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Studies on Morphometrics, Length-Weight Relationship, Condition factor and food and feeding habit of *Pseudotolithus elongatus* from Makoko River, Lagos State

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Abstract
Over the years, aquatic resources have reduced exponentially due to several factors particularly the influence of human activities. The aftermath of human activities on aquatic environment includes the depletion of species, breeding ground destruction, and fragmentation of the ecosystem and so on. Therefore, this study provides information on the Morphometrics, length-weight relationship, condition factor and guts content of *P. elongatus* from Mokoko River in Lagos State. The total of 398 fish samples was collected. The collection was performed once in a month for a period of six months, although not consecutive months but between January, 2021 to November, 2021. The highest mean body weight was obtained in the month of July (330±58.0g), while the lowest in September (38.4±70.0g). The month of May with the value of (550-4.3g) represented the widest fish range in a cohort while the least was observed in month of July (330-5.3g). The maximum total length (36.5±5.1cm) and standard length (30±4.3cm) was obtained in the month of July. The female had better sex ratio across the six months except for the month of March. The value of 'b' (growth exponent) for male, female and combined sexes were below 3 indicating negative allometric growth pattern. The results on condition factor of females, male and combined sexes are greater than 1 except the result obtained in the month of March. For gut contents, four major diets (mud, earthworm, fish and crab) were observed indicating predatory nature while mud dominated the gut contents of the fish. The overall result indicated partially healthy ecosystem. Intensive monitoring of this water body should be mandated to ensure sustainability of the fishery. However, further studies in relation to the proximate composition and reproductive aspect of Bobo Croaker and other fish species from the study area should be done in order to update and provide more scientific information.

Keywords: Makoko River. Gut content. Bobo croaker. Sustainability. Ecosystem

1. Introduction
Basically, the essentiality of the aquatic ecosystem resources is indispensible. Generally, these resources serves as means of livelihood for people far and wide but the most dependants on these resources are those within the coastal areas. Over the years, these resources have reduced drastically due to several factors particularly the influence of human events. The aftermath of various human activities imposed on aquatic environment have ceaseless damages such as depletion of species, breeding ground destruction, fragmentation and instability of the ecosystem. Proper monitoring or management of wetland resources is required to conserve these resources to ensure sustainability. Assessment of the biological relationship between fish weight and length is one of the major fisheries management metric used for estimation of fish and water condition [1].

Evaluation of fish growth through computation fish length and weight data is used specifically for the ascertainment of wellbeing of fish such as fish size in a particular aquatic community and at a specific period of time. Growth, in population biology simply means the alteration in length or weight of the fish within a period of time. Availability of food materials, ingestion rates, food compositions, fish species and sex, water quality such as temperature and dissolved oxygen are the major factors responsible variation of growth in fish [2]. Generally, fish exhibit several growth patterns which were categorized into four

phases. However, spontaneous alteration in growth and development of fish body might occur which tends to have impact on the progressive growth of fish length and weight. During fish early stage such as the senility stage, most of the energy stored are utilized for growth and development. Once the fish reach the maturity stage, majority of the energy is diverted and reserved for reproductive development especially in females [3].

Length weight relationship (LWR) is an important metric used for the evaluation of either individual or collective fish weight in relation to length distribution [4] from one or multiple aquatic communities. Variation in fish weight and length occurs at different stage of fish life cycle such as metamorphosis and maturity period [6]. The importance of Length-weight data alongside fish age data cannot fully be quantified as it is one of the parameter required for providing information on fish stock, age at maturity, life span, mortality, growth and reproduction [5]. Additionally, Length-weight relationship helps to determine fish biomass [7, 8] wellbeing of fish and some other necessary biological information of fish in various aquatic systems. Arithmetically, the estimation of growth metric in fish can either be isometric, negative allometric or positive allometric growth in its life [9]. When the result obtained from estimation of length and weight is equivalent to 3, it indicates the rate of growth of length and weight is equivalent thus isometric growth pattern, while positive allometric growth is achieved when the result obtained from estimation of length and weight is greater than 3 [10]. In contrast, when the result obtained from estimation of length and weight is lesser than 3, it denotes negative allometric growth, which indicates leanness of fish since it increases in length than body weight. It is worth to note that fish that exhibit positive allometric growth typically has deeper body and are relatively stouter due to high increase in eight than length [11].

The Family; Sciaenidae encompasses several genus and *Psedotolithus* is one of them. Species from the family Sciaenids possesses relatively similar attributes to snappers but they can apparently differentiated from snappers with their short spinous dorsal fins, long adipose tissue and one or two spinous anal fin [12]. *P. elongatus* which belongs to this genus are mainly distributed in the west coast of Africa [13]. *P. elongatus* is typically known as drum or bobo croaker. *Pseudotolithus elongatus* (*fonticulus*) occurs in similar habitats as *P. senegalensis* and they are mostly caught together. Generally, the species from the genus *Pseudotolithus* commands economic and nutritive importance to the abundant population of most African nations. Unfortunately, irresponsible and illegal fishing operations such overfishing, obnoxious fishing and adoption of menacing gears and non fishing activities such as dredging [14], have led to depletion and instability of the aquatic ecosystem resources in many part of the world. Subsequently, this result in shortage of sea produces available for human usage.

