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Length-weight Relationships and State of Well-being of *Parachanna obscura* Gunther1861, in Eleyele Reservoir, Southwestern Nigeria

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Abstract

The knowledge of length-weight relationship parameters has numerous practical applications in fishery research and management. However, there is currently dearth of information on the growth pattern and state of well-being of *Parachanna obscura* in Eleyele Reservoir. This study therefore investigates the allometry and condition factor of *P. obscura* inhabiting the Eleyele Reservoir, Southwestern Nigeria. 688 specimens of *P. obscura* were collected from artisanal fishers' at their landing sites on a bimonthly basis for 24 months. Standard Length (SL, cm), and Body Weight (BW, g) were measured. Length-Weight Relationships (b>3 or <3-allometric; b=3-isometric), and condition factor (K) were calculated using standard formula. Data were analysed using descriptive statistics and ANOVA at α0.05. The SL and BW of *P. obscura* ranged from 10.6 to 39.2 and 15.3 to 830.5 respectively. The LWR were 3.04 (male) and 2.99 (female) indicating positive allometric pattern of growth in male and negative allometric growth in female. The growth coefficient b ranged between 2.877 in July and 3.348 in May, with very significant coefficient of determination r^2 for all the months. Variations recorded in the b value of different size groups showed positive allometric growth in 10.1 cm -15.0 cm, 15.1 cm -20.0 cm and 20.1 cm -25.0 cm, but negative allometric growth in 25.1 cm -30.0 cm and 30.1 cm -40.0 cm. The maximum (1.54 ± 0.12) K was noticed during March 2016 and the minimum (1.30 ± 0.7) K in September 2015. Significant variation occurred in K with size groups. The mean K value in females (1.43 ± 0.21 and 1.44 ± 0.20) was higher than males (1.40 ± 0.18 and 1.42 ± 0.17) for 2014-2015 and 2015-2016, respectively. The results indicated that *P. obscura* were thriving very well in Eleyele Reservoir.

Keywords Eleyele reservoir; *Parachanna obscura*; Allometric growth

Introduction

Parachanna obscura, commonly known as African snakehead is a freshwater species belongs to the family Channidae and order Perciformes. African snakehead like other snakehead fishes is characterized by an elongated body, fusiform, sub cylindrical covered with cycloid scales of medium size (Figure 1). It also has a flattened head with large and protractile mouth. This fish is a natural inhabitant of ponds, streams, rivers, lakes, lagoons, marshes, floodplains and creeks of swamps [1,2]. It is a voracious pelagic carnivore, a formidable predator, a typical piscivorous, an insectivore and a consumer of crustaceans [3,4]. *Parachanna obscura* is an economically important fishery resource in Eleyele Lake. It is the most desirable fish species sought after *Gymnarchus niloticus*, for food and commercial purposes by majority of fishermen in Eleyele Reservoir. Also in recent times, it has got its entry into aquaculture and has been reported to be cultured in extensive farming in Nigeria, Cameroon, Gabon and Democratic Republic of Congo [5-7], Ivory Coast [8].

However, wild populations of this species has reportedly undergone decline in range and abundance due to over-exploitation and degradation of their habitat [9,10]. Hence, due to economic importance and concerns about their conservation, a detailed bionomic study was conducted for developing management measures for both aquaculture and wild fisheries. A better understanding of the life and growth parameters of the individual species is crucial for management of this freshwater fish. The length-weight relationship and condition factor of fish has got significant role in fishery management. This relationships can be used in estimating the average weight at a given length group [11] and in estimating the health status of the fish population [12]. Length and weight data provide statistics that are cornerstones in the foundation of fishery research and management. Anderson et al. [5] refer to length-weight data as basic parameters for any monitoring study of fishes, since it provides important information concerning the structures and function of population. In fishes, condition factor reflects through its variations and provides information on the physiological state of the fish in relation to its welfare.

