waters and aquaculture. Growth parameters are important in the selection of fishes for culture and in estimating food consumption of fish populations[9]. The LWR is very important for proper exploitation and management of the population of fish species[10]. LWR provides valuable information on the habitat where the fish lives[11] and is very critical in modeling and re-structuring aquatic ecosystems[12]. Fish can attain either isometric growth, negative allometric growth or positive allometric growth. Isometric growth is associated with no change of body shape as an organism grows[13]. Negative allometric growth implies that the fish becomes

more slender as it increase in weight while positive allometric growth depicts the fish becomes relatively stouter or deeper-bodied as it increases in length[14]. Knowledge on distribution, abundance, well-being and reproductive potential of the study fish is deficient and consequently the species is poorly understood and its future sustainability is unpredictable having being declared "near threatened"[15]. There is paucity of data on growth attributes of the species. The present work attempts to present base line data on length weight relationship of this near threatened fish species.

MATERIALS AND METHODS

Study Area

The study was conducted from April 2013 – March, 2014 in Ibikpe creek (Figure 1) situated (latitude 05^0 6´N and longitude 08^0 11´E) within the rainforest zone of South-eastern Nigeria, located west of the lower reaches of the Cross River System. The creek is a perennial forest tributary system and drains a catchment area of 318.9 km^2 into the Cross River system, thus forms part of the Atlantic drainage system east of the Niger. The area is considerably shaded by overwhelming canopy of riparian vegetation mostly *Elaeis guinensis, Raphia hookeri, R. venifera* and other tropical forest trees. Aquatic macrophytes are mainly *Nymphaea, Vossia and Musanga crinium sp.* The area comprises dry (November - March) and wet (April - October) seasons[16, 17, 18].

Field Sampling and Measurements

Samples of *E. calabaricus* were collected from designated fishers bi-monthly between April, 2013 and March, 2014 by means of non-return valve basket traps (baited with palm fruits) set on the flood tides, at three locations which were located 2-7 m deep and 10 m close to the shore; where there were relatively dense macro phyte vegetation at low tides and retrieved before high tides. Traps were 42-50 cm in length, 14 - 17 cm diameter of opening with mesh sizes of 0.2 - 0.5 cm.

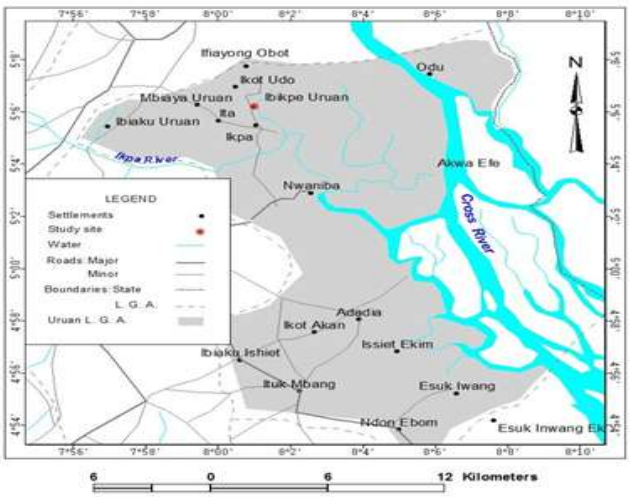

Figure1. *Location of study area on Map of Uruan Local Area*

(Source: Google earth map)

Solution for further analysis and transported to Fisheries Laboratory. Specimens were measured with a measuring board (scaled to ± 1 mm) to the nearest 0.1 cm to obtain total length (TL) and standard length (SL) and weighed on a top loading electronic meter balance (scaled to ± 0.01 g) to the nearest 0.00l g to obtain total weight (TW).

The length-weight relationship was computed using the formular[19]: $TW = a (TL)^b$ ----Eqn. 1; where, TW = total weight of fish, TL = total length of fish, a and b is the constants. The values of a and b were estimated by least square linear regression using double-log transformed weight and length data according to the formula: Log TW = log a + b log TL -- Eqn.2. The length weight relationship was computed and determined using linear regression analysis.

