Pakistan Journal of Marine Sciences, Vol. 32(2), 101-112, 2023.

BIOMETRIC INDICES OF *PSEUDOTOLITHUS ELONGATUS* (BOWDICH, 1825) FROM THE COASTAL WATERS OF RIVERS STATE, NIGERIA

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ABSTRACT: Length-weight relationships (LWRs), length-length relationships (LLRs), and condition factor of *Pseudotolithus elongatus* from the coastal waters of Rivers State, Nigeria, were studied. Specimens were collected from the catches of fishermen using various fishing gear. The dominant length ranged from 20 to 26 cm, with a mean length of 22.65±3.06cm. The monthly length-weight relationship was estimated separately for male and female, with the b values indicating positive allometric growth ($b > 3.00$) in November, January, and February for both male and female. The females experienced negative allometric growth ($b < 3.00$) in December, March, and April, while the males exhibited a negative allometric growth pattern in April. The combined b value of LWRs (TL vs. BW) indicates positive allometric growth, and SL vs. BW indicates negative allometric growth. Also, the b value of LLR (TL vs. SL) indicates negative allometric growth. The condition factors varied for both sexes, ranging from 0.35 to 1.2 in males and 0.57 to 1.14 in females, while the combined condition factor ranged from 0.35 to 1.2. The present findings will provide useful information for a well-organized and significant exploitation and regulation of Sciaenid species following the aftermath of massive fish kills and continuous exploitation of fish species in the study area.

KEYWORDS: allometric growth; condition factor; *Pseudotolithus elongatus*; coastal waters

INTRODUCTION

Fish kills are often associated with changes in water quality, pollution, and infection, which are either directly related to human activities or a mixture of causes. It could be the result of a natural phenomenon linked to natural events, human-related activity, or a combination of both. Old age, climate conditions, hypoxia, malnutrition, and disease outbreaks are all natural causes of big fish death occurrences. (Hoyer *et al.*, 2009), while human-induced factors include toxic substances (Koutrakis *et al.*, 2016). There have been several efforts to document and comprehend fish fatalities all around the world, especially as the frequency and severity of incidents appear to have grown recently. (La and Cooke, 2011).

Size, age, growth rate, and other biometric indices are acknowledged as underlying characteristics that can be used to describe and forecast how different species react to stressors like exploitation, climate change, and other things. (Hasan *et al.*, 2021). Information of LLRs disclose the index of well-being of fishes, growth dynamics, impression of first maturity, timing of reproduction, stock variation etc. In addition, the LLRs are very significant because several ecological and physiological factors depend

more on length (Hossain *et al.*, 2006). For example, relations between total and standard lengths of fish are important in management for comparative growth studies (Sandoval-Huerta *et al.*, 2014). Information on length-length relationships are still scarce for most tropical and subtropical fish species (Ecoutin *et al.*, 2005).

Length–weight relationships can be used for many fisheries biological investigations, i.e., health condition of fish (fatness, feeding and breeding state), age structure, growth rates among areas, regional comparisons of fish life history traits and species-specific environmental suitability (Jenllyman *et al.*, 2013). Length-weight relationships are also important in fisheries because it helps to understand fish population dynamics and the growth pattern on fish stocks (Froese, 2006) LWR is widely used in planning a better management strategy fisheries resource (Huang *et al.*, 2018)

The length-weight relationship provides means for finding out the condition factors, which indicate the "wellbeing of the fish" (Olopade, 2018).The most useful metrics for evaluating the health of fish species and the entire aquatic community are condition variables, which may also be used as practical instruments for managing and conserving natural populations. (Rahman *et al.*, 2012). When the condition factor value is larger, it indicates that the fish has gained a better condition. The condition factor in fish acts as an indicator of the physiological status of the fish in connection to its welfare. (Olopade *et al.*, 2015). For Baby (2011), the condition factor can be used as an index to assess the level of disturbance in an aquatic ecosystem that is strongly influenced by environmental parameters. Fish in optimal physiological condition should grow and reproduce successfully, thus ultimately ensuring the sustainability of the population (Ross, 1989). It is therefore critical that scientific investigations be conducted to determine the well-being of *P. elongatus* species, one of the most prominent Sciaenid species following the aftermath of massive fish kills and continuous exploitation of fish species.