Naturally, there are lower organisms present abundantly in aquatic environment which are part of the linear food chain for higher organisms such as fish. These organisms vary in terms of sizes, taxonomic classification, nutritional and chemical composition and inhabit several part of the aquatic habitat [15]. The aspects of food and habit of feeding vary from one fish to other. Based on their stomach formation, fish are classified majorly as omnivores, herbivores and carnivores species. They are also categorized based on their mouth part as deposit and suspender feeders [16]. Information on the food and feeding habit of fish through the evaluation of the gut content is a common practice in fisheries biology, although few of these methods are being used for assessment [17].

Information on the food and feeding habit of fish species from the family Sciaenidae is much available but there are little scientific literatures available on the stomach content of *Pseudotolithus elongatus*. Tiencheu [18] claimed that some species from this family such *Pseudotolithus typus* and *P. senegalensis*, obtained from the Cameroon coast feeds mainly on shrimp and smaller fishes indicating a carnivores feeding behavior. Additionally, biological information and ecological condition of Makoko River and organisms that lives are not available as there is no published paper that accounts for the aspect of biology (length-weight relationship and stomach analysis) of fish species of Makoko River within the axis of Lagos Lagoon. Therefore, this study seeks to provide information on the Morphometrc features, length-weight relationship and stomach contents of *P. elongatus* from Mokoko axis of Lagos Lagoon as well as ascertain the condition of this ecosystem.

2 Materials and Methods

2.1 Study Area

This research was conducted at Makoko fish landing site in Yaba Local Government Area of Lagos State, Nigeria. Makoko is situated within the coordinates; Latitude 6.29ºN and Longitude 3.23º E of the equator which is about 1.53 miles away from the University of Lagos. The Makoko market is structured closely to the river which allows the regular accessibility of fresh fish by the residencies of the Communities within the sampling location [19].

Fig 1: Map of Nigeria and Lagos state indicating Makoko area and the sampling site [20].

2.2 Sampling of fish

Monthly fish samples were purchased from the market near Makoko River after they have been collected from local fishermen who operated with several non mechanized gears. Fish sample collection from the sampling site was performed once in a month for a period of six months, although not consecutive months but between January, 2021 to November, 2021. The reason for inconsistency in the month of sampling was due to non-availability of the sampled fish species in fisher's catch in some months. The sampling was done between 7:00am-09:00am on each occasion of collection. The fish samples collected were transported in ice chest box to the laboratory of Department of Fisheries and Aquatic biology, Lagos State University, Lagos where the identification, measurement and dissection took place.

2.3 Identification

2.3.1 Morphological Assessment

The Fish spp belonging to the Family; Sciaenidae were identified using morphological attributes. Morphometric differentiation among populations such as was body weight (BW) and total length (TL) were also measured and recorded. The fishes were washed and the total length (cm) and their corresponding standard length (cm) of each fish sample were taken from the tip of the snout (mouth closed) to the extended tip of the caudal fin respectively using a measuring board. Their corresponding body weight was also measured for each fish to the nearest gram using a metallic loading balance after draining water from the bucal cavity and blotting out excess water on the fish body. Each spp were dissected and the gonads were removed. The sex of each specimen was identified by examination of the gonads.

The Total Length (TL): Each fish was placed on a meter rule, stretched in such a way as to get the most appropriate full length of the specimen. The measurement was taken from the tip of the caudal fin in the anterior to the tip of the mouth part at the posterior region.

The Standard Length (TL): The measurement was taken from the tip of the caudal peduncle in the anterior to the tip of the mouth part at the posterior region.

The Total Body weight: was obtained by use of an electric Melter balance model PM400. Each specimen was weighed one after the other and each respective weight was recorded.

Fig 2: *Pseudotolithus elongatus* from the study area prior to Laboratory analysis

2.4 Length-Weight Relationship

The morphometric data obtained such as the total lengths (STL) and body weights (BWt) from the evaluated fish samples was computed to ascertain the length-weight relationship for males, females and pooled sexes using the below equation

$W = {}_aL^{b}$ [21].

Where
a = intercept
b = slope
r = correlation coefficient
BW = body weight of fish (g)

L = total body length of fish (cm)

The values obtained from length and weight were transformed to give the expression LogW = Log a + b LogL via least square linear equation (Zar, 1984). The values "a' and "b" were obtained from the transformed equation via linear regression equation. The "b" values were used to determine the growth pattern (b=3 Isometric growth, b>3=Positive allometric growth or b <3 negative allometric growth)**.** The correlation coefficient (r^2) was estimated from the linear regression analysis; $R = r^2$ to ascertain the degree of association between the morphometric features (length and weight) of the fish.

Fig 3: *Pseudotolithus elongatus* was placed on the measuring board in the laboratory

Table 1: Description of morphometric, Meristic and Weight Parameters of fish

S/N	Morphometric & Meristic Variables	Codes	Measurements and Counts
1.	Body weigth	BW	Entire weight of fish
2.	Total length	TL	It is measured from the most forward point of the head, with the mouth closed to the farthest tip of the tail.
3.	Standard length	SL	It is measured from the tip of its nose to the end of its last vertebrate.
4.	Body depth	BD	It is the maximum vertical distance between dorsal and ventral margin of the fish body.
5.	Head length	HL	It is measured from the tip of the snout or mouth to the posterior portion of the gill plate.
6.	Eye diameter	ED	
7.	Spinous dorsal fin	SDF	Counting of spinous dorsal fin usually between 6 to 10
8.	Rayed dorsal fin	RDF	Counting of rayed dorsal fin usually between 24 to 30
	Spinous anal fin	SAF	Counting of spinous anal fin usually between 1 to 3
10.	Rayed anal fin	RAF	Counting of rayed anal fin usually between 5 to 8

2.5 Sex Ratio

The inconsistency of sex ratio in relation to the total number of sampled fish is useful because it helps to provide biological information of fish such as life span in relation to sex, sexology, vulnerability to fishing gear, abundance and seasonal distribution of species [22]. Based on the number of fish samples, the following metric was used to compute the sex ratio.