However, scientific concerns about the sustainability of the African snakehead populations have led to several studies of the population biology and distribution of *P. obscura* in inland water bodies of Nigeria. Notable among these are the reports of [13] on reproductive biology, length-weight relationship and condition factor in River [14] on the biology from Anambra River [15] on some aspects of the reproductive biology in Itu-Cross river system and [16] on preliminary study on the aspects of the biology in flood plain of the Enyonk creek, Akwa-Ibom. There is dearth of information on growth pattern and well-being of *P. obscura* in Eleyele Reservoir. Hence, the absence of fishery data on this lake triggers the necessity to conduct this study. The major objective of the study is to investigate the growth pattern and condition factor of *P. obscura* in Eleyele Reservior.

Figure 1: African snakehead, *Parachanna obscura*.

Materials and Methods

Study area

This study was carried out in Eleyele Reservoir in North-west Local Government Area of Oyo State, Nigeria. Eleyele Reservoir lies between the latitude of 7025' 0" to 7026' 15" N and longitude of 3050' 45" to 3052' 15" E (Figure 2). It has a storage capacity of 29.5 million litres [17] an altitude of 125 m and catchment area of 323.7 km^2 (GKW, 2003). A number of stream channels serve as recharge streams to the Eleyele wetland basin. Major portion of Reservoir is lately dominated by submerged and free floating macrophytes. The location is surrounded by Eleyele neighbourhood in the South, Apete in the East and Awotan in the North. The occupation of the people includes fishing, farming, agro-processing, canoe construction, boat traffic, and trading. Also, there is presence of small scale industries around the Lake and some of these are Car mechanic workshops, Concrete blocks industries, Palm-wine shops and horticultural gardens. Artisanal fishers within the Reservoir mainly exploit the fisheries using wooden/dug-out canoes ranging in size from 2.5 m to 5 m long, mostly paddle by one man. The fisher used a wide range of fishing gear such as hook and line, long line, cast nets, gill nets and traps.

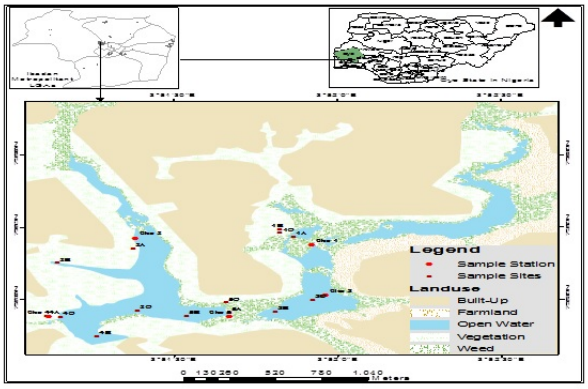

Figure 2: Map of Eleyele Reservoir with sampling distributions and land cover.

Fish sampling: 688 specimens of *P. obscura* comprising of 294 males and 394 females were collected from artisanal fishers and middlemen at their landing sites during November, 2014 to October, 2016. Total length and weight of the fishes were recorded to the nearest 0.1 cm and 0.01 g respectively. Sex was determined by macroscopic examination of the gonads. Total length was measured from the tip of the snout to the tip of the longest ray in the caudal fin [18] while standard length was measured from the tip of the snout to the caudal peduncle [19]. The fish Standard length and Body weight ranged from 10.6 cm to 39.2 cm and 15.3 g to 830.5 g, respectively.

The method implied was followed to compute the length and weight relationship. Accordingly, the length-weight relationship can be expressed as: W=aLb, the logarithmic transformation of which gives the well-known linear equation: log W=a+b log L. Where W and L are weight (g) and length (cm) of the fish respectively and 'a' and 'b' are two constants (initial growth index and regression constants respectively). Constant 'a' represents the points at which the regression line intercepts the y-axis and 'b' the slope of the regression line. The relationship between length and weight was determined for males and females separately by transforming the values of both variables to logarithmic values and fitting a straight line by the method of least square.