Reports of dead fish washing ashore within 2 nautical miles in some areas of Nigerian coastal waterways, particularly in the Niger Delta region, was reported March 2020. After 8 days, the fish mortality phenomena subsided, normal conditions returned, and after 20 days, no mortality was observed. The fishes of the family Sciaenidae, also known as "drums" or "croakers," were harmed in all the affected locations reported. A fish kill brought on by a disease will typically only involve one or two species that are closely related, and it will take place over a few days or weeks. Local fish populations may be significantly impacted by mass fish kills, occasionally even collapsing as a result. This study aims to estimate LWRS, LLs, and assess the well-being of *P. elongates* in the affected coastal waters of Nigeria following fish kills.

MATERIALS AND METHODS

Rivers State is one of the 36 States of Nigeria bordered on the south by the Atlantic Ocean and on the north by Imo, Abia and Anambra States. It is situated on the map of Nigeria at latitudes 4° 431′ 3411′ North and longitude 6° 55′ 1511′ East in the Niger Delta area of the South-South geopolitical zone. Wikipedia, (2010). This study was conducted in a coastal fishing community in Rivers State, which is located in the southern part of Nigeria's coastal waters (Fig. 1).

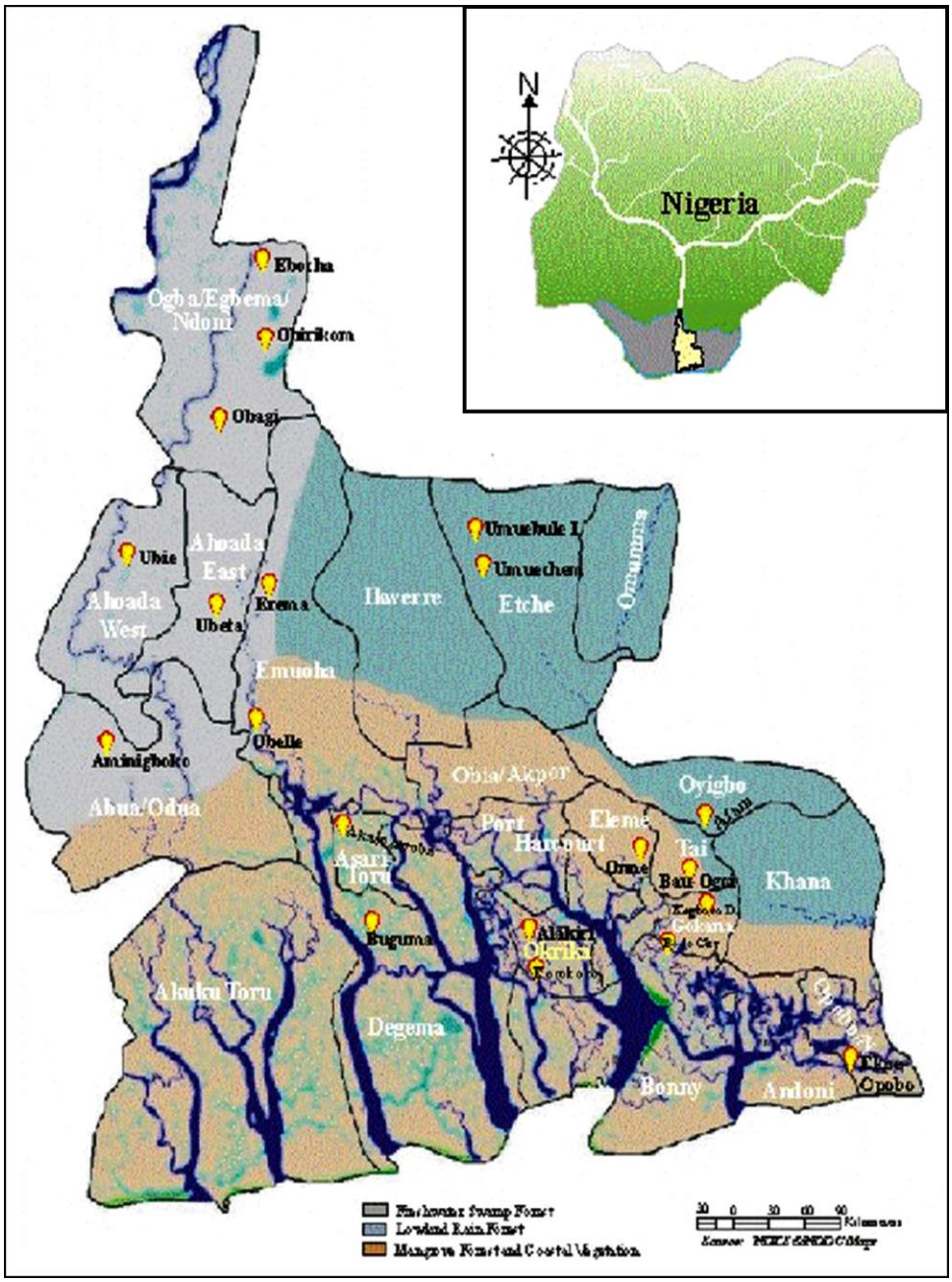

Fig.1. Map of Rivers State showing its coastal location.

Sample and Data Collection: Samples were collected twice a month from the catches of artisanal fishermen at the fish landing sites in Bonny at random from