Sex-ratio (S-R) = 100 x number of males/number of females
Equation adopted; $\chi 2$ Chi-square = $\sum O_i - E_i/E_i$

Where
O_i is the observed value
E_i is the expected value

2.6 Food and Feeding Habits

The specimens were dissected and subsequently the stomach was removed, placed in petri dish and later preserved in 5% neutralized formalin for further analysis. The stomach contents were later removed and dried before examination under binocular microscope. Soon, the relative importance for food items was determined after adopting the necessary metric for evaluation [23].

2.6.1 Frequency of occurrence

The stomach contents were analyzed by frequency of occurrence method. Each food item was identified and number of stomach in which each food occurred was counted and expressed as a percentage of stomach containing food. The method showed the proportion of individuals eating a particular food item in a species. The occurrence of each food item was expressed as a percentage of all stomach with food. That is,

P = (b/a) x 100

Where
a = Total number of fish examined with food in the stomach;
b = number of fish containing a specific food;
P = percentage of occurrence of each food item.

2.7 Data for Analysis

The raw Morphometric data and stomach content obtained from the experimental fish were computed using Microsoft excel version 16. Differences in sex ratio were evaluated using the chi-square (χ^2) test (significant level of 0.05) by SPSS version 16.0.

3. Results

Table 2 depicts the monthly distribution of average, minimum and maximum morphometric characters of *P. elongatus*. The highest fish mean body weight was obtained in the month of July (330±58.0), while the lowest fish mean body weight was recorded in September (38.4±70.0g). The highest individual fish body weight was obtained in fish sample in the month of May. The month of May with the value of (550-4.3g) represented the widest fish range in a cohort while the least range was observed in month of July (330-5.3g). Similarly, in terms of the fish mean total and standard length, the highest mean values 36.5±5.1cm and 30±4.3 cm respectively, was obtained in the month of July which corresponded with the mean body weight obtained. As seen in table 2, the highest fish range for total length was obtained in month of November while the highest for standard length was obtained in the month of May. The minimum body depth 1.4 cm was obtained in month of January and the maximum was observed in the month of May. The maximum head length and eye depth was recorded in the month of March while the minimum head length and eye depth was recorded in the month of September and March respectively.

Illustrated in table 3 is the monthly distribution of average, minimum and maximum meristic count of *Pseudotolithus elongatus*. Four (4) meristic characters which include the spinous dorsal fin (SDF), rayed dorsal fin (RDF), spinous anal fin (SAF) and rayed anal fin (RAF) were presented. The highest mean SDF (10±0.9) and RDF (32±1.7) were obtained from fish sampled in the month of July while the least mean SDF (8.03±0.87) was observed in the month of September, and the least mean RDF (26.5+4.4) was obtained from fish sampled in January. The maximum and minimum value SDF was obtained in March and July November and the maximum and minimum value for RDF was obtained in January. Similar results SAF result was recorded across all months except for January and March. The highest and lowest mean RAF was obtained from fish sampled in July and January respectively.

Table 2: Monthly distribution of average, minimum and maximum morphometric and meristic characters of *Pseudotolithus elongatus*

	BW	TL	SL	BD	HL	ED
January (Max - Min)	68.8+84.2 (409.5 – 4.3)	15.9+7.8 (38.5-7.3)	13.3+6.5 (31.0-5.8)	4.4+2.0 (10.6-1.4)	3.6+1.7 (8.0-1.5)	1.0+0.3 (1.9-0.4)
March (Max - Min)	143.0+140.6 (540-5.3)	22.4+9.4 (40-7.2)	18.8+8.0 (36.0-6.0)	4.2+2.7 (11-1.6)	4.2+3.8 (25-1.5)	0.9+0.4 (2-0.3)
May (Max - Min)	94.6+127.9 (550-4.3)	17.8+9.6 (40-7.3)	14.9+8.1 (33.5-5.8)	4.8+2.5 (11.2-1.9)	3.9+2.0 (8.6-1.5)	1.0+0.4 (2-0.5)
July (Max - Min)	330±58.0 (330-5.3)	36.5±5.1 (36.5-7.0)	30±4.3 (30-5.8)	4.00±0.5 (4-1.7)	3.5±0.4 (3.5-1.5)	1.6±0.2 (1.6-0.4)
September (Max - Min)	38.4±70.0 (398.7-4.7)	12.7±5.9 (34-7.6)	10.8±5.2 (30.5-6.2)	3.3±1.7 (9.8-2.0)	3.02±1.4 (8.2-0.8)	0.92±0.26 (1.9-0.4)

November (Max - Min)	70.59±122.40 (544.9- 5.20)	14.08±8.06 (40-5.2)	11.63±6.77 (33-6.5)	3.84±2.06 (11-2.1)	3.50±1.89 (8.6-0.7)	1.00±0.32 (1.9-0.5)

Table 3: Monthly distribution of average, minimum and maximum meristic count of *Pseudotolithus elongatus*