Condition factor K, a measure of the well-being or plumpness of fish was calculated according to the equation presented in Carlandar; K=W × 105/L^3. Where W is the weight of the fish in grams and length is the total length of the fish in centimetres. The number 105 is scaling factor when metric units are used (i.e. grams and centimetres) and is used to bring the value of K near unity. The fluctuation in LWR and condition were examined both seasonally and size wise.

Statistical analysis

The significance of regression was assessed by Analysis of Variance (ANOVA). The regression coefficient of the sexes was compared by analysis of Covariance (ANACOVA) [20] to establish the variations in the 'b' values, if any, between them. Bailey's t-test [21] was employed to find out whether 'b' value significantly deviated from the expected cube value of 3(t=(b-3)/Sb, where b is the regression coefficient, Sb is the standard error of 'b'). The t-test [22] on 'r' values reveals whether significant correlation exists between length and weight. SPSS version

2 and MS Excel 2007 software was used in analysing the data set. Graphs and charts were plotted with the use of MS Excel 2007.

Results

The logarithmic relationship between length and weight of males, females and pooled population of *P. obscura* together with correlation coefficient is depicted in Table 1 and Figures 3-5 respectively. The correlation coefficient 'r' between log length and log weight was found to be 0.971 in males, 0.983 in females, and 0.984 in pooled. The 't' test on 'r' values (Table 1) showed the existence of very good relationship between length and weight ($P<0.05$). The errors in the regression coefficients were highest in females indicating that more than one weight is obtained for a given length more frequently than in males while the errors were minimum in the case of males. The value of the regression coefficient 'b' in males, females and pooled were 3.04, 2.99 and 3.10 respectively, thus, manifested significant departure of 'b' value from 3 in all.

Months	n	a	b	r	r^2	b-3/SE(b)
Male	294	-1.901	3.04	0.971	0.985	-48.268*
Female	394	-1.838	2.99	0.983	0.965	-49.870*
Combined Sex	779	-1.924	3.1	0.984	0.969	-76.806*

n Sample size; a Intercept; b Regression coefficient; r Correlation coefficient; r^2 Correlation of determination; b-3/SE(b) t test; *Significant at 5%.

Table 1: Length-weight relationship of *P. obscura* population from Eleyele Reservoir.

The monthly statistics on length-weight relationship (LWR) of *Parachanna obscura* in Eleyele Reservoir are as shown in Table 2. The results indicated that LWR throughout the year were highly significant ($P<0.05$) with correlation coefficients (r) of the fishes greater than 0.9. The value of b also showed deviation from cube law throughout the year except October, where b was observed to be equal to 3 and growth of fish was isometric. However, positive allometric growth was observed for the rest of the months excluding July and November that showed negative allometric growth as b was less than 3. The growth coefficient was minimum in July (b=2.877) and maximum in May (b=3.348).

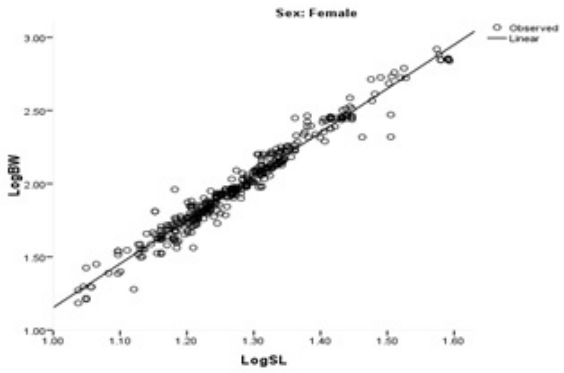

Figure 3: Length-weight relationship of female *P. obscura* in Eleyele Reservoir.