November 2021-April 2022. This landing site is mainly fed by the catches from the coastal waters of Rivers State. The fish samples were caught using different fishing gear (beach seine nets, cast nets, gill nets, and hook and line). The specimens were transported in ice chests to the laboratory. Identification was done using a key given by Schneider (1990). A total of 228 fish samples (male and female) were collected. Biological data: total length (TL) standard length (SL) in cm, body weight (BW) in g, and sex samples (males and females) of *P. elongatus* in coastal waters of Rivers State, Nigeria.

Statistical Analysis: The length-length relationships (LLRs) between Total length (TL) and Standard length (SL) were calculated using linear regression analysis. The equation was used to express these length relationships. Y = a + bX Where,= a dependent variable (various body lengths), X = an independent variable (total length) a = constant (intercept) = regression coefficient (slope) Estimates of „a" and „b", and their 95% confidence limits were computed statistically.

Length–weight relationships ($W = aL^b$) were estimated according to Anderson and Neumann, (1996). Condition factor (K) was computed according to Le-Cren (1951), using the equation: 100W K/ L = where K = condition factor. L = standard length in centimetres. W = body weight of fish in grams

RESULTS AND DISCUSSION

The length-frequency class for *P. elongates* from the coastal waters of Rivers State, Nigeria, in Figure 2, showing a unimodal distribution. The lowest length was 16 cm, and the highest length recorded throughout the study period was 36.4 cm. The dominant length ranged from 20 to 26 cm, with a mean length of 22.65±3.06 cm.