Parameters	SDF	RDF	SAF	RAF
January (Max-Min)	9.4+0.9 (12-6)	26.5+4.4 (35-14.0)	2.1+0.4 (4.0-1.0)	6.2+1.2 (9.0-3.0)
March (Max-Min)	9.2+1.0 (11-7)	28.0+2.2 (32-21)	1.5+0.5 (2-1)	7.0+0.8 (8-6.0)
May (Max-Min)	8.6+0.9 (10-7)	28.6+1.9 (32-25)	2.0+0.1 (2.0-1)	7.1+0.8 (8-5)
July (Max-Min)	10±0.9 (10-6.0)	32±1.7 (32-23.0)	2±0.0 (2.0- 2)	8±0.8 (8-5.0)
September (Max-Min)	8.03±0.87 (10.0-7.0)	27.93±1.76 (34.0-26)	2±0.0 (2.0- 2)	6.44±0.64 (8.0-5.0)
November (Max-Min)	9.20±0.75 (10-8)	28.08±2.89 (34-25)	2±0.0 (2.0- 2)	6.55±1.10 (8-5)

Table 4 depicts the monthly sex distribution, ratio and Chi-Square analysis of *Pseudotolithus elongatus* from Makoko axis of Lagos Lagoon. Across the total 398 fish samples analyzed, the highest sampling was obtained in the first month (112) while the least fish samples were collected in 2nd month (46). The female sex had the highest number (215) of samples and sex ratio across the six months except for the month of March where samples were equally distributed and the last month where the ratio of male to female was (1.04:1.00). Of the 183 total samples of male fish, the highest number was obtained in the first month, march and September had similar numbers while similar number of fish samples were also obtained in the month of May and July (29 samples). Generally, the calculated values were lesser than the tabulated values (3.841).

The result of the monthly Length weight relationship using linear regression, Condition factor, Correlation coefficient and morphemetric data and related statistics of male, female and pooled sexes of *Pseudotolithus elongatus* are presented in Table 5. The illustrated results revealed the experiment was carried out for six inconsecutive months. As shown in the table above, the slope values (b) for both sexes exhibited similarly negative allometric growth, since the slope values obtained was less than 3. As obtained in the month of January, the mean body weight and total length values were (49.90g and 13.65 cm) for female, (89.10g and 18.34cm) for female and (68.80g and 15.9cm) for combined sex respectively. Similarly, the female exhibited the highest slope (b) value (2.828) while the lowest can be seen in male (2.532). Generally, the combined sex had the value of 2.660. All values obtained for Fulton's condition factor for month one (January) were greater than 1 indicating that the fish was in a good condition. The correlation coefficient 'r' between log length and log weight was found to be 0.961 in males, 0.988 in females and 0.975 for combined sex. The second analysis (March) established that the value of coefficient coefficient (r) was found close to 1. However, the k value observed for male, female and pooled sexes were below the acceptable range of 1.

Table 4: Sex Distribution, Ratio and Chi-Square analysis of *Pseudotolithus elongatus* in the monthly samples from Makoko axis of Lagos Lagoon

Month	No of Fish Combined	Expected (e)	No of Males (o)	No of Females (o)	Sex Ratio M.F	$\frac{(O-E)^2}{E}$ Males	$\frac{(O-E)^2}{E}$ Females	X^2 Cal	X^2 Tab P<0.05)
January	112	56	53	59	1.0:1.1	0.16	0.16	0.32	3.841
March	46	23	23	23	1.0:1.0	0	0	0	3.841
May	59	29.5	29	30	1.0:1.03	0.08	0.08	0.16	3.841
July	70	35	29	41	1.0:1.4	1.03	1.03	2.06	3.841
September	60	30	23	37	1.0:1.6	1.63	1.63	3.26	3.841
November	51	25.5	26	25	1.04:1.0	0.01	0.01	0.0001	3.841

Table 5: Length weight relationship using linear regression, Condition factor, Correlation coefficient and morphemetric data of *Pseudotolithus elongatus* from Makoko axis of Lagos Lagoon

January	N	A	B	k	R	$W=_aL^b$	Mean of body weight	Mean of total length
Female	58	0.018	2.828	1.20	0.988	$_{0.018}L^{2.660}$	49.90	13.65
Male	54	0.034	2.532	1.08	0.961	$_{0.034}L^{2.532}$	89.10	18.34
Combined sex	112	0.028	2.660	1.19	0.975	$_{0.028}L^{2.660}$	68.80	15.91
March								
Female	23	0.021	2.733	0.95	0.984	$_{0.021}L^{2.733}$	198.98	25.13
Male	23	0.035	2.540	0.98	0.967	$_{0.035}L^{2.340}$	87.08	19.58
Combined sex	46	0.027	2.647	0.97	0.977	$_{0.027}L^{2.65}$	143.03	22.35
May								
Female	30	0.021	2.758	1.07	0.997	$_{0.021}L^{2.758}$	128.69	19.99
Male	29	0.156	1.931	1.31	0.788	$_{0.156}L^{1.931}$	59.27	15.43
Combined sex	59	0.050	2.471	1.19	0.906	$_{0.050}L^{2.471}$	143.03	17.75
July								
Female	41	0.033	2.576	1.20	0.958	$_{0.033}L^{2.576}$	21.52	10.51
Male	29	0.022	2.742	1.09	0.956	$_{0.022}L^{2.742}$	29.81	11.11
Combined sex	70	0.027	2.657	1.26	0.957	$_{0.027}L^{2.657}$	24.954	10.761
September								
Female	38	0.018	2.813	1.14	0.991	$_{0.018}L^{2.813}$	45.32522	13.522
Male	22	0.018	2.810	1.16	0.995	$_{0.018}L^{2.810}$	34.019	12.178
Combined sex	60	0.018	2.801	1.14	0.987	$_{0.018}L^{2.801}$	38.353	12.693
November								
Female	31	0.024	2.755	1.12	0.995	$_{0.024}L^{2.755}$	75.871	13.333
Male	20	0.103	2.137	1.28	0.772	$_{0.103}L^{2.137}$	67.935	15.096