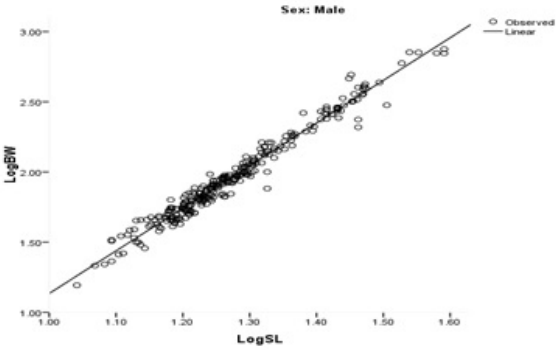

Figure 4: Length-weight relationship of male *P. obscura* in Eleyele Reservoir.

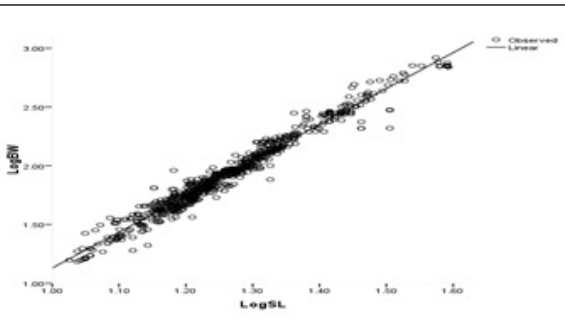

Figure 5 Length-weight relationship of combined sexes *P. obscura* in Eleyele Reservoir.

Table 3 present the parameters of LWR obtained among various length groups of *P. obscura* population for the study. Correlation coefficients (r) are ranged from 0.659 (25 cm to 30 cm) to 0.903 (15 cm to 20 cm) and all regressions were highly significant ($p<0.05$). The coefficient b ranged from 2.484 for 30.1 cm -40.0 cm to 3.424 for 20.1 cm -25.0 cm length groups.

Months	n	a	b	r	r^2	b-3/SE(b)
November	77	-1.791	2.947	0.982	0.965	-20.189*
December	67	-1.925	3.05	0.988	0.975	-24.779*
January	72	-2.094	3.194	0.985	0.971	-25.474*
February	54	-1.995	3.108	0.983	0.967	-20.477*
March	62	-1.951	3.083	0.977	0.955	-18.477*
April	64	-2.196	3.271	0.983	0.967	-22.938*
May	60	-2.297	3.348	0.984	0.968	-22.532*
June	69	-2.01	3.127	0.983	0.966	-22.067*
July	68	-1.688	2.877	0.971	0.942	-15.010*
August	57	-2.107	3.199	0.968	0.937	-15.244*
September	63	-1.939	3.058	0.992	0.985	-31.288*
October	66	-1.861	3.001	0.982	0.963	-11.554

n Sample size; a Intercept; b Regression coefficient; r Correlation coefficient; r^2 Correlation of determination; b-3/SE(b) t test; *Significant at 5%.

Table 2: Monthly statistics on Length-Weight Relationship of *Parachanna obscura* in Eleyele Reservoir from November, 2014 to October, 2016.

The distribution of the exponent b of the various length groups showed allometric growth. The category between 10.1 cm and 25.0 cm showed positive allometric growth (b>3) while 25.1 to 40.0 cm revealed a negative allometric growth (b<3).

Length group (cm)	n	a	b	r	r^2	b-3/SE(b)
10.1-15.0	138	-2.112	3.222	0.8777	0.768	-12.355*
15.1-20.0	390	-1.932	3.055	0.903	0.816	-21.217*
20.1-25.0	139	-2.4	3.424	0.817	0.668	-8.724*
25.1-30.0	83	-1.289	2.618	0.659	0.434	-2.705*
30.1-40.0	29	-1.07	2.484	0.675	0.456	-1.328

n Sample size; a Intercept; b Regression coefficient; r Correlation coefficient; r^2 Correlation of determination; b-3/SE(b) t test; *Significant at 5%.

Table 3: Lengthwise statistics on Length-Weight Relationship of *P. obscura* from Eleyele Reservoir.