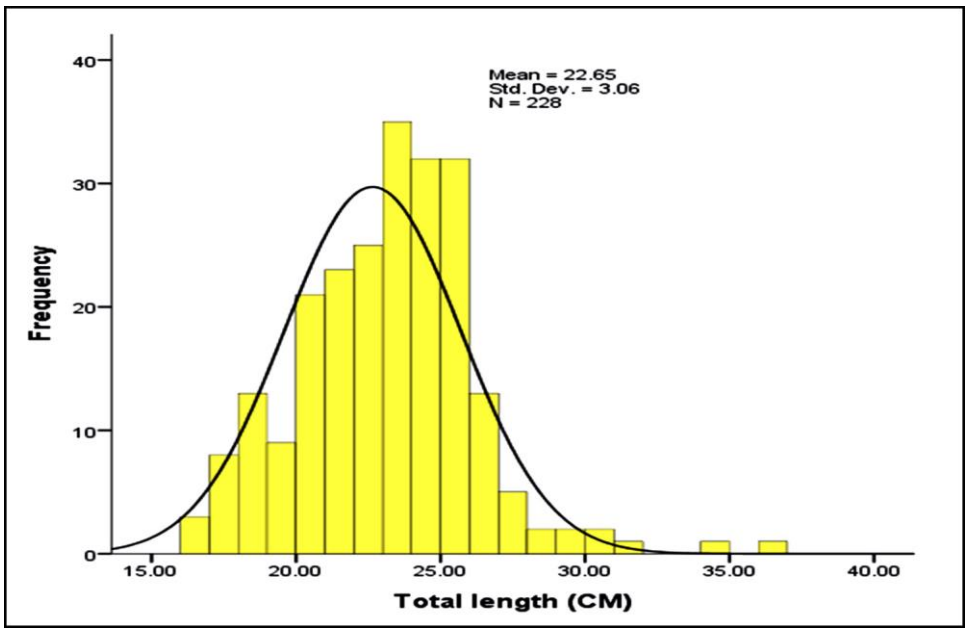

Fig. 2. Total length frequency distribution of *P. elongates* from Rivers State coastal waters.

Table 1. Length (cm) and weight (g) measurements of combined sexes of *P. elongates* from Rivers State coastal waters.

Measurement	N	Minimum	Maximum	Mean(±SD)
Total length (cm)	228	16	36.5	22.65±3.06
Weight (g)	228	27	351	95.28±43.40

The minimum and maximum standard length for males were 12 and 24 cm, while the weight ranged from 27 to 214 g. The female standard length ranged from 12 to 30 cm, while weight varied between 32 and 351 g (Table 1). Table 2 summarizes monthly length and weight measurements, sample sizes (n), regression parameters and 95% confidence limits for a and b of the LWR, and coefficients of determination (r^2) of *P. elongatus* in Rivers State coastal waters. The b values for TL-BW relationships (Figure 3) indicate positive allometric growth (b > 3.00) in November, January, and February for both males and females. Females exhibited negative allometric growth (b 3.00) in December, March, and April, whilst males experienced the same in April.

Table 2. Monthly Descriptive statistics of LWRs of *P. elongates* from Rivers State coastal waters.

Month	Sex	n	Parameters of the LWR		r^2	T
			a (95% CL)	b (95% CL)		
January	M	2	-7.495(-9.101 - -5.89)	3.825(3.309 - 4.341)	0.923	A+
	F	9	-5.014(-6.546 - -3.481)	3.042(2.552 - 3.531)	0.91	A+
February	M	0	-5.982(-7.08 - -4.883)	3.347(2.989 - 3.705)	0.955	A+
	F	5	-6.142(-7.182 - -5.101)	3.399(3.074 - 3.724)	0.953	A+
March	M	6	-5.008(-6.552 - -3.463)	3.061(2.563 - 3.56)	0.87	A+
	F	9	-3.689(-6.229 - -1.149)	2.661(1.847 - 3.476)	0.737	A-
April	M	0	-2.84(-4.564 - -1.117)	2.332(1.765 - 2.898)	0.806	A-
	F	4	-2.914(-4.618 - -1.21)	2.368(1.817 - 2.92)	0.879	A-
November	M	3	-5.532(-9.447 - -1.617)	3.19(1.924 - 4.456)	0.737	A+
	F	9	-5.474(-6.474 - -4.473)	3.171(2.853 - 3.489)	0.963	A+
December	M	8	-6.308(-7.353 - -5.263)	3.449(3.116 - 3.783)	0.968	A+
	F	3	-4.447(-5.922 - -2.972)	2.876(2.402 - 3.35)	0.942	A-