Combined sex	51	0.018	2.801	1.19	0.987	$_{0.018}L^{2.801}$	38.353	12.693

Presented in table 6 is the Percentage of Frequency of food items in the stomach of *Pseudotolithus elongates* from Makoko axis of Lagos Lagoon. The overall stomach contents of the fish species examined reveal a high dietary complexity involving the utilization of a variety of food resources with the species exhibiting four functional feeding guilds. The table 6 revealed four major diets (Mud, Earthworrm, fish and crab) were present in the stomach of *P. elongatus*. Surprisingly, fish did not appear in *P. elongatus* diet in first month and was the least found in the stomach having shown less than 10% across all other sampled months. Mud dominated/constituted the fish diet having the highest with the percentage frequency of 67.11%, 44.44, 41.07%, 62.79%, 51.11% and 58.33% across all the sampled months as shown in Table 6. The different food items in the gut of the Bobo Croaker from Makoko fish market constitute one of the most important aspects of this study. From the result obtained, crabs and Earthworms varied across all sampled months but showed a relatively similar % frequency cumulatively.

The gut fullness and emptiness for each sampled months were shown in Table 7. The table revealed that over 50% of the sampled fish had food in their stomach for all the months sampled. The number of specimens with non-empty guts (% GRI) was highest in month of March (2.17%) followed closely by May (5.08), similarly the number of fish sampled with highest fullness of stomach was obtained in the month of March (97.83%) followed closely by the percentage (94.92) recorded in month of May.

Table 6: Percentage of Frequency of food items in the stomach of *Pseudotolithus elongates* from Makoko axis of Lagos Lagoon

Month	Food Items	Frequency of Occurrence	% Freq. of Occurrence
January	Mud	51	67.11
	Earthworm	16	21.05
	Crab	9	11.84
Total	3	76	100
March	Mud	20	44.44
	Earthworm	6	13.33
	Crab	17	37.78
	Fish	2	4.44
Total	4	45	100
MAY	Mud	23	41.07
	Earthworm	18	32.14
	Crab	13	23.21
	Fish	2	3.57
Total	4	56	100
July	Mud	27	62.79
	Earthworm	6	13.95
	Crab	10	23.26
Total	3	43	100
September	Mud	23	51.11
	Earthworm	9	20.00
	Crab	12	26.67
	Fish	1	2.22
Total	4	45	100
November	Mud	21	58.33
	Earthworm	8	22.22
	Crab	5	13.89
	Fish	2	5.55
Total	4	36	100

Table 7: Frequency of Occurrence of the stomach Fullness and emptiness of *Pseudotolithus elongatus* from Makoko

Months	Stomach Fullness	Number of Samples	Percentage (%)
January	Stomach with foods	76	67.86
	Empty Stomach	36	32.14
	Total	112	100
March	Stomach with foods	45	97.83
	Empty Stomach	1	2.17
	Total	46	100
May	Stomach with foods	56	94.92
	Empty Stomach	3	5.08
	Total	59	100
July	Stomach with foods	43	61.43
	Empty Stomach	27	38.57
	Total	70	100
September	Stomach with foods	45	75
	Empty Stomach	15	25
	Total	60	100
November	Stomach with foods	36	70.59
	Empty Stomach	15	29.41

	Total	51	100

4. Discussion

This present study examined 398 samples for six inconsecutive months. The population and morphometric structure of *P. elongatus* examined in this study contained mostly small sizes that are more vulnerable to multifilament gears. This is supported by the small minimum and maximum body of length and body length irrespective of the sex. The dominant lengths for *P. elongatus* ranged from 10.761 cm to 25.5 cm. This results obtained indicated that most of the fish sampled are yet to attain the adult size. The average length and body weight obtained in this current study for the both sexes is lower than what was reported by Sossoukpe [24]. The differences might be due the dissimilarity of the gear types and sizes used for the capture of fish within the water body [22]. However, Nunoo [25] also reported that 90% of individual of *P. elongatus* assemblages from Lagos Lagoon. Smallest mature male and female fish were 30 cm and 45cm respectively. Generally, the higher morphometric data obtained for females than males might due to environmental factors which tend to instigate phenotypic variation in fishes leading to inconsistent sizes of fish at maturity [26].

As illustrated in table 3, the numbers of female fish samples were more abundant than male sex in all sampled months. Similarly, the ratio of females to males was found to be higher across all sampled months except the month of November. Olapade and Sandy [27] reported that consistency in sex ratio enhances reproductive stability required to increase the recruitment of the fish population. The dominance of female obtained from this study was similar to that of Sidibe [28] and Troadec [29] but in contrast with the report of Austin et al. [22] who worked on *P. senegalensis* and *P. typus* within the coastal waters of Liberia. The sex ratio obtained in this study by Olapade and Tarawallie [27] on *Scomberomorus tritor* in Tombo, of Sierra Leone was also similar to that of our study. This might be due the abundance of females than males in this water. This result obtained in this study was also similar to what was obtained for *B. auritus* in Cape coast Ghana where the number of females exceeded that of the males [30]. The sex ratio of 1: 1.09 (male to female) obtained for trout sweet lips grunt *Plectorhynchus pictus* [31] was not different from what was obtained in this study.