The condition factor (K) obtained in this study ranged from 0.64 to 2.31 with mean condition factor of 1.41 ± 0.20. The fluctuation observed in mean K of males and females during 2014-2015 and 2015-2016 are represented in Figures 6 and 7, respectively. In 2014-2015, the mean K values of males showed highest peak of 1.49 ± 0.21 in December followed by July (1.48 ± 0.21) and October (1.45 ± 0.16) while least K value was noticed in September (1.30 ± 0.17). However in 2015-2016, the maximum K value recorded in March was (1.54 ± 0.12) and lowest in February (1.32 ± 0.13). Incidentally among males, no month have less than 1.30 mean K value during both years of study. During 2014-2015, female revealed highest K value of 1.50 ± 0.30 in July followed by 1.49 ± 0.16 in June and 1.47 ± 0.17 in August. A sharp inflection occurred in May, recording the lowest value of 1.33 ± 0.11. Whereas during 2015-2016, the value of condition factor (K) ranged from a minimum of 1.31 ± 0.15 in August to the maximum of 1.55 ± 0.13 in May. The condition factor recorded an irregular trend throughout the year, but show conformity with the previous year.

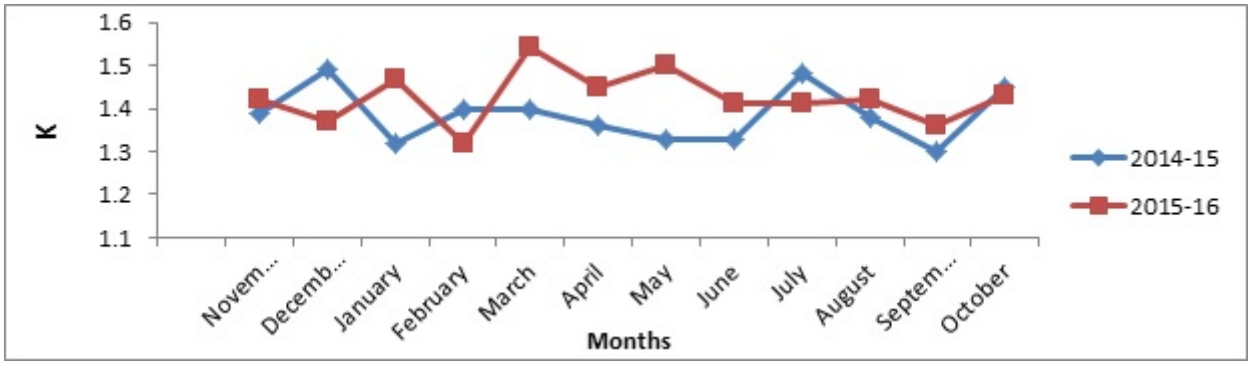

Figure 6: Monthly variation in ponderal index (K) of male *P. obscura*.

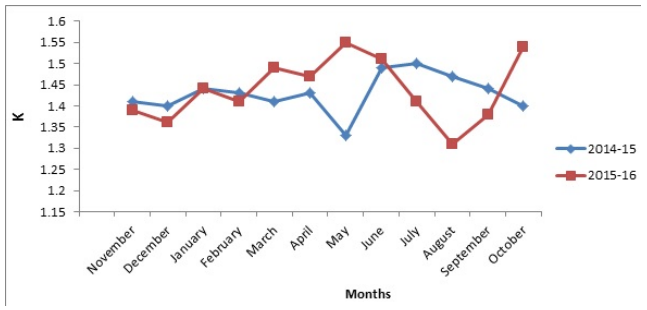

Figure 7: Monthly variation in ponderal index (K) of female *P. obscura*.