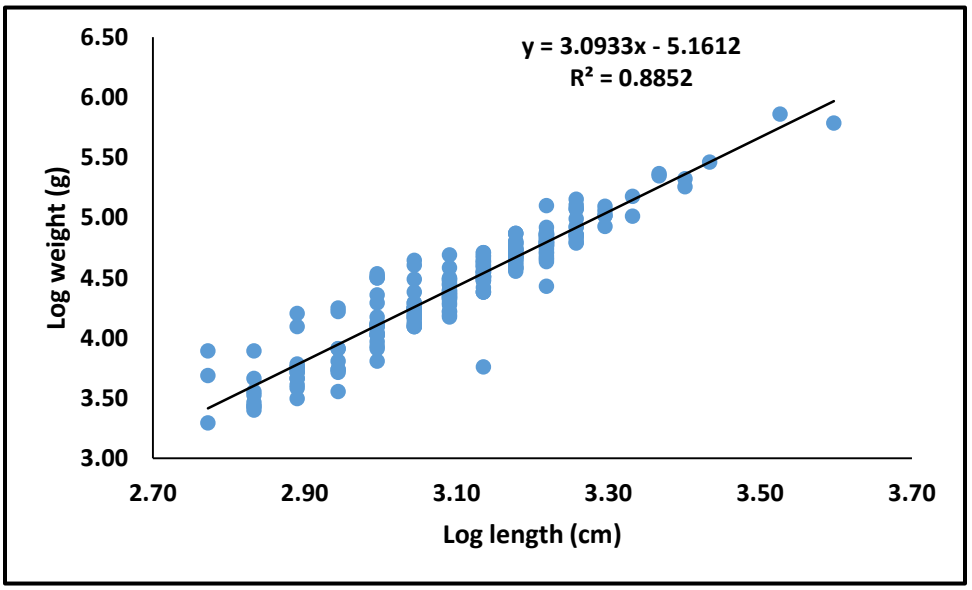

Fig. 3. Length weight relationship of *P. elongates* from Rivers State coastal waters.

The regression parameters of the LWR and LLR, the 95% CL of a and b, the coefficient of determination (r^2), and the growth pattern of *P. typus* are given in Table 3. The b value of LWRs (TL vs. BW) indicates positive allometric growth, and SL vs. BW indicates negative allometric growth (Figs. 3 and 4). Also, the b value of LLR (TL vs. SL) indicates negative allometric growth (Fig. 5). The correlation coefficient determinations of 0.97, 0.89, and 0.88 for TL versus SL, TL versus BW, and SL versus BW, respectively.

Table 3. Descriptive statistics and estimated parameters of the length-weight and length-length relationships of *P. elongates* from Rivers State coastal waters.

	Regression parameters		95% CI of a	95% CI of b	r2	GT
	a	b				
BW =a*TLb	-5.16	3.09	-5.62 - -4.71	2.947 - 3.239	0.89	A+
BW = a*SLb	-3.36	2.72	-3.74 - -2.98	2.588 - 2.852	0.88	A-
TL=a+b*SL	0.61	0.87	0.55 - 0.67	0.848 - 0.889	0.97	A-

TL, total length; SL, standard length; BW, body weight; *a*, intercept; *b*, slope; *CI*, confidence interval; r^2, coefficient of determination; GT, growth type; A-, negative allometric; TL = a + bGL