The computation of length-weight relationship result was carried out using the equation of Rickter [21]. The value of 'b' (growth exponent) for male, female and combined sexes were below 3 indicating negative allometric growth pattern based on the generally known values for classification. However, Ayoade and Ikulala [32] affirmed that the growth values of 'b' between 2- 4 falls in the categories of isometric growth. According to Rizvi *et al.* [33] the value of 'b' is generally close to 3 and may vary between 2.5 and 4.0 while [34] also claimed that the standard limit of 'b' values required for isometric growth classification falls between 2.5 to 3.5 which is the case in this study. Based on this claims, our suggested isometric growth pattern since all the values obtained for 'b' in this study were above two ($b > 2$) except for the month of May where ($b = 1.931$) was obtained. This finding is similar to the findings of [35] who obtained a 'b' value of 2.392 for *P. typus*. Similarly, Pathak [36] reported a 'b' value of less than 3 in *Labeo calbasu* from Soni River and Kumar *et al.* [37] reported values less than 3 for the males and females of *Rasbora daniconius* from Karnataka. Abujam and Biswas [51] and Dakua *et al.* [39] all observed dissimilar values for 'b' among or between the members of similar fish species (*Acrossocheilus hexagonolepis*, *Macrognathus aral* and *Esomus danricus*) at different stages of their growth. Availability of food materials, ingestion rates, food compositions, fish species and sex, water quality such as temperature and dissolved oxygen are the major factors responsible variation of growth in fish [2]. Gerritsen *et al.* [40] also claimed that the number of fish evaluated might influence variations in 'b' values between males and females. Equally, Wooten [41] and Sarkar *et al.* [42] reported that proximate composition particularly the lipid content and body morphological structure as well as environmental factors such as temperature, salinity content, availability of food and food type, sex and maturity stage are the major reasons for variation of 'b'. Similarly, the value of 'b' in length-weight relationship of fish is influenced by stomach fullness, overall health status, and the preservative measures adopted during sampling and before laboratory assessment as well as season and the ecosystem [43].

Correlation analyses used in this research revealed "r" value obtained across all months for males which is closely similar to the findings of [35]. The higher correlation coefficient (r) for LWR for female fish samples in this study indicates that length increases with increasing weight more than in male and these values were obtained in the month of January, May and November.

Fulton's condition factor (k), ranged from 0.97 to 1.26 obtained in month of March and July respectively. Although, the condition factor of males, females and pooled sex obtained was greater than 1 except for the values obtained in month of March which means the habitat is stable enough for the wellbeing of fish. However, the highest value of k recorded for male in most months could be related to the claims of Da Costa and Araujo [44] who affirmed that at maturity stage of fish, female reserves their energy specifically for growth and emptying of ovaries which subsequently instigate low condition factor in female fish. Additionally, the differences of the k values between males and females may be attributed to metabolic strain during maturation as well as changes in feeding activity. Similar condition factors were observed in several species of fish by earlier studies [45, 46].

The fish samples evaluated for stomach analysis in this study had complex dietary composition such that this fish ingested varieties of food [47] which includes mud, crabs, earthworms and fish as their major diet. Varieties of food content in the gut of various fish are one major reason for studying the aspect of fish stomach. Of the food items discovered in fish samples, fish as one of the food content observed in the stomach had extremely low index of dominance (< 10.0%) which showed that fish is not part of the major food consumed by this fish examine in this study. Differences in diet observed in fish gut showed that the fish samples within the study area inhabit several part of the way body and not a single part. Robin and Richard [48] affirmed that the biological nature and food choice of Croaker fish allows them to feed on the specific set of food components, although in different quantities regardless of their geographical location. The stomach content analysis revealed that the bobo croaker from Makoko fish market is predatory in nature. It is important to note that environmental and physical factor influences the choice and size of food items fish consume [19]. From the results obtained, mud dominated the content found in the stomach of the fish samples obtained from this study, this might be because they mostly lives or stay in demersal part over the mud bottom. This result compared favorably with the findings of Fagade and Olaniyan [49] that reported that crabs

were the main food items of croaker. Although, crabs found in the stomach of fish samples from this study were not the most abundant. Lagler *et al.* [50] reported that the fish species from the sciaenidae family are often known with diets such as snails, clams and hard bodies of crustaceans.

Graphical illustrations of length-weight relationship

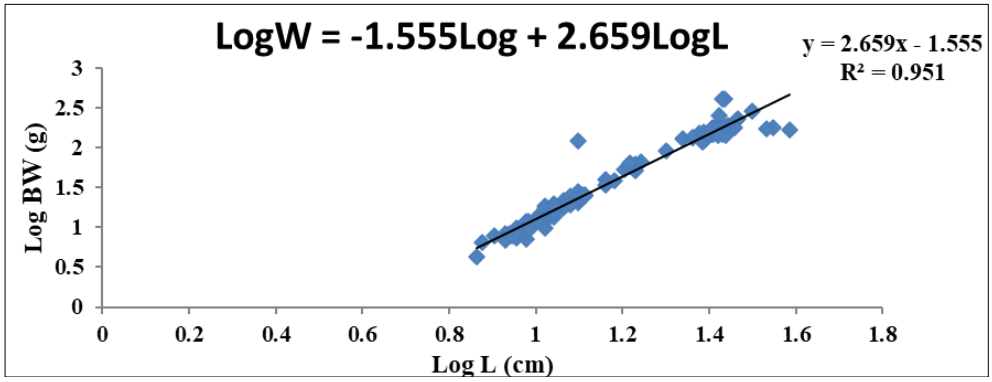

Fig 1: Logistic length weight relationship of *Pseudotolithus typus* (Pooled sex) for January, 2021

