SOME ASPECTS OF THE GROWTH FEATURES AND CONDITION FACTOR OF *ARIUS GIGAS* (BOULENGER, 1911) FROM OBUAMA CREEK (RIVERS STATE, NIGERIA)

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DOI: 10.2478/trser-2021-0015

KEYWORDS: length-frequency distributions, length-weight relationship, length-length relationship, Giant sea catfish.

ABSTRACT

Length-frequency distributions, length-weight relationships, length-length relationships and condition factors (Fulton's K_F , allometric K_A , and relative K_R) of *Arius gigas* in the Obuama Creek in Rivers State, Nigeria were investigated. 217 samples were collected from artisanal fishermen fishing on the Obuama Creek from March to September 2019. The parameter b of the length-weight relationship was 2.52 indicating negative allometric growth. The K_F ranged from 0.51 to 2.03 with a mean value of 0.85 ± 0 while the overall low values of K_R and K_A in this study are generally a characteristic of fish in poor health. This study provides basic information on some of the biological features of *A. gigas* which should be useful for facilitating management strategies and regulations of the stocks.

RÉSUMÉ: Quelques aspects des caractéristiques de croissance et du facteur de condition d'*Arius gigas* (Boulenger, 1911) d'Obuama Creek (État de la Rivière, Nigéria).

Les distributions de fréquence de longueur, les relations longueur-poids, les relations longueur-longueur et les facteurs de condition (K_F de Fulton, K_A allométrique et relatif, K_R) d'*Arius gigas* dans le ruisseau Obuama dans l'État de la Rivière, au Nigeria, ont été étudiés. De mars à septembre 2019, 217 échantillons ont été prélevés avec l'aide des pêcheurs artisanaux qui pêchent dans le ruisseau Obuama. Le paramètre b de la relation longueur-poids était de 2,52 indiquant une croissance allométrique négative. Le K_F variait de 0,51 à 2,03 avec une valeur moyenne de $0,85 \pm 0$, tandis que les valeurs globales et faibles de K_R et de K_A dans cette étude sont généralement caractéristiques des poissons en mauvaise santé. Cette étude fournit des renseignements de base sur certaines des caractéristiques biologiques de l'*A. gigas* qui devraient être utiles pour faciliter les stratégies de gestion et la réglementation des stocks.

REZUMAT: Unele aspecte ale caracteristicilor de dezvoltare și indicele ponderal la *Arius gigas* (Boulenger, 1911) din Pârâul Obuama (Statul Râurilor, Nigeria).

Distribuțiile lungime-frecvență, relațiile lungime-greutate, relațiile lungime-lungime și factorii de condiție (K_F al lui Fulton, K_A alometric și relativ K_R) ai lui *Arius gigas* în Pârâul Obuama din Statul Râurilor, Nigeria au fost investigați. 217 probe au fost colectate de la pescari artizanalii care își desfășoară activitatea în Pârâul Obuama în martie-septembrie 2019. Parametrul b al relației lungime-greutate a fost de 2.52 indicând o creștere alometrică negativă. K_F a variat de la 0.51 la 2.03, cu o valoare medie de 0.85 ± 0 , iar valorile globale scăzute ale K_R și K_A din acest studiu sunt, în general, caracteristice peștilor cu o sănătate precară. Acest studiu oferă informații de bază cu privire la unele dintre caracteristicile biologice ale *A. gigas*, care trebuie să fie utile pentru facilitarea strategiilor de gestionare și reglementare a stocurilor.

INTRODUCTION

The majority of Ariidae fish, which are known as marine catfish, inhabit shallow coastal areas and estuaries in tropical and temperate regions. A restricted number of species is either entirely confined to marine waters where they can be found at depths of 150 m or to freshwaters in the upper tributaries of rivers 500 km away from their river-mouths. (Marceniuk and Menzes, 2007) This family has 30 genera and 143 species; the genus *Arius* has 27 species (Froese and Pauly, 2011). Out of the four species recorded in the Gulf of Guinea, three species are found in the Nigerian freshwaters, these are *Arius gigas*, *Arius lutiscutatus*, and *Arius heudeloti* (Schneider, 1990; Adesulu and Sydenham, 2007).