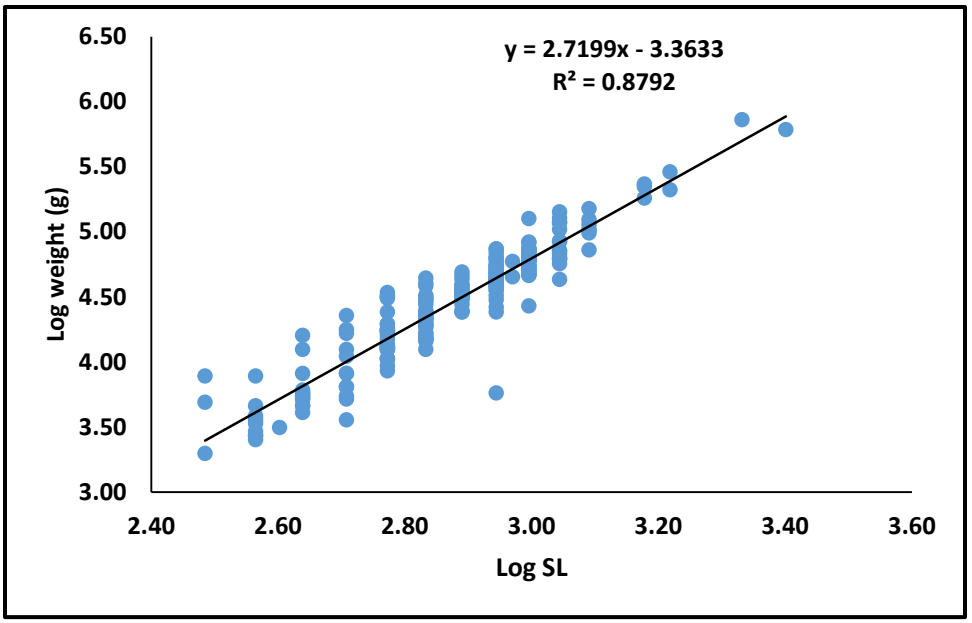

Fig. 4. Standard length-body weight relationship of *P. elongates* from Rivers State coastal waters.

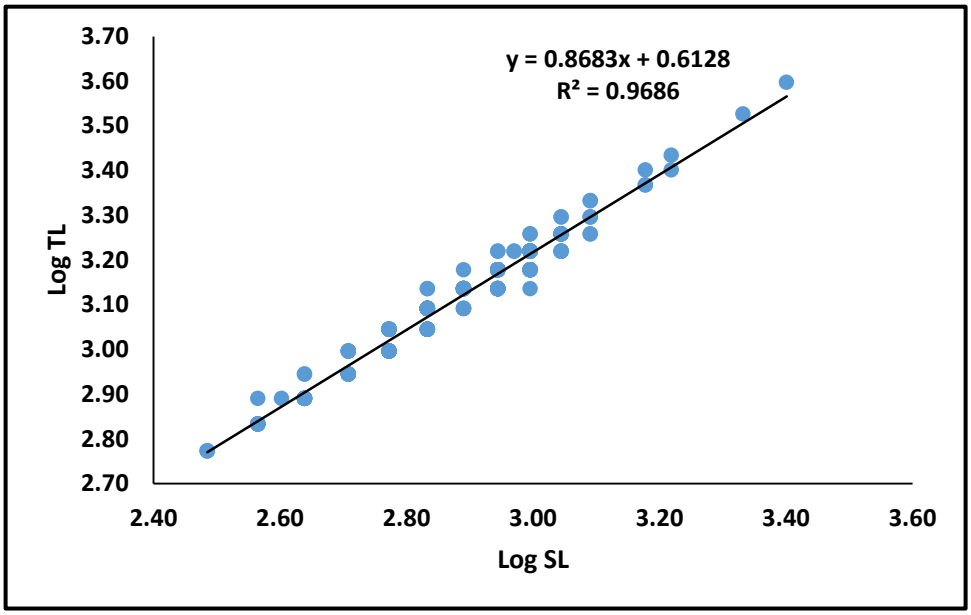

Fig. 5. Total length-standard length relationship of *P. elongates* from Rivers State coastal waters.

The condition factors varied for both sexes, ranging from 0.35 to 1.2 in males with a mean value of 0.76±0.12 and 0.57 to 1.14 in females with a mean value of 0.79±0.11 Table 4). The combined condition factor ranged from 0.35 to 1.2, with a mean value of 0.78±0.12.

Table 4. Condition factor of male, female and combined sex of *P. elongates* from Rivers State coastal waters.

	Minimum	Maximum	Mean	t-test	p-value	CL95
Male	0.35	1.2	0.76±0.12	-1.597	0.112	-0.056 - 0.0059
Female	0.57	1.14	0.79±0.11			
Combined	0.35	1.2	0.78±0.12			

Discussion: The length frequency distribution of *P. elongatus* from Rivers State coastal waters revealed in this study that the most frequent length class was 23 cm and the mean length was 22.65±3.06 with size classes 20 to 25 cm dominating the stock. This showed that the stock ranged from immature specimens to sub-adults and a few mature ones, with the majority of fish captured by the fishermen falling into the category of immature to sub-adults. Thus, there is a need to regulate fishing activities in the study area. Indicators based on length and frequency can be used to establish management measures for fisheries (Froese *et al.*, 2016).