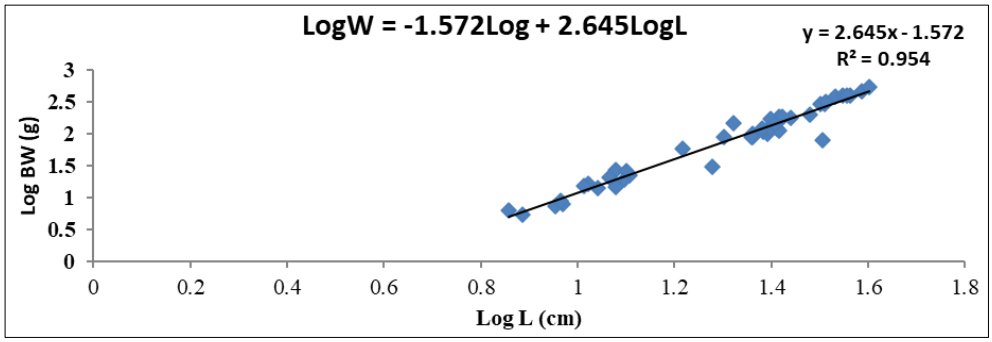

Fig 2: Logistic length weight relationship of *Pseudotolithus typus* (Pooled sex) for March, 2021

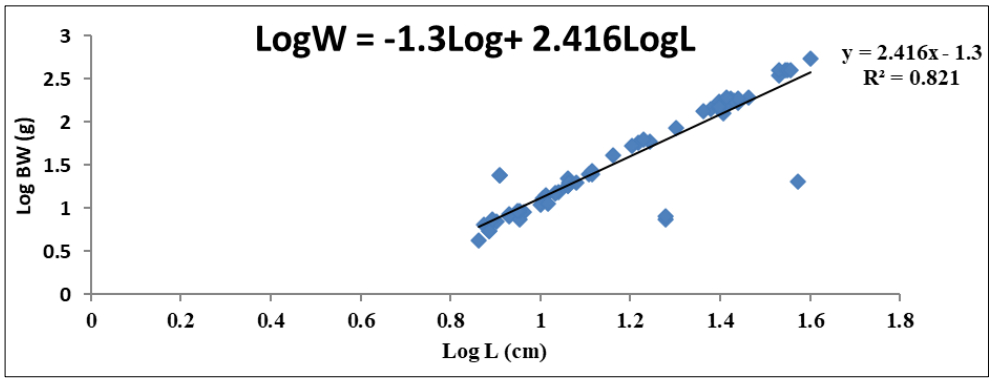

Fig 3: Logistic length weight relationship of *Pseudotolithus typus* (Pooled sex) for May, 2021

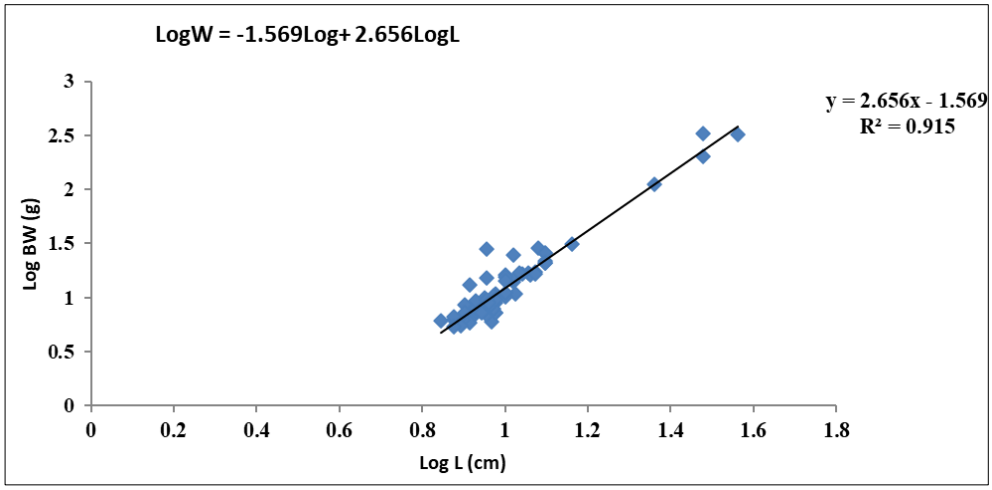

Fig 4: Logistic length weight relationship of *Pseudotolithus typus* (Pooled sex) for July, 2021

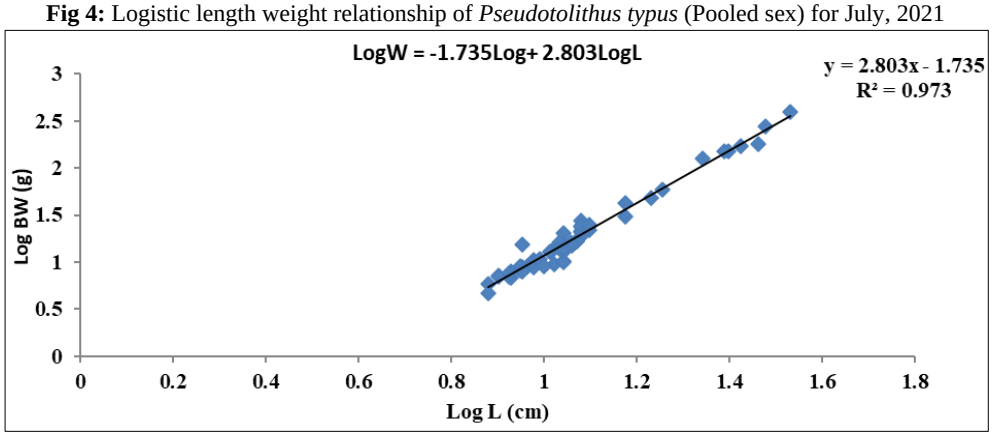

Fig 5: Logistic length weight relationship of *Pseudotolithus typus* (Pooled sex) for September, 2021

