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Length-Weight Relationship, Length Frequency Distribution and Condition Factor of the Shiny Nose *Polydactylus quadrafilis* (Cuvier, 1829) From the Cross River Estuary, Nigeria

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ABSTRACT

This study was carried out to evaluate the length-weight relationship, length frequency distribution and condition factor of the Shiny Nose *Polydactylus quadrafilis* from the Cross River estuary, Nigeria. A total of 350 freshly caught specimens of *P. quadrafilis* were collected between April 2012 and March 2013 from the catches of the artisanal fisheries from major landing points of the estuary. Results obtained showed a negative allometric growth pattern for this fish species with a significant linear relationship given by the equation: TW= $0.1325TL^{2.1884}$ and Log TW = 2.1884LogTL – 0.8777 (r = 0.8610, r^2 = 0.7413t, n = 350, P< 0.05, df = 348). The length frequency distribution of *P. quadrafilis* showed a unimodal class size distribution with the highest length frequency in 20.1cm -25 cm length class (291), followed by 25.1 cm -30.0 cm (32) and lowest (27) in 15.1cm – 20.0 cm respectively. Fulton's condition factor (K) ranged between 0.579 to 1.650 with a mean 1.075 ± 0.15, indicating that *P. quadrafilis* were in good physiological health condition. In conclusion, the baseline data on length-weight relationship, condition factor and length-frequency distribution of *P. quadrafilis* from the Cross River estuary provided in this study is crucial in the sustainable management of this species in the estuary. Also, these findings will be useful in evaluating the population dynamics, stock and the aquaculture potential of *P. quadrafilis* for future purpose.
Keywords: *Polydactylus quadrafilis*, Length-Weight Relationship, Length Frequency Distribution, Condition Factor and Cross River Estuary

I. INTRODUCTION

The Shiny Nose or Giant African Threadfin, *Polydactylus quadrafilis* commonly called "Edeng" by the Ibibio and Efik tribes in Nigeria belongs to the family polynemidae and is one of the important food fish for the inhabitants of the Cross River Estuary. Its size, taste and meat quality makes it highly valued by consumers and is used in both local and continental dishes in smoked or fresh form. *P. quadrafilis* is also dominant species in the catches from other major rivers in Nigeria and Africa. Length-weight relationship (LWR) of fish is an important growth index used as a sustainable management tool in fisheries science. According to Abowei and Davies [1], length-weight relationship (LWR) is vital in estimating the average weight of fish at a given length group. Length-weight relationship data (LWR) are very useful in growth rate estimation. According to Kolher *et al.*, [2], LWRs are needed to estimate length and age structures. Fisheries scientists also apply length-weight relationships to convert growth in-length equations to growth-in-weight in stock assessment models [3] and [4], and also to estimate biomass from length frequency distributions [5]. Length-weight relationship data (LWR) are also used in comparing life history and morphological aspects of fish populations inhabiting different regions [4]. Length frequency distribution of fishes are fundamental to different aspects of fisheries science. It provides deep knowledge on the size structure of natural fish population. According to Andem *et al.,* [6], it is the first step in the evaluation of gear selectivity of catches from different gears used in the same water. Condition factor has been used in fisheries science as an index of growth and feeding intensity [7]. The importance of condition factor in fisheries science is related to growth, health status and feeding intensity in various fish species [8]. Bagenal and Tesch [9] hypothesized that heavier fish of a given length are in better condition. Condition factor helps in understanding the life cycle of fish species and it also crucial in management of the species, hence maintaining the equilibrium in the ecosystem [10]. In the Cross River estuary, information of some aspect of the biology of *P. quadrafilis* which could be useful in the sustainable exploitation of this species is lacking. Therefore, the objective of this study is to determine the length-weight relationship, condition factor and length frequency distribution of *P. quadrafilis* in the Cross River estuary, Nigeria.

