

Length-weight Relationships and Condition Factor of Three Species of Mullet (Mugilidae) in the New Calabar River

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ABSTRACT

This study was conducted to estimate the length-weight relationship and condition factor of mullets (Mugilidae) in the New Calabar River, Nigeria. The fish samples were collected monthly from the local fishermen landings between February and July 2018. A total of 578 individuals were collected that belong to three species (*Neochelon falcipinnis* Valenciennes, 1836, *Parachelon grandisquamis* Valenciennes, 1836 and *Mugil cephalus*, Linnaeus, 1758) of the family Mugilidae. The total length mean values were found to be 16.26 ± 2.41 cm (*N. falcipinnis*), 19.95 ± 4.73 cm (*P. grandisquamis*) and 16.11 ± 2.44 cm (*M. cephalus*). The mean wet weight values were 39.53 ± 22.16 g (*N. falcipinnis*), 81.54 ± 76.94 g (*P. grandisquamis*) and 38.43 ± 21.12 g (*M. cephalus*). *N. falcipinnis*, *P. grandisquamis* and *M. cephalus* exhibited isometric, negative allometric and isometric growth pattern with “b” values of 3.0, 2.895 and 2.964, respectively. The condition factors of all the three species ranged from 0.30-1.73 indicating that the three species were in good state.

Keywords: Allometry, Condition factors, Length-weight, Mugilidae, New Calabar River

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INTRODUCTION

The family Mugilidae containing ray-finned fishes commonly called mullets or grey mullets, are one of the most ubiquitous teleost families in coastal waters of the world, occurring in most temperate, sub-tropical and tropical waters in both hemispheres (Crosetti & Blaber, 2016). Mugilidae belongs to the order Mugiliformes, containing 18 genera and 81 species (Nelson, 2006).

According to Ditty and Shaw (1996), mullets are said to be semi-catadromous, with the recruitment of its juveniles to lagoons and estuaries, following a period of offshore spawning. Mulletts are important economic resources that support many small communities through both fishing and aquaculture (Pina & Chaves 2005; Katselis *et al.*, 2005). The extraordinary adaptability of the family Mugilidae, has resulted in species that are found mainly in the clear and pristine waters of coral reefs to those that prefer highly turbid estuarine and fresh waters (Crosetti & Blaber, 2016).

Species belonging to this family are medium to large sized silvery-grey fishes with moderately

long body covered in large rough scales (lateral line is absent), having broad flattened head, small or moderate mouth size and eyes partly covered by an adipose eyelid (Harrison & Senou, 1997), known to attain a common maximum length of 41 cm with a maximum published weight of 262 g (Dankwa & Blay, 2005).

Length-weight relationship (LWR) is another important tool in fisheries science. Among biometric relation in fishes, the length-weight relationship (LWR) are widely presented by authors as useful tools with several applications in the domains of fisheries sciences, population dynamics, ecology and stock assessment (Pauly, 1983). Its importance is pronounced in estimating the average weight at a given length group (Beyer, 1987) and in assessing the relative well-being of a fish population (Bolger & Connoly, 1989).

Fishery resources (mulletts included) are declining due to overexploitation and inadequate management of inland and coastal waters as well as environmental degradation (Lawson & Olusanya, 2010; Jamu & Ayula, 2003). The statistics for mullet fish production for 2011 was 11,115 metric tons while it decreased to

10,923 metric tons in 2014 (NBS, 2017). Therefore, this study is aimed at estimating the length-weight relationship, condition factors of the mugilid species in the New Calabar.

MATERIALS AND METHODS

Study Area

The study was carried out in the New Calabar River of Rivers State, Nigeria which is a partially mixed estuarine river (Figure 1). The climate is tropical, with high rainfall and annual precipitation of 2372 mm (range 2000 – 3000 mm; Abowei, 2000).