RESULTS

Length-Weight Relationship (Overall Pattern)

Length frequency distribution of females and males of *E. calabaricus* Samples were immediately preserved in 10 % formalin showed no marked difference. Both sexes occurred over the entire range of body size except the 36 cm and 37 cm groups where

females were absent. The largest fish (TL $_{max}$) examined was 39.9 cm TL female, while the smallest fish (TL $_{min}$) was 21 cm TL male (Figure 2).Table 1 shows comparison of weights of similarly-sized females and males of E. calabaricus in Ibikpe creek

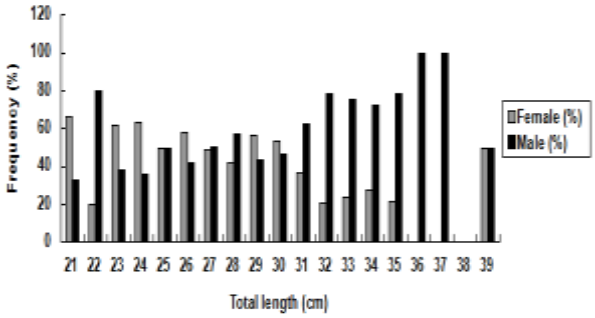

Figure2. *Length-frequency distribution of E. calabaricus in Ibikpe creek*

Table1. *Comparison of weights of similarly-sized females and Males of E. calabaricus in Ibikpe creek*

	Females			Males		
	N	**min - max**	**mean**	**N**	**min - max**	**mean**
23.0	3	19.17 - 21.50	37.53	3	17.58 - 19.24	18.28
24.0	5	22.27 - 26.27	24.31	5	18.67 - 29.01	23.48
25.0	7	24.37 - 33.40	27.48	7	21.62 - 30.13	26.17
26.0	7	24.74 - 31.51	28.48	7	25.69 - 32.73	28.78
27.0	9	29.24 - 44.70	36.15	9	27.29 - 35.26	31.25
28.0	13	32.75 - 46.78	38.82	13	29.37 - 40.08	34.44
29.0	11	32.71 - 52.01	44.50	11	31.12 - 43.49	37.19
30.0	12	46.26 - 60.81	51.72	12	34.71 - 52.43	42.65
31.0	5	48.02 - 61.72	55.20	5	38.00 - 53.45	47.89
32.0	4	44.95 - 63.61	56.05	4	48.63 - 59.73	55.23
33.0	3	60.11 - 75.33	68.92	3	61.01 - 64.60	62.75
34.0	4	49.40 - 69.44	60.92	4	54.99 - 65.75	61.04
35.0	2	56.16 - 72.80	64.48	2	66.96 - 67.10	67.03

There was positive correlation between total length and total weight ($r = 0.8931$, $p < 0.001$) with an exponential relationship thus: $TW = 0.004645\ TL^{2.6903}$ (Figure 3). The value of the length exponent (2.6903) in the length-weight regression indicates negative allometric growth, suggesting that as the fish increases in length, the body shape becomes “thinner”.

Monthly and Seasonal Variations in Length-Weight Relationship

E.calabaricus exhibited negative allometric relationship (Table 2). Correlation for LWR was positive for both seasons. Exponential equations were TW = 0.00735 TL 2.555, (wet season) and TW = 0.00248 TL 2.8772. (Dry season). Monthl y LWR coefficients are shown in Table 3 (fem ale) and Table4 (male). **TW = 0.004645 TL2.6 90**

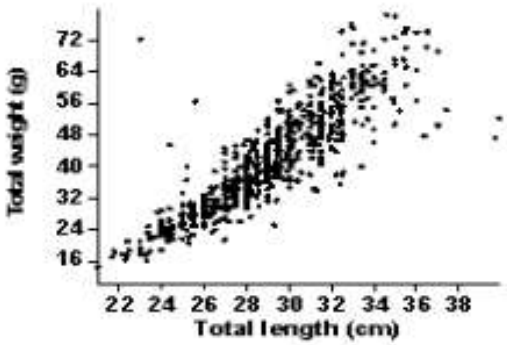

Figure3. *Length-weight relationship of E. calabaricus in Ibikpe creek*

Table2. *Monthly relationship between total length and Total weight (overall) of E. calabaricus in Ibikpe creek*