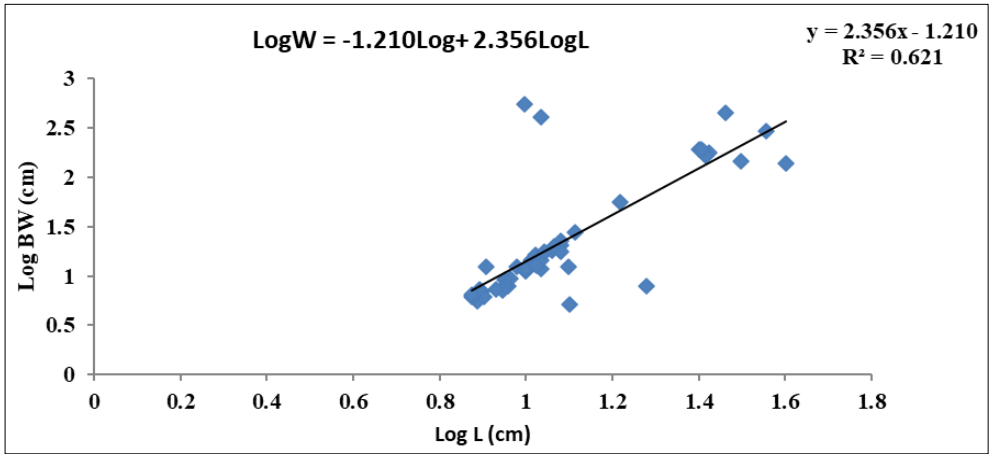

Fig 6: Logistic length-weight relationship of *Pseudotolithus typus* (Pooled sex) for November, 2021

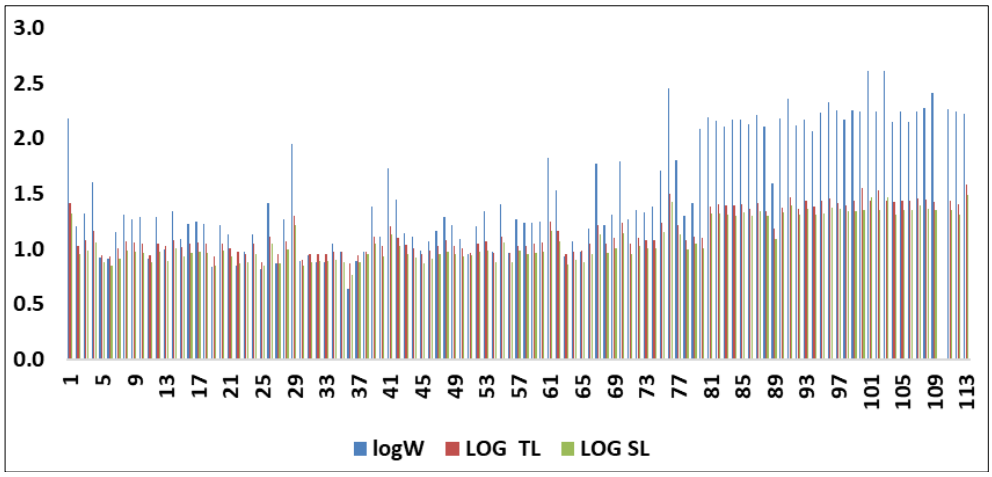

Fig 7: Histogram showing computation of TL and SL and BW of *Pseudotolithus elongatus*

5. Conclusion

This work provides scientific information on the Meristic, length-weight relationships, condition factor and stomach content of *Pseudotolithus elongatus* from Makoko market of Lagos Lagoon complex. Although, the results obtained for length-weight relationship in the study indicate negative allometric growth for females, male and combined sexes. However, the results on condition factor of females, male and combined sexes are greater than 1 except the result obtained in the month of March. This indicates that these fish samples are healthy and that the environment is conducive. The study on stomach content analysis revealed that the bobo croaker from Makoko fish market is predatory in nature with earthworm and crabs the major items. Further studies in relation to the proximate composition and reproductive aspect of Bobo Croaker from the study area should be done in order to update and provide more scientific information. Intensive monitoring of this water body should be mandated to ensure sustainability of the fishery.

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7. Author's contributions

All authors contributed to the research concept and study design. The conceptualization, supervision and Methodology were done by Jolaosho Toheeb Lekan and Olorunniyi Shema Itunuola. Data curation and funding by Olorunniyi Shema Itunuola while the editing and visualization was done by Jolaosho Toheeb Lekan and Olorunniyi Shema Itunuola. The original draft preparation and data analysis was done by Jolaosho Toheeb Lekan. The final manuscript was read and approved by all authors prior to submission.

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9. Data Availability Statement

The data used for evaluation is available upon reasonable request

10. Conflict of Interest

The authors declared no conflict of interest.

11. Ethical approval Statement

This research paper as reported by the authors does not involve animals provided that the ethical rules exclude Finfish.

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