The giant sea catfish (*Arius gigas*) is of commercial significance as a food fish and one of the dominant species in the Nigerian Industrial coastal fisheries; however, its population has declined due to overfishing and possibly chemical pollution from the outcome of these factors, the IUCN red list currently lists the species as Data Deficient (IUCN, 2019). According to the National Bureau of Statistics (2017), fish production by species in Nigerian waters from 2010 to 2015 showed a steady increase in the sea catfish from 2010 (17,236 tons) to 2014 (23,854 tons) and then declined sharply in 2015 to 17,444 tons.

The studies on growth are components of fish stocks management and are used to characterize the state of fish populations. For example, relations between total and standard lengths of fish are important in management for comparative growth studies (Sandoval-Huerta et al., 2014). Information generated from length-weight relations can also be used to assess fish conditions and fish growth patterns, whether isometric or allometric (Pope and Kruse, 2001; Hashim et al., 2017), based on the assumption that heavier fish of a given length are in better condition (Pope and Kruse, 2001; Sandoval-Huerta et al., 2014; Hashim et al., 2017).

Information on the length-weight relationship and condition factor of *A. gigas* inhabiting the Nigerian water is very scarce and incomplete (IUCN, 2019). Thus, the goal of this study was to assess the length-frequency distributions (LFDs), length-weight relationships (LWRs), length-length relationships (LLRs), and condition factors (allometric, K_A , Fulton's, K_F and relative, K_R) of *Arius gigas* from the Obuama Creek, Rivers State, Nigeria, so as to provide background information for its conservation and better management.

MATERIAL AND METHODS

The study was conducted in Obuama Creek (Fig. 1) a tributary of the Sombrero River, in Rivers State, Nigeria. A freshwater system whose waters originate from outside or wholly within the lowlands of the coast and which experiences tidal effects as manifested in many species of marine fish. Rivers State features a tropical monsoon climate with lengthy and heavy rainy seasons and very short dry seasons. The dry season is between November and March and the wet season is from April to November. In the wet season, annual rainfall is between 49.5 mm in January and 580 mm in July and is usually interrupted by a short dry spell in August. The average temperature ranged from 27.1°C to 31.1°C.

Monthly fish samples were collected at random (once a month) from the local fishermen using beach seine nets of various mesh sizes (stretched) ranging between two and 19 cm from March to September 2019. Specimens were taken from two major landing sites along the creek. Station 1 (Mission Poku) is situated between 04°48.004' North latitude and 006°46.565' East longitude, while station 2 (Erimia Poku) is situated between 04°48.033' North latitudes and 006°46.523' East longitude (Fig. 1). These two sites are considered representative sampling sites due to the routine landing of *A. gigas* caught by beach seine. A total of 109 and 108 fish samples were recorded in station 1 and station 2, respectively.

Figure 1: Map of the study area showing the sampling stations on Obuama Creek, Nigeria.

Fresh samples (dead fish) were immediately chilled in ice on site and fixed with 10% alcohol upon arrival in the Fisheries Laboratory of University of Port Harcourt, Nigeria for proper identification using the keys constructed by Schneider (1990) and Adesulu and Sydenham (2007). After cleaning and washing the specimens, total length (TL), fork length (FL) and standard length (SL) were recorded to the nearest 0.1 cm, and weight (W) was measured with a precision balance (0.01 g).

The length-weight relationships were calculated using the equation $W = aL^b$, where W: body weight (g), L: fish length (TL, cm), a : regression constant and b : regression coefficient (Le Cren, 1951). The length-length relationships were estimated by the simple linear regression: $Y = a + bX$, where Y: various body lengths, X: total length, a : proportionality constant, and b : regression coefficient (Zar, 1996).