The length-weight relationship is very important for proper exploitation and management of the population of fish species (Qamar *et al.*, 2017). The LWR relationships observed for male and female individuals showed differences in monthly b values with negative and positive allometric growth patterns. Values of the exponent "b" provide information on fish growth (Olopade *et al.*, 2019). As fish growth is variable, the same species may have different growth patterns according to its environment (Baldé *et al.*, 2019). This variable can be attributed to the spawning period (Tiedemann and Brehmer, 2017), food availability (Thiaw *et al.*, 2017), and environmental conditions (Diankha *et al.*, 2018).

The overall results of the present study indicated a positive allometric growth pattern with a coefficient b value of LWR (TL vs. BW) of 3.09, indicating that the species became heavier as they grew longer. Recently, Froese *et al.* (2014) reported that b values should be between 2.9 and 3.1 for most species. The range of b values from the current study appears to be in this range, supporting the claim by Froese *et al.* (2014). A b value greater than 3 indicates that large specimens have increased in height or width more than in length, either as a result of notable ontogenetic changes in body shape with size or because most large specimens in the sample were thicker than small specimens (Froese, 2006). The higher the value of b, the more likely it is that the environmental conditions are relatively productive (Gopakumar *et al.*, 1991; Olopade *et al.*, 2018a). Similar findings (an allometric pattern of growth) in *P. typus* were also found by Olapade and Tarawallie (2014) with a b value of 3.35 from Tombo, a coastal fishing community in the

western rural district of Sierra Leone, and Ndiaye *et al.* (2015) from the Bandiala River in the Saloum Delta, Senegal. However, studies conducted by Nunoo *et al.* (2013) and Awotunde (2021) reported a negative allometric growth pattern for *Pseudotolithus typus* in the near-shore waters of Benin and the Lagos lagoon in Nigeria, respectively.

In the present study, the correlation coefficient r between log length and log weight was found to be high, indicating that the fish species was suggestive of a close relationship between length and weight. Also, all the LLRs of *P. elongates* are highly correlated. However, there is no prior study dealing with LLR to restrain the comparison with other studies.

The condition factor is an index reflecting interactions between biotic and abiotic factors in the physiological conditions of fishes (Lizama *et al.* 2002, Olopade *et al.* 2018b). The mean condition factors obtained for this study were 0.76±0.12, 0.79±0.11 and 0.78±0.12 for male, female, and combined *P. elongatus*. Olapade and Tarawallie (2014) reported mean factor of 0.98. Abowei *et al.* (2010) found a mean condition factor of 0.94-0.99 in the Nkoro River, Niger-Delta, Nigeria. However, when the $K \geq 0.5$, it indicates that the fish is in a healthy condition (Abdul *et al.*, 2016). Konan *et al.* (2017) showed that the high values of condition factor K could be explained by the presence of a diverse and abundant diet in the environment.

CONCLUSION

This study analyzed the length-weight, length-length, and condition factor of *P. elongatus* from the coastal waters of Rivers State. The growth measurements revealed that the dominant length ranged from 20 to 26 cm with a mean length of 22.65±3.06 cm indicating that the fish population was composed of immature specimens. The results of LWRs (TL vs. BW) indicate positive allometric growth, SL vs. BW indicates negative allometric growth, and LLR (TL vs. SL) indicates negative allometric growth, along with a strong correlation between length and weight increment. The condition factor represented the suitability of habitat and conducive environmental conditions for the growth of *P. elongatus,* with the value of this species being higher than 1. The findings of this study will serve as a critical baseline for monitoring and implementing an immediate conservation and management plan aimed at protecting and restoring the species, as well as other Sciaenidae species, in the aftermath of massive fish kills and continuous exploitation of fish species in Nigeria's affected coastal waters.

Funding: This research was funded by the Tertiary Education Trust fund (TETFund) Institution-Based Research Grant (IBR) (TETF/UPH/IBR/2019/7/015).

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