Plate 1: The Giant African threadfin, *Polydactylus quadrafilis* from the Cross River Estaury, Nigeria

II. METHODS AND MATERIAL

Study Area Description

The Cross River estuary, Nigeria lies approximately between latitude 4° and 8° N and longitude 7 °30 and 10 °E in the southern part of Nigeria. It flows from the Cameroon Mountain and meanders westwards into Nigeria and then southward through the rainforest before discharging into the Atlantic Ocean at the Gulf of Guinea. The study area is characterized by mangrove forest vegetation [11]. The climate of the study area is now characterized by long wet season from April to November and a dry season from December to March with a mean annual rainfall of about 2000 mm. There is a short dry period which occurs in August, known as August break. Between December and January, there is a cold, dry and dusty period known as the harmattan season. In the wet season, Temperatures range from 22ºC in the wet to 35ºC in the dry seasons.

Collection and identification of the Giant African Threadfin (*P. quadrafilis*) from the Cross River estuary

A total of three hundred and fifty (350) freshly caught *P. quadrafilis* were collected between April 2012 and March 2013 from the catches of the artisanal fisheries at Nsidung beach, Obufa Esuk, and Esuk Atu, Calabar, which are the major landing point of the artisanal fisheries of the Cross River estuary. Fish samples were transported in ice-packed containers to the Fisheries and Aquaculture laboratory, Institute of Oceanography, University of Calabar, for identification and biometric measurement [12]. Identification of *P. quadrafilis* was done using identification key given by Fischer *et al.,* [13] and Schneider [14].

Measurements of biometric indices

Biometric parameters measured for each specimen were Total length (TL-cm) and Total weight (TW-g). Total length (TL-cm) was measured using from the tip of the mouth to the end of the caudal fin to nearest 0.1 cm using measuring board. Total weight (TW-g) was measured to the nearest 0.1 g using Metlar-2000D electronic weighing balance [15].

Condition factor (K)

Fulton's condition factor (K) of *P. quadrafilis* was calculated using Pauly [16] equation, $K = 100W/L^3$, where W is the total weight (TW-g), L is the Total length (TL-cm) and 3 is a constant.

Length-Weight Relationship

Length weight relationship of *P. quadrafilis* was estimated using Pauly [16] equation as follows:

$$W = aL^b$$

Where W is the Total weight (TW-g), a is the intercept, L is Total length (TL-cm) and b is the slope. The parameters a (intercept) and b (slope) were estimated by linear regression based on logarithms using the linear regression routine of Microsoft Office Excel in PC, windows (2010) as follows: Log (W) = Log (a) + b Log (L)

Where W = Total weight of *P. quadrafilis* in grams, L = Total length of *P. quadrafilis* in cm. Departure from isometry (i.e. b = 3) for the exponent (b) of the length-weight relationship was tested using a t-statistic function according to Pauly [16] as follows :

$$t = \frac{s.d.(x)}{s.d.(y)} \cdot \frac{|b-3|}{\sqrt[2]{1-r^2}} \cdot \sqrt[2]{n-2}$$

Where s.d. (x) is the standard deviation of the Log L values, and s.d. (y) is the standard deviation of Log W values, n is the number of samples used in the computation, b is the estimated exponent of the LWR and r^2 is the correlation coefficient of the relationship. According to Pauly [17], the value of b is significantly different from 3 if t- calculated is greater than t-tabulated for the degree of freedom, n – 2.

Length Frequency Distribution

Data obtained from the Total length measurement of 350 specimens of *P. quadrafilis* were distributed into three length classes of 5 cm interval. A bar chart was plotted using Microsoft excel version 2010 to show the variation of length frequency distribution of *P. quadrafilis* from the Cross River estuary.

Statistical Analysis

Values of regression coefficient 'b' intercept 'a' and coefficient of correlation 'r' in Length-Weight relationship (LWR) of *P. quadrafilis* from the Cross River estuary were determined by linear and power regressions.

III. RESULTS AND DISCUSSION

RESULTS

Fulton's Conditon Factor (K) of *P. quadrafilis* from the Cross River estuary

Fulton's condition factor (K) determined for three hundred and fifty (350) specimens of *P. quadrafilis* (Table 1) collected from the Cross River estuary ranged between 0.579 for fish with total length (24.2 cm) and total weight (82.0 g) to 1.650 for fish with total length (20.2 cm) and total weight (136.0 g) with a mean and standard deviation value of 1.075 ± 0.15.