The New Calabar River is a black water type (Ubong & Gobo, 2001), which takes its rise from Elele-Alimini where it is acidic, fresh and non-tidal (Erondu & Chindah, 1991). It is joined by a smaller tributary river at Aluu, which takes its rise at Isiokpo. It further empties into some creeks and lagoons bordering the Atlantic Ocean. According to Dienye (2015), the New Calabar River is regarded as one the important water resources in the Niger delta region of southern Nigeria, because a lot of communities present around these areas directly depend on the river for their agricultural, recreational and sometimes domestic water supplies. The sampling stations are the middle reaches of the river which empties into the Bonny

River. These sampling stations were chosen because they are major landing sites in the river course.

Data Collection

Fish samples were collected from three sampling stations along the New Calabar River, they include; Choba, with a distance of 5021.5meters to Ogbogoro and also with a distance of 3806.86 meters to Iwofe landing sites. Weekly field survey was carried out from February to July 2018 with the help of local fishermen using various fishing gears: beach net (10–15 m length, 2–3.5 m height, mesh size 0.5–5 cm), fixed gill net (40–60 m long, mesh size 15–57 mm), Cast net (2–5 m diameter, mesh size 15–20 mm) and local traps (made from raffia palm; diameter 20 mm and 80 mm deep). Gillnets and traps were set between 1600 hours and 1800 hours and fishes caught were removed from the gear between 0600 hours and 0900 hours the next day. Dugout canoes with paddles were used during the sampling within the river. Fishes were identified after Adesaulu and Sydenham (2007). Fish specimens were measured to the nearest mm using a meter rule and weighed to the nearest 0.1 g with a top loading Sartorius balance (model BP 310S). The sampling duration with the fishing gear and methods were approximately the same

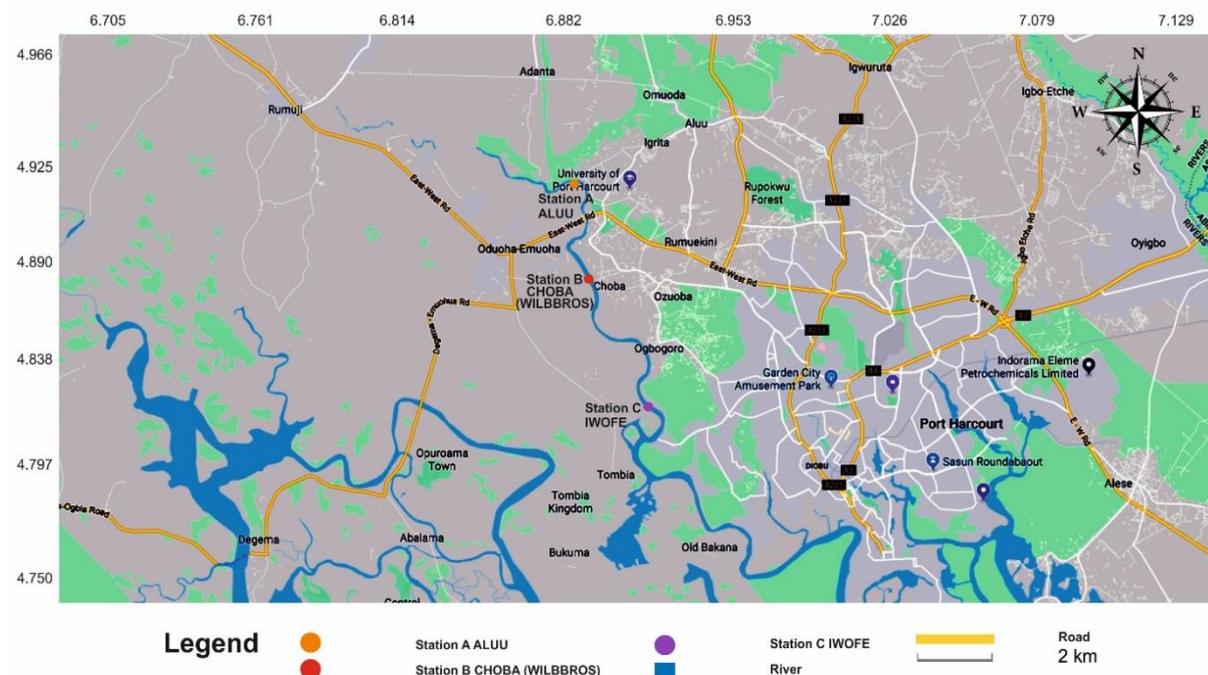


Figure 1. Map of the study area showing the sampling stations.

throughout the period.