The seasonal variation in K values of *P. obscura* showed almost similar trend during both year. However, during 2014-2015, the mean condition factor in wet season (1.41 ± 0.21) was slightly higher than that (1.39 ± 0.18) in dry season ($p<0.05$) (Figure 8). Whereas in 2015-2016, dry season value (1.42 ± 0.17) was insignificantly higher than wet season (1.41 ± 0.19). The average K values for different length groups with respect to males and females are depicted in Figure 9. In case of males, lowest K value (1.38 ± 0.14) was observed in 16.1 cm to 19.0 cm size class. In any case, K value was direct proportional to sizes as 31.1 cm-34.0 cm and 34.1 cm-37.0 cm length classes had maximum values. Females showed summit value of 1.59 ± 0.24 in 22.1 cm-25 cm length class while the lowest value of 1.36 ± 0.38 was found in 31.1 cm-34.0 cm length class. Sex-wise analysis revealed that the mean K values in females (1.43 ± 0.21 and 1.44 ± 0.20) were higher than males (1.40 ± 0.18 and 1.42 ± 0.17) for both the years.

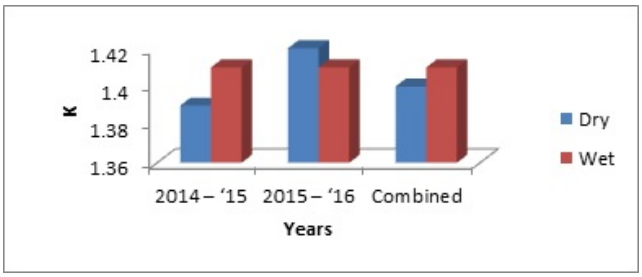

Figure 8: Seasonal variation in ponderal index (K) of *P. obscura*.

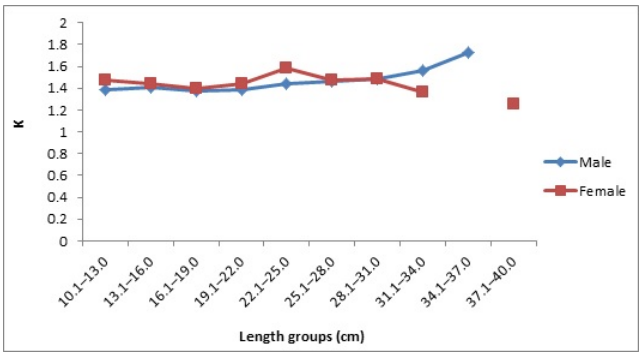

Figure 9: Lengthwise variation in ponderal index of *P. obscura* population from Eleyele Reservoir.

Discussion

Length-weight relationship (LWR) provides information on growth patterns and growth rates of animals. Ayoade [7] asserted that during their development, fish are known to pass through stages in their life history which are defined by different length-weight relationships. In the present study, the correlation coefficient 'r' for LWR for both years is high for *Parachanna obscura* in Eleyele Reservoir which implied that the length increases with increase in weight of the fish. This result is in agreement with earlier studies involving fish species from different water bodies in Southwestern Nigeria [22-25]. The regression

coefficient 'b' of male (3.04) was found to be higher than female (2.99). According to Wooton [26] if the fish retains the same shape and its specific gravity remain unchanged during lifetime, it is growing isometrically and the value of exponent 'b' would be exactly 3.0. However, a value significantly larger or smaller than 3.0 indicates allometric growth. A value less than 3.0 shows that the fish become lighter (negative allometric) and greater than 3.0 indicate that the fish become heavier (positive allometric) for a particular length as it increases in size [26]. Therefore, statistical analyses of the LWR showed that the females exhibited negative allometric growth while males and combined sexes manifest positive allometric pattern of growth. Generally, *P. obscura* demonstrated isometric growth in Eleyele Reservoir as its exponential value does not vary significantly from 3.