Month	N	Size-range	Regression Equation
Apr	34	21.0 – 35.2	Log TW = 0.00135 Log TL $^{3.0518}$
May	61	24.1 – 36.5	Log TW = 0.00500 Log TL $^{2.6814}$
Jun	58	25.0 – 37.4	Log TW = 0.01877 Log TL $^{2.2852}$
Jul	61	23.0 – 34.2	Log TW = 0.00217 Log TL $^{2.9179}$
Aug	62	26.2 – 39.9	Log TW = 0.01360 Log TL $^{2.7038}$
Sep	61	21.7 – 39.7	Log TW = 0.00914 Log TL $^{2.4985}$
Oct	61	23.0 – 33.6	Log TW = 0.00182 Log TL $^{2.9665}$
Nov	63	23.3 – 36.0	Log TW = 0.00307 Log TL $^{2.8235}$
Dec	60	22.2 – 33.7	Log TW = 0.01000 Log TL $^{2.4531}$
Jan	58	22.3 – 32.5	Log TW = 0.01302 Log TL $^{2.3461}$
Feb	39	21.8 – 31.5	Log TW = 0.00240 Log TL $^{2.8425}$
Mar	16	22.5 – 33.5	Log TW = 0.00127 Log TL $^{3.1065}$

Table3. *Monthly relationship between total length and total Weight of female E. calabaricus in Ibikpe creek*

Month	N	Size-range	Regression Equation
Apr	15	26.0 – 35.2	Log TW = 0.001251 Log TL $^{3.0895}$
May	27	24.1 – 34.0	Log TW = 0.000470 Log TL $^{3.4103}$
Jun	24	27.5 – 34.0	Log TW = 0.003523 Log TL $^{2.7812}$
Jul	24	24.5 – 33.5	Log TW = 0.001538 Log TL $^{3.0421}$
Aug	25	26.2 – 39.9	Log TW = 0.024238 Log TL $^{2.5405}$
Sep	23	21.2 – 35.0	Log TW = 0.005022 Log TL $^{2.7035}$
Oct	33	23.0 – 32.5	Log TW = 0.000809 Log TL $^{3.2248}$
Nov	25	23.3 – 33.5	Log TW = 0.002588 Log TL $^{2.8933}$
Dec	29	23.4 – 31.2	Log TW = 0.003517 Log TL $^{2.7880}$
Jan	25	22.3 – 31.2	Log TW = 0.018000 Log TL $^{2.2467}$
Feb	21	21.8 – 31.5	Log TW = 0.000835 Log TL $^{3.2210}$
Mar	8	26.3 – 33.4	Log TW = 0.004374 Log TL $^{2.7650}$

TW – total weight, TL – total weight

Table4. *Monthly relationship between total length and total Weight of male E. calabaricus in Ibikpe creek*

Month	N	Size-range	Regression Equation
Apr	19	21.0 – 35.0	Log TW = 0.001112 Log TL $^{3.0982}$
May	34	24.5 – 36.6	Log TW = 0.006763 Log TL $^{2.5757}$
Jun	34	25.0 – 37.4	Log TW = 0.019765 Log TL $^{2.2660}$
Jul	37	23.0 – 34.2	Log TW = 0.001974 Log TL $^{2.9347}$
Aug	37	26.5 – 37.7	Log TW = 0.045572 Log TL $^{2.0136}$
Sep	38	23.0 – 39.7	Log TW = 0.005573 Log TL $^{2.6291}$
Oct	28	23.0 – 33.6	Log TW = 0.002141 Log TL $^{2.9053}$
Nov	38	25.0 – 36.0	Log TW = 0.002305 Log TL $^{2.8967}$
Dec	31	22.2 – 33.7	Log TW = 0.008180 Log TL $^{2.5045}$
Jan	33	22.4 – 32.5	Log TW = 0.010891 Log TL $^{2.4001}$
Feb	18	22.4 – 30.8	Log TW = 0.008657 Log TL $^{2.4948}$
Mar	8	22.5 – 33.5	Log TW = 0.003122 Log TL $^{3.0962}$