The condition factor (K_F) was calculated according to the formula by Fulton (Froese, 2006) as follow: $K_F = 100 \cdot W/L^3$, where W: body weight (g) and L: fish length (TL, cm). The relative condition factor (K_R) for each individual was calculated using the formula by Le Cren (1951): $K_R = W/(a \cdot L^b)$, where W = body weight, L = total length, a and b = LWR parameters. The allometric condition factor (K_A) was calculated using the formula by Tesch (1968): $K_A = W/L^b$, where W = body weight and L = total length and b = LWR parameter. The condition factors from the two stations were quantified using t-test.

RESULTS AND DISSCUSION

The total length ranged from 17 to 39 cm with a mean value of 26.91 ± 4.57 cm and the body weight ranged between 40 and 556 g with a mean value of 174.25 ± 90.62 g. The mean values for fork length, standard length and weight of liver weight were 21.40 ± 4.00 cm, 19.41 ± 3.80 cm, and 1.96 ± 1.20 g respectively. The size of *A. gigas* in the present study (17 to 39 cm) was similar to the findings of Abohweyere (2011) who reported that the total length of *A. gigas* ranged from 15-42 cm in Sombreiro River and Creek. However, the size of the species in the present study was lower than in Taylor (1986) who reported a maximum length of 165 cm. This may be related to differences among fishing gear used, and too different of ecological condition of these habitats.

Descriptive values of the length (cm) and weight (g) measurements (TL, FL, SL, W, and LW) are presented in table 1. The TL-frequency distribution showed that the maximum population stands on 25 cm TL size group and dominant length groups were 25 to 29 cm (Fig. 2). Length-frequency distributions provide a vision to help understand when the fishing pressure starts and ends (Khan and Khan, 2014). In this study, the variation in fish size (length-frequency) indicated that the fish population ranged from immature specimens to fully matured ones with the majority of fish captured by the fishermen in the category of immature or small individuals. This means that the Obuama Creek could be characterized as nursery ground. This is in agreement with Little et al. (1988), who noted that creeks serve as a nursery ground, in which fingerlings are developed. Nevertheless, their large-scale exploitation has resulted in mass destruction of the stock. Heavy fishing produces a population of mainly young small individuals, since the fish are caught as they reach a catchable size and before spawning, so that reproduction capacity of the stock is seriously impaired and where adult survival is lower, the fish begin reproduction at an earlier age and invest a greater proportion of their energy budget into reproduction (Molles, 2010). Therefore, there is a need for regulations requiring a minimum legal size of the fish caught as a conservation measure for *A. gigas*. The minimum mesh size used by the fishermen ranged from two cm and the maximum size was 19 cm in the study area. By increasing the minimum mesh size to from two to 7.5 cm, it will reduce juvenile fish being caught and allow the fish mature and reproduce before they are captured. The mesh size (7.5 cm) was recommended as the standard as minimum mesh size for all inland water bodies in Nigeria. However, in the absence of effective regulations, all native communities in Nigeria have customary laws on water rights. For example, community regulations stipulate who should fish where, when, and with what fishing gear in a river. Other measures include closure of areas, of seasons, ban on taking small fish, and provisions allowing a portion of catch to escape. So, devolution of the resources and allocation decisions to the local fishers will often be the most effective way of resolving uncertainties and improving management (Bailey, 1982). It would be far easier, more effective and less costly. However, in the last few decades, fishing communities in Nigeria have been fragmented as a result of civil unrest and have found it difficult to survive and operate as unit as a result of continuous conflicts in rural areas. Integrating and mobilizing fishermen to manage the fish is the only solution.

Table 1: Descriptive statistics on the length (cm) and weight (g) measurements of the *Arius gigas* in the Obuama Creek, Nigeria; n, sample size; TL, total length; SL, standard length; CL, confidence limit for mean values.

Measurement	N	Min	Max	Mean $\pm$ SD	CL _{95%}
Body weight (g)	217	40	556	174.25 $\pm$ 90.62	162.13 – 186.38
Total Length (cm)	217	17	39	26.91 $\pm$ 4.57	26.30 – 27.52
Fork Length (cm)	217	13	33	21.40 $\pm$ 4.00	20.87 – 21.94
Standard Length (cm)	217	12	30.2	19.41 $\pm$ 3.80	18.90 – 19.92
Weight of liver (g)	217	0.34	6.4	1.96 $\pm$ 1.20	1.80 – 2.12

Figure 2: Total length distribution frequency of *Arius gigas* in the Obuama Creek, Nigeria.

