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Length-Weight Relationships and Morphometry for Eleven (11) Fish Species from Ogudu Creek, Lagos, Nigeria

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Abstract: The Length-weight relationships (LWRs) were investigated in eleven (11) fish species from Ogudu Creek between December 2010 and October 2011. Specimens were caught with non return valve traps, gill and cast nets. They were sorted to the lowest taxonomy level and identified using identification manuals. The morphometric data such as fish's eye diameter (ED), head length (HL), body depth (BD) and total length (TL) measurements were determined from Vernier caliper and measuring board and body weight (BW) from Sartorious weighing balance. The growth coefficients of the LWRs were determined using the SPSS and Microsoft office Excel software. The fish assemblages consisted of 191 individuals belonging to 8 families, 10 genera and 11 species of freshwater and marine origins. The fish size varied between 7 cm TL (10.7 g BW) in *Psettias sebae* and 25.1 cm TL (136.1 g BW) in *Liza falcipinnis*. Growth coefficient, b ranged from 1.84 (*Elops lacerta*) to 5.20 (*Chiromidotilapia guentheri*) and correlation coefficient, r^2>0.60. The eight (8) species exhibited allometric (b<3<b) and one (1) isometric (b=3) growth patterns. There were variations in the species morphometry. This information provides important tool in fishery management and modeling of aquatic ecosystem.

Key words: Standing Stock Biomass · Aquatic Ecosystem Modeling · Allometry · Isometry · Morphometric Measurement

INTRODUCTION

Length-weight relationship (LWR) is an important tool in fishery management; its importance is pronounced in estimating the average weight at a given length of a fish. Length weight regressions have been used frequently to estimate weight from length because direct weight measurements can be time consuming in the field [1]. The morphometric relationships between fish length and weight can be used to assess the well being of individuals and to determine possible differences between separate stocks of the same species [2]. LWR is important in fisheries management for comparative growth studies [3, 4]; it provides valuable information on the aquatic habitat [5] and in aquatic ecosystem modeling [6]. It is often used as an indication of fatness and general well being [7], in gonad development of fish [8] and in the estimation of standing stock biomass and comparing the ontogeny of fish population from different regions [9]. Length weight relationships for some fishes are documented in some recent reviews [10-13]. In Lagos, Nigeria, reviews of LWRs include Fafioye and Oluajo [14] for five species from Epe lagoon, Agboola and Anetekhai [15] for 35 species from Ologe lagoon, Kumolu-Johnson and Ndimele [16] for 21 species from Ologe lagoon and Lawson [17] on Mudskipper, *Periophthalmus papilio* from Lagos lagoon. In Niger Delta area, Nigeria, some of the reviews are also documented in King [2], Anene [18], Abowei [19] and Aboweiet *al.* [20]. Information on the fish and fisheries of Ogudu Creek, Lagos (including the length weight relationships for its fishes) is lacking. In view of this our investigation is the first documented information on aspects of the fish and fisheries of this important water body.

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MATERIALS AND METHODS

Description of Study Area: Ogudu Creek, Lagos is located on latitude of 6°33' 52 N and a longitude of 3°24' 9 E. It is a relatively a small, narrow and shallow creek with average depth of 2 meters, It has an average elevation of 37 meter above sea level and adjourned by Lagos lagoon, Majidun and Ogun River. The Creek is of importance to artisanal fisheries, serves as a mean of transportation for the residents of Kosofe Local Government area and the neighboring Ikorodu, Somolu and Ikeja Local Government Areas of Lagos State. The Creek also serves as a major drainage channel that receives both domestic and industrial wastes from nearby industries at Maryland, Ikeja and Ogudu areas of the Lagos metropolis. Sand mining is a common practice in the area. The land area is not cultivated and most part of the natural vegetation remains intact. Its climate is tropical savanna with a tropical dry forest biozone. Major source of water into the creek is from Ogun River via Lagos lagoon.

The shore of the creek is denticulate and surrounded with forest, typical of those found in the mangrove swamps and brackish water system. Its major biotopes include the mangroves (*Rhizophora racemora*, *Avicennia nitida*); the sedges (*Cyperus articulatus*, *C. papyrus* and *Paspalum vaginatum*); the ferns (*Achrosticum* sp., *Marsilea* sp., *Cyclosorus* sp. and *Ceratopleris* sp.) and the palms (*Pandanus candelabrum*, *Raphia hookeri* and *Phoenix reclinata*).