TW – total weight, TL – total weight

DISCUSSION

The monthly and seasonal patterns in the length-weight relationship of *E. calabaricus* in Ibikpe creek revealed that the length exponents did not approximate the standard cube value of the length. The overall regression coefficient b = 2.6903 connoted a negative allometric growth in the fish, suggesting that as the fish increased in size, body shape became "thinner". The result of this study agrees with the findings of[20] who reported a regression coefficient of b = 2.66 on same species from Iba - Oku stream, Nigeria. But however, this study disagrees with the b value of 2.55 reported by[21] on the species from the wet lands of Ogun water side, Nigeria. The reason for this could be attributed to the differences in the geographical location of the sampling site and the overall ecological health of the ecosystems and should provoke further investigations on the species from other regions and environments.

Both females and males showed negative allometry (b=2.8902) and (2.7078), respectively. Length-weight relationship is commonly used to

predict the potential yield and determination of size at capture for obtaining optimum yield[22, 23]. The regression coefficient (b-value) shows that the growth pattern in fish which varies between stocks of the same species is either isometric or allometric[24, 25]. When "b" value is less than 3, it's indicative of a negative allometric growth, when greater than 3, a positive allometric growth and when "b" value is equal to 3, its indicative of an isometric growth pattern in species[26]. The b-values obtained from this study for female, male and pooled population of *E. calabaricus* from Ibikpe creek exhibited a negative allometric growth pattern. As documented by[24, 27], species exhibiting a negative allometric growth pattern tends to become thinner as its increase in length. The author also posited that when a fish species exhibit a negative allometric growth pattern, some conventional population dynamic models which assumes isometry in fish growth (b = 3) cannot be useful in analyzing the population of such species.

The LWR was positively correlated during the wet and dry seasons. From length-weight parameters (a, b), fishes are affected by a series of factors such as season, habitat, gonad maturity, sex, diet, stomach fullness, health, preservation technique and annual differences in environmental conditions[28]. Such differences in "b" values can be ascribed to one or a combination of factors including differences in the number of specimens examined, area and seasonal effects as well as distinctions in the observed length ranges of the specimen caught to duration of sample collection added as well[29]. The "b' values = 2.6903, 2.8902 and 2.7078 for overall, females and males, respectively showed that the rate of increase in body length was not proportional to the rate of increase in body weight, when compared with the cubic value (3). Findings of the present study may be used in predicting potential yield and size at capture of the species for optimum development and sustainability in the future. This work recommends further research of this parameter and other parameters of this near threatened species before the fish goes into complete extinction.

Conclusion

The present study has presented baseline first hand in-depth data on length-weight relationship of *E. calabaricus* in Ibikpe where there was none, including other water bodies. The continuous disappearance of this species could be attributed to environmental factors and other natural causes threatening the species and its ecology. Further studies might determine other parameters such as food and feeding habits, sex ratio, condition factor, population dynamics and fecundity of the species.

Significant Statement

The study discovered that body condition of *E. calabaricus* species was impaired at Ibikpe creek. Which consequently affected its growth in length and weight? Knowledge of this aspect of the growth biology of the species proffered by this research would to a large extent help other researchers determine the commercial productivity and population's resilience to exploitation or perturbation from human activities. Therefore, this study would form a mile stone and foundation on other parameters that would be further researched on the species.

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This work was carried out in collaboration between all authors. The first author designed the study, wrote the design and first drafts of the manuscript. Second author performed literature searches of the study. All authors read and approved the final manuscript.

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