The regression parameters (a and b) and their 95% CL in the LWRs, co-efficient of determination (r^2) and growth type of *A. gigas* are shown in table 2 and figure 3. The exponential value of length-weight relationships ' b ' was 2.52 for the TL vs. W, 2.34 for the FL vs W and 2.22 for SL vs. W (Tab. 2) all which indicated negative allometric growth. The b value in this study falls between two and four and are close to three that are usually obtained for fishes (Tesch, 1968). By negative allometry ($b < 3$), the fish is said to be "lighter for its length" as it grows (Froese, 2006). The b parameter of the length-weight relations of fishes is affected by a number of factors, including environmental conditions (such as temperature and salinity), sex, gonad maturity, health, season, habitat, nutrition, area, degree of stomach fullness, differences in the length range of the caught specimen, and the fishing gear used (Tesch, 1971; Froese 2006).

Table 2: Descriptive statistics and estimated parameters of the length-weight relationships ($BW = a \times L^b$) with 95% confidence limits and – A negative allometric growth types of *Arius gigas* in the Obuama Creek, Nigeria; TL, total length; FL, fork length, W, body weight; K_A , allometric.

Equation	a	b	CL95% of a	CL95% of b	r^2
$BW = a \times TL^b$	-3.21	2.52	-6.98 – -0.05	1.58 – 3.64	0.79
$BW = a \times FL^b$	-2.10	2.34	-2.99 – -1.8433	2.33 – 2.57	0.80
$BW = a \times SL^b$	-1.50	2.22	-2.67 – -0.79	1.99 – 2.62	0.79

Figure 3: Relationship between the body weight with the total length, fork length, and standard length of *Arius gigas* in the Obuama Creek, Nigeria.

Furthermore, results of the length-length relationships (SL vs. TL, TL vs FL, and SL vs FL) of *A. gigas* are presented in table 3 with the regression parameters (a and b) of the LLRs and, co-efficient of determinations (r^2). The calculated b value was 1.05 for SL vs. TL with the r^2 value of 0.86 and SL vs FL the b value was 1.02 and r^2 value was 0.95 while TL vs FL, the b value was 0.87 and r^2 was 0.89. LLR is important in fisheries management for comparative growth studies (Moutopoulos and Stergiou, 2002). In this study, the b value of length-length relationships for SL vs. TL, TL vs FL and SL vs FL were 1.05, 1.02 and 0.87 respectively indicating allometric growth *A. gigas* in the Obuama Creek. The results were lower than the minimum and maximum b values of 1.2 and 1.3 respectively reported by Fishbase (2019). The corresponding significant correlation coefficients (r^2) indicating a length-weight relationships (in log scale) are strongly linear in all the cases.

Table 3: Descriptive statistics and estimated parameters on the length-length relationships of *Arius gigas* in the Obuama Creek, Nigeria; TL, total length; FL fork length, SL, standard length; a, intercept; b, slope ; r^2 , coefficient of determination.

Equation	a	b	r^2
SL = a + bTL	-0.50	1.05	0.86
SL = a + bFL	-0.16	1.02	0.95
TL = a + bFL	0.62	0.87	0.89

The condition factor K_F ranged from 0.51 to 2.03 with a mean value of $0.85 (\pm 0.22)$ close to the standard threshold of one, indicating that the species were in good condition. Carlander (1950) identified K_F as a sensitive measure of changes and differences in body form. According to Ricker (1975) condition factor below 0.7 is considered to be low, and above 0.9 is high, the larger the factor the better the condition. This study postulates that the K_F is the best biometric index for assessing the well-being of this species in the study area with values ranging from 0.51 to 2.03 and a mean value of 0.85 ± 0.22 . Koivogui et al. (2020) reported lower values of 0.40 ± 0.04 to 0.68 ± 0.05 and 0.33 ± 0.04 to 0.50 ± 0.06 for male and female *A. gigas* respectively from the bays of Tabounsou and Sangareah in Republic of Guinea. The condition factor in the lifetime of fish may vary with change depending on various factors such as climatic condition, locations, time, and stages of development (Blackweel et al., 2000). Due to differences in environmental conditions, between systems different fish populations display different levels of condition according to exploitation pressure such as quality and type of fishing gears, level of fishing efforts, food availability, or catchment characteristics (Boys et al., 2012).