Field and Laboratory Procedures: The fish specimens were caught from the Creek between December 2010 and October 2011. They were caught with non return valve traps, gill and cast nets. Local artisanal fishermen were employed for the setting of gears and collection of fish. Gears were carefully set to maximize the number of species captured, species not captured after extensive sampling were assumed to be absent or so rare as to be of minimal ecological importance. Rare species were retained; their exclusion reduces the chances of distinguishing communities represented by a few samples only. The specimens were preserved with 10% formaldehyde buffer solution in the field.

In the laboratory, the fish were identified and sorted to the lowest level of taxonomy following Reed *et al*. [21, Schneider [22], FAO [23, 24], Oguzie [25] and Olaosebikan and Raji [26]. Further descriptions of the species were carried out on the free encyclopedia Wikipedia [27]. Number of individuals in each taxonomic level and species abundance were taken into cognizance.

Collection of Biometric Data: Morphometric data such as eye diameter (ED), head length (HL), body depth (BD) and total length (TL) measurements were obtained for individual fish using Vernier caliper and standard measuring board with snout facing left. The body weight (BW) measurement was obtained, using Sartorious weighing balance (model: 1106). In the present study, ED was taken as a measurement of the eye orbit, HL as a distance between the snout and a point direct behind the operculum and BD was a vertical distance between a dorsal fin base and the ventral fin base (the deepest part of the body). TL was a distance from the snout to the tip of caudal or tail fin. ED, HL, BD and TL measurements were in nearest 0.01cm and BW in nearest 0.01 g. Body ratio was expressed as proportion of one part of the fish to another, these included ED:HL, HL:BD, HL:TL and BD:TL proportions.

The Length-weight relationship (LWR) was derived from equation: $W=aL^b$. [7, 28].

The logarithm transformation of the equation was expressed as:

$\text{Log } W= \text{Log}a+b\text{Log}L$ [7, 29].

This equation is sometimes known as the length-weight key [30].

where, W=fish body weight in grams, L=fish total length in centimeters, a=intercept or constant and b=slope or length exponent and r=correlation coefficient. The "a" and "b" and "r" values were calculated from linear regression of the fish length and weight measurements. The determination of coefficient r^2 was used as indicator of the quality of the linear regressions [31]. Growth was regarded as isometry when the value of b=3 and allometry when less or greater than 3 ($b<3<b$ or $b<3$, $b>3$). The student's t-tests were used to verify whether the parameter b were significantly different from the expected or theoretical value of 3 (i.e $b=3$, $p<0.05$). Thus,

$t_s=(b-3)/sb$ ([32].

where t_s=student's t test, b=slope, sb=standard error of the slope.

$$sb = \sqrt{\frac{[(sW/sL)-b^2]}{(n-2)}}$$

where sW=variance of body weight, sL= variance of total length, n=sample size.

All the statistical analyses were considered at significance level of 5% ($p<0.05$). The Statistical Package for Social Sciences (SPSS, version 16) and Microsoft Office Excel software were implored in this study.

RESULTS

Summary of Length-weight relationships for eleven fish species in Ogudu Creek is presented in Table 1. The fish assemblages of Ogudu creek comprised 191 individuals from 10 families, 10 genera and 11 species. Species composition consisted two (2) marine and nine (9) freshwater fish. All species considered in this study were commercially important to residents of this creek.

The fish size was as small as 7 cm TL (10.7 g BW) in *Psettias sebae* and as large as 25.1 cm TL (136.1 g BW) in *Liza falcipinnis*. The growth parameter (b) of LWR varied between 1.23 and 5.50. Species exhibited both allometric (b<3, b>3) and isometric (b=3) growth types. The Student's t-test showed that the b (b=1.23-2.72; S_b=1.49-7.25; t-test: t=-0.188--0.746; $p<0.05$) was significantly lower than the theoretical value of 3 indicating negative allometric growth for *Tilapia dageti*, *Sarotherodon melanotheron*, *Synodontis ocellifer*, *Chrysichthys aluuensis* and *Elops lacerta*, while the student t-test for *Chiromidotilapia guentheri*, *Kribia kribiensis*, *Citharinus latus* and *P. sebae* showed significant higher values (b=3.11-5.2; S_b=3.26-27.04; t-test: t=-0.091-0.139; $p<0.05$) indicating positive allometric growth. However, *T. mariae* exhibited isometric growth (b=3; S_b=1.24; t-test: t= 0.083; $p>0.05$), with no significant difference from the theoretical value of 3.