Table 1: Fulton's Condition Factor (K) of the Giant African Threadfin (*P. quadrafilis*) from the Cross River estuary

Range of Condition Factor (K)	Mean Condition Factor (K)
0.579 – 1.650	1.075 ± 0.15

Length-Weight Relationship of the Giant African Threadfin (*P. quadrafilis)* From The Cross River Estuary

Length-weight relationship of the Shinny Nose (*P. quadrafilis)* from the Cross River Estuary as shown in figure 1 is given by the equation: $TW = 0.1325TL^{2.1884}$ (r = 0.8610, r^2 = 0.7413, n = 350, P<0.05). There was a significant linear relationship between total length and total weight of *P. quadrafilis*. However, t-statistic indicated that the value of b (2.1884) is significantly different from 3. The equation for the logarithmic plot of total weight against total length for *P. quadrafilis* from the Cross River Estuary as shown in figure 2 is as follows: Log TW = 2.1884 Log TL - 0.8777 (r = 0.8610, r^2 = 0.7413, n = 350, P<0.05).

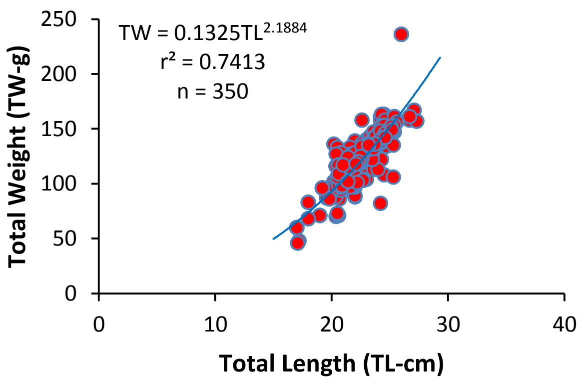

Figure 1: Length-Weight Relationship of the Giant African Threadfin *P. quadrafilis* from the Cross River Estuary, Nigeria

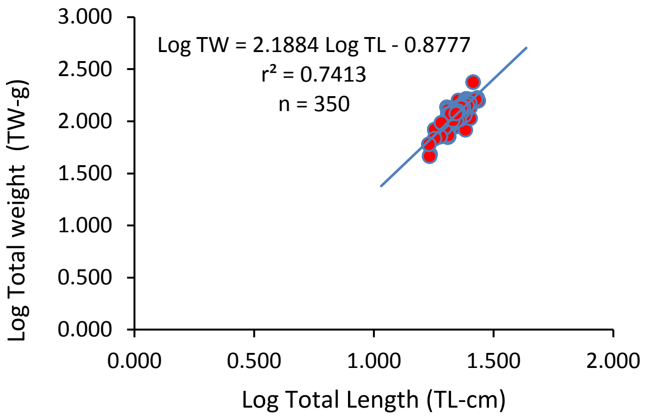

Figure 2: Log-Log transformation graph of Length-Weight of the Giant African Threadfin (*P. quadrafilis* from the Cross River Estuary

Length Frequency Distribution of the Giant African Threadfin (*P. quadrafilis*) from the Cross River Estuary

The length frequency distribution of *P. quadrafilis* from the Cross River estuary (Table 2 and Figure 3) showed that the highest length frequency was in 20.1cm -25 cm length class (291), followed by 25.1 cm -30.0 cm (32) and lowest (27) in 15.1cm – 20.0 cm respectively.

Table 2: Length Frequency Distribution of the Giant African Threadfin (*P. quadrafilis*) from the Cross River Estuary

Length Class (cm)	Frequency
15.1cm -20.0 cm	27
20.1cm -25cm	291
25.1cm -30cm	32
Total	**350**

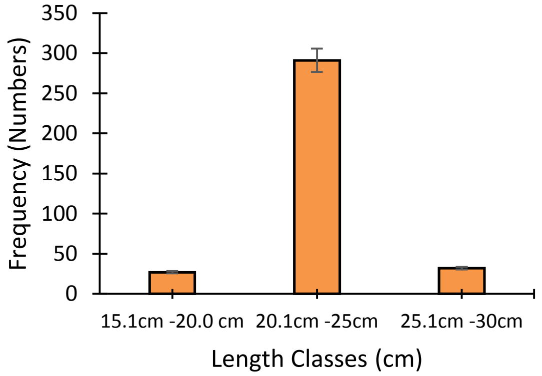

Figure 3: Length Frequency Distribution of the Shinny Nose (*P. quadrafilis*) from the Cross River Estuary