Monthly variations of K_F showed that the lowest value (0.73) was recorded in September and the highest value (2.03) in June (Fig. 4). The monthly variations in condition factors could be attributed to various reasons such as changes in environmental factors with time (i.e. water quality), availability of natural food supply, physiological condition (i.e. accumulation of fat and gonads development) (Jennings et al., 2001) and stage of maturity (Khallaf et al., 2003). The higher condition recorded in June could be attributed to good water quality and an abundance of food in the study area due to the highest rainfall in the month. The condition factor is a quantitative indicator of individual wellbeing reflecting recent food availability conditions (Le Cren, 1951). According to several researchers, many tropical fish were reported to breed at the beginning of the rainy season due to the large varieties of food items (Marsh et al., 1986).

Monthly variations of K_F showed that the lowest value (0.73) was recorded in September and the highest value (2.03) in June (Tab. 4). In this study, K_R was studied in order to evaluate the health and productivity of *A. gigas* in the Obuama Creek. According to Le Cren (1951) the value of K_R higher than one indicates good health and less than one indicates relatively poor condition of the fish. The mean value for K_F as shown in table 5 below in station 1 was 0.83 ± 0.02 , while that of station 2 was 0.90 ± 0.03 . The t test indicates that there was no significant relationship between the two stations ($t = -2.32 = P < 0.16$) (Tab. 5). The overall, low values of K_R and K_A in this study are generally characteristic of fish in poor health. However, low values of K_R and K_A could be attributed to the fact that the morphometric condition indices may have a limited sensitivity, and provide a rapid, non-invasive measurement of the physiological status of the fish (Brown and Murphy 1991; Neumann and Murphy, 1991).

Figure 4: Monthly fluctuation of Fulton's condition factor of *Arius gigas* in the Obuama Creek, Nigeria.

Table 4: Descriptive statistics and condition factors measurements and their 95% confidence limits of the *Arius gigas* in the Obuama Creek, Nigeria; allometric condition factor; K_A ; K_F ; Fulton's condition factor; K_R , relative condition factor values; CL, confidence limit; P, shows the level of significance.

Condition factors	N	Min	Max	Mean $\pm$ SD	CL _{95%}
K_F	217	0.51	2.03	0.85 ± 0.22	0.82 – 0.88
K_R	217	0.60	1.13	0.61 ± 0.11	0.55 – 0.61
K_A	217	0.52	0.71	0.54 ± 0.31	0.04 – 0.54

Table 5: Comparisons between conditions factors of *Arius gigas* in the two stations in the Obuama Creek, Nigeria; allometric condition factor; K_A ; K_F ; Fulton's condition factor; K_R , Relative condition factor.

	Station 1	Station 2	t-value	p-value	Decision
K_F	0.83 ± 0.02	0.90 ± 0.03	-2.32	0.16	NS
K_R	0.61 ± 0.03	0.70 ± 0.01	-2.22	0.18	NS
K_A	0.57 ± 0.01	0.64 ± 0.02	-2.10	0.15	NS

CONCLUSIONS

This study provides important data on the length frequency distributions length-weight relationship, length-length relationships, and condition factors of *Arius gigas* from Obuama Creek which should be useful in facilitating management strategies and regulations for the sustainable conservation of the fish stocks of this species.

ACKNOWLEDGEMENTS

We thank the University of Port Harcourt, Faculty of Agriculture, Rivers State, Nigeria for providing access to the equipment and facilities during this study.

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