In the present study, overall growth parameter, r^2 values were positive and highly correlated with $r^2>0.60$ between fish total length and body weight measurements. All relationships were highly significant ($p<0.05$) with $r^2>0.90$ in eight (8) different species and r^2=0.67-0.77 in three (3). The least, r^2= 0.61 was in exhibited by *C. aluuensis* and the highest value of r^2= 0.99 by *L. falcipinnis*, *P. sebae* and *S. ocellifer*.

Summary of the morphometric data for eleven (11) fish species from Ogudu Creek, Lagos, Nigeria is presented in Table 2. The species variations in the morphometric measurements of fish in Ogudu Creek included: ED, 0.14±0.02 in *E. lacerta* to 0.97±0.49 cm in *T. dageti*; HL, 2.37±0.37 (*P. sebae*)-5.2±0.69 cm (*K. kribiensis*); and BD, 0.7±0.95 (*P. sebae*) -5.34±0.57 cm (*C. latus*). The ratios of ED in HL varied from 2.53±0.1 in *P. sebae*) to 7.49±2.52 in *K. kribiensis*, HL:BD, 0.02±0.03 (*K. kribiensis*) – 2.76±0.27 (*P. sebae*); HL:TL, 3.32±0.25 (*K. kribiensis*) - 4.85±0.31 (*L. falcipinnis*); and BD:TL, 1.29±0.13 (*P. sebae*) – 8.37±5.47 (*E. lacerta*).

Table 1: Summary of Length-weight relationships for eleven (11) fish species from Ogudu Creek, Lagos, Nigeria.

			Total length (cm)			Body weight (g)			Growth coefficient					
Family	Species	Sample size (n=)	min	max	mean±SE	min	max	mean±SE	a	b	r^2	sb	t-test	Type of growth
Cichlidae	*Tilapia dageti*[f]	52	9.0	16.8	13.01±1.61	23.8	129.1	50.23±19.55	-0.659	2.1	0.77	1.69	-0.532	-A
	Tilapia mariae[f]	44	8.5	15.4	11.56±2.14	9.6	68.9	31.81±18.48	-1.844	3.0	0.97	1.24	0.083	I
	Sarotherodon melanotheron[f]	43	9.1	14.7	11.77±1.48	18.6	89.1	38.55±14.57	-1.344	2.72	0.92	1.49	-0.189	-A
	Chromidotilapia guentheri[f]	5	12.2	13	12.8±0.35	36.7	62.5	46.88±9.56	-4.093	5.20	0.74	27.04	0.081	+A
Mugilidae	*Liza falcipinnis*[m]	21	9.7	25.1	14.1±3.44	9.6	136.1	30.71±27.60	-1.846	2.84	0.99	1.72	-0.091	-A
Eleotridae	*Kribia kribiensis*[f]	6	13.6	20.2	17.2±2.26	37	118.6	80.03±31.85	-2.039	3.17	0.96	6.86	0.025	+A
Citharinidae	*Citharinus latus*[f]	5	12	14.5	13.36±1.12	22.6	51.1	36.36±11.24	-2.671	3.75	0.98	5.38	0.139	+A
Monodactylidae	*Psetias sebae*[f]	6	7	9.8	8.32±1.13	10.7	30.1	19.02±8.14	-1.606	3.11	0.99	3.26	0.034	+A
Mochokidae	*Synodontis ocellifer*[f]	3	14.5	16.5	15.73±1.08	41.4	48.2	45.87±3.87	0.187	1.23	0.99	3.37	-0.523	-A
Bagridae	*Chrysichthys aluuensis*[f]	3	16	22	18.27±3.26	38.9	82.8	66.73±24.2	-0.259	1.64	0.67	7.25	-0.188	-A
Elopidae	*Elops lacerta*[m]	3	12.2	16.5	13.87±2.30	12.4	22.8	4.22±5.56	-0.896	1.84	0.93	1.55	-0.746	-A

Legend: [m]=marine species, [f]=freshwater species, n=sample size, min=minimum, max=maximum, cm=centimeters, g=grams, a=intercept, b=slope, r= correlation coefficient, sb= standard error of the slope, t= student's t-test, +A=positive allometric growth, -A=negative allometric growth, I=isometric growth.