DISCUSSION

In fisheries science, length- weight relationship is useful in providing reliable data on the relative well-being and growth patterns of fish [8]. In length-weight studies, the regression coefficient (b-value) indicates the growth pattern in fish (isometric or allometric) which is reported to vary between stocks of same species [8] and [18]. When 'b' value is less than 3, it indicates a negative allometric growth in fish, when greater than 3, it indicates a positive allometric growth and when 'b' value is equal to 3, it indicates an isometric growth pattern in fish [19]. Deviation from isometric growth is commonly observed in most aquatic organisms which changes shape as they grow [20]. In the present study, values obtained for the length –weight relationship parameters (b=2.1884, a = 0.8777), indicates that *P. quadrafilis* from the Cross River Estuary exhibit a negative allometric growth pattern. This finding is similar to results obtained by Kumolu-Johnson and Ndimele [21] who reported a negative allometric growth pattern (b = 2.860) for *P. quadrafilis* collected from Ologe Lagoon, Lagos, Nigeria. Also, similar findings was reported by Lawson and Olagundoye [22] for *P. quadrifilis* (b = 2.27 for males and 2.92 for females from Badagry creek, Nigeria. According to [11] and [8], fish exhibiting a negative allometric growth pattern tends to become thinner as they increase in length. Asuquo et al., [8] explained that when fish species exhibit a negative allometric growth pattern, some conventional fish population dynamic models which assumes isometry in fish growth (b = 3) cannot be useful in analyzing the population of such species. Findings of this study agrees with findings of King [23] who reported a negative allometric growth pattern function for some Nigerian freshwater fishes and Torres [24] who also reported a negative allometry (b<3) in multi-species study. Results of this study indicates that growth parameters vary according to species and water bodies. Abowei and Hart [25] reported a positive allometric growth (b=3.6 and 3.5) for *S. maderensis* and *Cynoglossus senealensis* in a typical tropical water. Earlier, Olurin and Soluba [26] reported an allometric growth pattern in three Cichlids (*C. guntheri, T. mariae and Hemischromis fasciatus*) in Owa stream, South-West, Nigeria. According to Lagler *et al.*, [27], such variations in growth parameters documented for different fish species could be attributed to sex, maturity, developmental stage, season and harsh environmental conditions. Froese [28] opined that length-weight parameters of fish are influenced by both intrinsic and extrinsic factors such as diet, season, stomach fullness, health, preservation techniques, habitat, sex, gonad maturity and annual variation in environmental conditions. Also, 'b' value in fish can be affected by sample size, habitat suitability, fishing activities, individual metabolism, age and maturity [29], [30], [31], [32] and [33]. In this study, the high correlation coefficient (r) obtained for *P. quadrafilis* (0.8610) indicates a strong association between the total length and total weight of the fish [6]. Condition factor is an important index used in fisheries science to ascertain the relative well-being of fish species. Condition factor which could be used to reflect the health status of water bodies is influenced by factors such as age, sex, food availability, and environmental conditions. Low condition factor in fish may be attributed to poor environmental conditions and reduced availability of food and prey items [25] and [34]. The ranged of condition factor for *P. quadrafilis* in this study was between 0.579 to 1.650 with a mean of 1.075 ± 0.15 and this indicates that the fish were in healthy condition. In this study, the length frequency distribution of *P. quadrafilis* showed a unimodal class size distribution was highest length frequency in 20.1cm -25 cm length class (modal class) with 291 individual, followed by 25.1 cm -30.0 cm with 32 individuals and lowest in 15.1cm – 20.0 cm with 27 individuals. According to Andem *et al.*, [6], length frequency distribution is crucial in growth and age determination in fish. The length composition of a population is reported to exhibits modes among species with short spawning period and a fast and uniform growth, from which the modal length of the first few age groups could be determined easily [35].

IV. CONCLUSION

It could be concluded that the baseline data on length-weight relationship, condition factor and length-frequency distribution of *P. quadrafilis* from the Cross River estuary provided in this study is crucial in the sustainable management of this species in the estuary. Also, these findings will be useful in evaluating the population dynamics, stock and the aquaculture potential of *P. quadrafilis* for future purpose.

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