Reports on the length-weight relationship of channid fishes divulge that many of them strictly follow cube law while there are many in which the weights of fishes either tend to increase or decrease in proportion to the cube of length. In support to this, Odo et al. [27] reported exponential 'b' value of 2.939 for *Parachanna obscura* population in Anambra River. This result also agrees with the work of [28] who reported that male *P. obscura* showed positive allometric growth while females grew isometrically in River Oshun, South-west Nigeria. Similar sequels were also recorded in *Channa striatus* [29-34]. Moreover in this study, the growth pattern showed variation between the months. Isometric growth (b=3) was observed in March, September, October and December. Whereas for the rest of the months, the growth was positively allometric (b>3) except July and November which revealed negative allometric (b<3). According to Kleanthids et al. [35-37] such changes in b value may be attributed to certain environmental factors such as overfishing, food competition and trophic potential of the reservoir. The findings [38] coincided with the present results who reported that different growth pattern was demonstrated in different months of the year by *Gymnarchus niloticus* in Eleyele Lake. The present results also show a similar trend with *Boops boops* in Izmir Bay [39], *Schilbe mystus* in Asejire and Eleyele Lakes [7], and *Schizopyge curvifrons* in River Jhelum [40].

In the same way, the present work revealed that smaller length groups had positive allometric growth as compared to larger ones that shows negative allometric growth. The result is consistent with the view of [34] who opined that Juvenile and adult stages of a fish may exhibit differences in the length-weight relationships owing to the changes in the body form with size, feeding habits and factors related to reproduction. Similar observation was also reported for *Gymnarchus niloticus* and for Schilbe mystus [7]. However, the high K obtained for *P. obscura* in the Eleiyele Reservoir indicated that the fish were heavy for their length and was a reflection of the growth pattern. According to Ekelemu [18] when K is greater than unity (>1), the fish species is heavy and indicate good wellbeing of fish in the Lake. The condition of fish is subjected to variations with a number of factors including reproductive cycles [35] availability of foods [36], environmental factors, age and physiological state of the fish [37-39].

The condition factor of *P. obscura* showed variation in different months. The significant difference in K between the months with higher value in June to January is attributed directly to feeding activity, with peak in July during 2014-2015 in males and females. Whereas highest monthly values of K obtained for 2015-2016 in males and females occurred between March and June, and exhibited a major peak of 1.54 ± 0.38 in October. The result agrees with the earlier report by Odo [27] on *P. obscura* in Anambra River though with lower K values as compared to present study. This same phenomenon has been reported for other fish species such as [40-46]. However, the mean condition factor for *P. obscura* observed in dry seasons was statistically similar with the mean value of wet seasons. Thus, indicating that seasonal variations did not affect the general condition of the fish. The result was in consonance with the findings of [21] for *Gymnarchus niloticus* in Lekki Lagoon, Ikongbeh et al. [24] for Bagrus docmac in Lake Akata, [47] for *Schizothorax niger* in Dal Lake. The mean K for large size group is higher than smaller ones which coincided with the result of Onimisi et al. [48] who reported that the juveniles of Auchenoglanis occidentalis in Zaria Reservoir had the lowest condition factor (0.93), the sub – adults had a moderate K (1.01) and the bigger fish (adults) were in better condition (1.28). Also, females have better condition factor than males during the period of study. This may be attributed to the higher fat accumulation and higher gonadal weight [49-54]. This is in line with the findings of Migiro et al. [44] for *Oreochromis niloticus*, [15] for *Barbus occidentalis* and *Tilapia marie*, Ikongbeh et al. [24] for *Bagrus docmac*, [3] Schizopyge esocinus, [12] for *Channa aurantimaticulata*. Olurin et al. [28] however, reported significant higher condition factor for males (59.49 ± 9.52) than females ((1.357 ± 0.4305) in *P. obscura* from River Oshun, South-west Nigeria.

Conclusion

The male *P. obscura* are longer in length than female, while female have greater weight due to robustness than corresponding male. However, the species exhibited allometric growth with b values ranging from 2.48 to 3.42. Positive allometric growth pattern was observed in case of male while females on the other hand exhibited negative allometric growth pattern. Also, variations occurred in the growth pattern and condition factor of this species with season and size groups. The condition factor confirmed that the species is in good condition of well-being though female are more robust than males. These results will help in further studies on the population assessment of the species in Eleyele Reservoir.

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