Table 2: Summary of the Morphometric data for eleven (11) fish species from Ogudu Creek, Lagos, Nigeria

	Morphometric measurements* and ratios												
	Eye diameter (ED)			Head length (HL)			Body depth (BD)			ED:HL	HL:BD	HL:TL	BD:TL
Fish species	min	max	mean± SE	min	Max	mean±SE	min	max	mean±SE	mean±SE	mean±SE	mean±SE	mean±SE
T. dageti	0.6	4.3	0.97±0.49	2.9	5.2	3.71±0.52	3.3	5.6	4.22±0.45	4.10±0.81	1.15±0.13	3.53±0.38	3.09±0.26
T. mariae	0.4	0.9	0.86±0.16	2.5	4.5	3.41±0.66	2.1	5.4	3.23±0.75	5.03±0.81	0.95±0.10	3.4±0.2	3.62±0.31
S. melanotheron	0.5	0.9	0.82±0.12	2.5	4.2	3.47±044	2.8	5.1	3.97±0.52	4.28±0.48	1.15±0.08	3.4±0.24	2.98±0.26
C. guentheri	0.9	1.0	0.94±0.06	3.5	4.4	3.80±0.37	4.0	4.5	4.26±0.18	4.03±0.22	1.13±0.07	3.39±0.27	3.01±0.13
L. falcipinnis	0.4	1.3	0.69±0.22	2.0	5.0	2.91±0.66	1.9	6.4	2.82±0.99	4.40±0.78	0.96±0.11	4.85±0.31	5.10±0.47
K. kribiensis	0.4	1.9	0.83±0.54	4.3	6.1	5.20±0.69	2.5	3.7	3.23±0.52	7.49±2.52	0.02±0.03	3.32±0.25	5.35±0.37
C. latus	0.6	0.8	0.72±0.08	2.7	3.8	3.30±0.49	4.7	6.0	5.34±0.57	4.59±0.46	1.63±0.08	4.08±0.32	2.51±0.10
P. sebae	0.8	1.1	0.93±0.14	1.9	2.9	2.37±0.37	5.6	8.2	0.70±0.95	2.53±0.10	2.76±0.27	3.53±0.13	1.29±0.13
S. ocellifer	0.6	0.8	0.67±0.12	3.2	5.2	3.93±1.10	3.7	4.0	3.87±0.15	5.33±0.60	1.03±0.23	4.12±0.86	4.07±0.33
C. aluuensis	0.9	1.1	0.97±0.12	3.5	5.6	4.60±1.05	2.1	3.5	3.00±0.78	4.80±1.25	0.65±0.07	4.03±0.51	6.28±1.34
E. lacerta	0.8	1.2	0.14±0.02	2.9	4.5	3.63±0.81	0.9	3.4	2.20±1.25	3.63±0.13	0.57±0.23	3.96±1.09	8.37±5.47

Legend: *=measurements in centimeters (cm), min=minimum, max=maximum, SE=Standard Error, ED=Eye Diameter, HL=Head Length, BD=Body Depth, TL=Total Length.

DISCUSSION

The present study showed there were variations in length and weight data of fish from Ogudu Creek. Captured fish varied in size between 7 cm TL (10.7 g BW) in *Psettias sebae* and 25.1 cm TL (136.1 g BW) in *Liza falcipinnis*. The fish assemblages were mainly populations of juvenile fish. This is a confirmation that Ogudu creek tends to follow a typical classical estuary pattern where juveniles utilize as nursery and feeding grounds. The absence of fish below 7.0 cm total length may be associated with fish gear selectivity rather than implying the absence of small sized individuals.

The growth parameter values of b=1.23 (*S. ocellifer*), 1.64 (*C. aluuensis*), 1.84 (*E. lacerta*) and 5.2 (*C. guentheri*) (Table 1) were outside the limits of 2 to 4. Others (*T. dageti*, *T. mariae*, *S. melanotheron*, *L. falcipinnis*, *K. kribiens*is, *P. sebae* and *C. latus*) with values of b ranging from 2.1 - 3.75 were within limits and were in agreement with reports of Bagenal and Tesch [33] and Koutrakis and Tsikliras [29]. Furtherance to this, Agboola and Anetekhai [15] reported b= 2.53–3.35 for 35 fish species from Badagry Creek, while Fafioye and Oluajo [14] documented between 2.790 and 3.210 for five (5) fish species from Epe Lagoon. It is pertinent to know that growth is isometry when b=3, an indication that species are growing symmetrically and by implication the species are neither too heavy nor light for their size. Therefore, the fish lengths increase in equal proportion with body weights [34, 35]. Values less or greater than 3 (i.e. b<3<b) are allometry [36]. Therefore, growth is a negative allometry when b<3, an indication that fish are lighter than their body weights. Growth is described as positive allometry when b>3, meaning the fish are heavier than their lengths. Fish with high b values are heavy for their lengths, while those with low b are lighter [8]. For these reasons fish are light when b<3, heavy when b> 3 or isometric when b=3 indicating poor, over or symmetric growths of length and weight respectively.

Growth (b=3.11-5.2; S_b=3.26-27.04; t-test: t=-0.091-0.139; p>0.05) in *C. guntheri*, *K. kribiensis*, *C. latus* and *P. sebae* showed positive allometry and indications of their heaviness in Ogudu creek. Values (b=1.23-2.72; S_b=1.49-7.25; t-test: t=-0.188--0.746; p>0.05) indicating negative allometric growth for *T. dageti*, *S. melanotheron*, *S. ocellifer*, *C. aluuensis* and *E. lacerta* and the fish were lighter than their body weights. However, isometric growth (b=3; S_b=1.24; t-test: t= 0.083; p=0.05) in *T. mariae* implies that *T. mariae* was neither too heavy nor light for its size.

Reviews of allometric growth in some Nigerian waters include that of Lawson [17] who documented b= 2.806 (males) -2.915 (females) in the mudskipper (*Periophthalmus papilio*) from Lagos lagoon. Lawson and Jimoh [37] gave accounts of 2.968 (males) -2.929 (females) in the grey mullet (*Mugil cephalus*) from Lagos lagoon, Lawson and Aguda [38] reported 2.27 in tenpounder (*Elops lacerta*) from Ologe lagoon, Lawson *et al.* [39] recorded 2.48 (males)-2.91(females) in stripped mullet (*Liza falcipinnis*) from Badagry Creek. In Giant African threadfin, *Polydactylus quadrifilis* b=2.27 (males)-2.92 (females) were reported from Badagry creekby Lawson and Olagundoye [40] and 1.43 in frillfin goby (*Bathygobius soporator*)from Badagry creek [41]. Isometric growth was reported in *Ethmalos afimbrata*, *Ilisha africana* and *Elops senegalensis* from Nkoro River by Abowei *et al*., [20], while Marcus [42] in *E. fimbriata* from coastal and brackish waters of AkwaIbom and King [2] in *Pseudotolithus elongatus* from Qua Iboe Estuary in Nigeria.

The values of b in fish are affected by several factors such as season, habitat, gonad maturity, sex, diet, stomach fullness, health, preservation techniques and annual differences in environmental condition [7, 30]. Others include seasonal variability of the environment and food availability [43, 44], sample size and the length interval within different areas [45] or habitat suitability [46]. In addition, growth increment, differences in age and stage of maturity as well as environmental conditions such as temperature, salinity and seasonality can affect the value of b for the same species [47, 48].

In the present study, overall growth parameter, r^2 values of the LWRs were positive and highly correlated with r^2>0.60 between fish total length and body weight measurements. All relationships were highly significant (p<0.05) with r^2> 0.90 in eight (8) different species and 0.67-0.77 in three (3). The least, r^2 =0.61 was in exhibited by *C. aluuensis* and the highest value of r^2 =0.99 by *L. falcipinnis*, *P. sebae* and *S. ocellifer*. These imply that species' lengths and weights were growing proportionately. The LWR parameters may be affected by age, maturity and sex [49]; feeding, reproduction and fishing activities [50]; environmental changes, individual metabolism, sexual maturity and age [51].

The present study showed variations in the morphometric measurements of fishes, these variations differed within each and across fish species. It is also important to know that the variations exhibited by each species were not significant enough to conclude whether

there was racial difference within each species [52]. The variations are confirmations that eleven (11) fish species in this study are genetically diversified. In addition, the measurements did not show that each species was taxonomically separable based on our stated methodology. Therefore, more precise results on genetic and morphological diversities among the populations of the fishes are required. In furtherance to this, we have embarked on a research program at molecular level of analysis such as Randomly Amplified Polymorphic DNA (RAPD) primers and RAPD markers to provide better and more precise results.

CONCLUSION

This present study therefore highlights the length-weight relationships and morphometry for eleven (11) fish species from Ogudu Creek and it is the first documented report on biological aspects of any fish species from this water body. Report also serves as an additional research work to what had been reported by workers in the adjourning waters. It is a useful source of information in fisheries management, especially in fish sampling programs, to estimate growth rates, length and age structures and other components of fish population dynamics and fish stock assessment. Finally, it is important for assessment of well being of the individuals and possible differences between separate unit stocks of the fish.

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