Data Analysis

A growth index using FiSAT II (Pauly, 1983) was performed to statistically analyse the length-weight relationship and condition factor. Regression analysis was carried out using Scientific Package for Social Science (SPSS) version 23 in the New Calabar River (Eq. 1).

$$\text{Length-weight relationship (W)} = aL^b \quad (1)$$

where,

W = Weight of fish in grams (g)

L = Length of fish in centimeters (cm)

a = Describe the rate if change of weight with length (intercept)

b = Weight at unit length (slope).

Eq. 1 was then transformed to log (Eq. 2) to estimate the parameters 'a' and 'b' (Nehemia *et al.*, 2012).

$$\text{The condition factor (K)} = 100 w/L^b \quad (2)$$

where,

w = Weight of the fish in gram (g)

L = Total length in centimeters (cm)

b = Value obtained from the length-weight equation

RESULTS

Three species belonging to Mugilidae family was identified (Table 1). A total of 578 fish samples belonging

to three species were caught during the study: *Neochelon falcipinnis*, *Parachelon grandisquamis* and *Mugil cephalus*. The size composition of the three mullet species ranged from 9.00 to 27.50 cm (*N. falcipinnis*), 11.40 and 41.60 cm (*P. grandisquamis*) and 10.00 to 27.20 cm (*M. cephalus*). *P. grandisquamis* had the highest mean wet weight of 81.54±76.94 g, followed by *N. falcipinnis* (39.53±22.16 g) and *M. cephalus* (38.43±21.12 g).

Table 2 below shows that the value of parameter b ranged from 2.895 for *P. grandisquamis*, to 3.004 for *N. falcipinnis*. The coefficients of determination (r²) of the length-weight relationship (LWR) regressions as shown in Figures 2a, 2b and 2c ranged from 0.635 for *N. falcipinnis* to 0.868 for *P. grandisquamis*, and 0.644 for *M. cephalus*. The condition factors of the studied fish species were found to be between 0.30–1.71 for *N. falcipinnis* to 0.92–0.32 for *P. grandisquamis*.

DISCUSSION

The study revealed that mean total length value varied between 16.26±2.41 cm (*N. falcipinnis*), 19.95±4.73 cm (*P. grandisquamis*) and 16.11±2.44 cm (*M. cephalus*). Mean of wet weight varied from 39.53±22.16 g (*N. falcipinnis*), 81.54±76.94 g (*P. grandisquamis*) and 38.43±21.12 g (*M. cephalus*). According to King *et al.* (2017) mullets attain sexual maturity in 3 to 4 years at a size of about 30 cm. Studies

Table 1. Mean weight, standard length and total length of fish species.

	N	Weight (g)		Standard Length (cm)		Total Length (cm)		Girth (cm)	
		Mean±SD	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	Range
<i>Neochelon falcipinnis</i>	274	39.53±22.16	10.00 - 180.00	12.64±1.98	9.00 - 22.00	16.26±2.41	9.00 - 27.50	6.90±1.56	4.00 - 12.50
<i>Parachelon grandisquamis</i>	91	81.54±76.94	10.00 - 560.00	15.59±3.62	9.00 - 30.00	19.95±4.73	11.40 - 41.60	8.24±2.28	4.50 - 16.00
<i>Mugil cephalus</i>	213	38.43±21.12	10.00 - 160.00	12.55±1.94	7.90 - 20.00	16.11±2.44	10.00 - 27.20	6.81±1.58	4.00 - 12.00

Table 2. Overall condition factors and the growth pattern of Mugilidae in the New Calabar River.

Species	K		a	b	r ²	Growth pattern
	Mean	Range				
<i>Neochelon falcipinnis</i>	0.89±0.27	0.30-1.71	-4.811	3.004	0.635	Isometry
<i>Parachelon grandisquamis</i>	0.92±0.32	0.33-2.15	-4.438	2.895	0.868	Negative allometry
<i>Mugil cephalus</i>	0.83±0.25	0.34-1.73	-4.700	2.964	0.644	Isometry

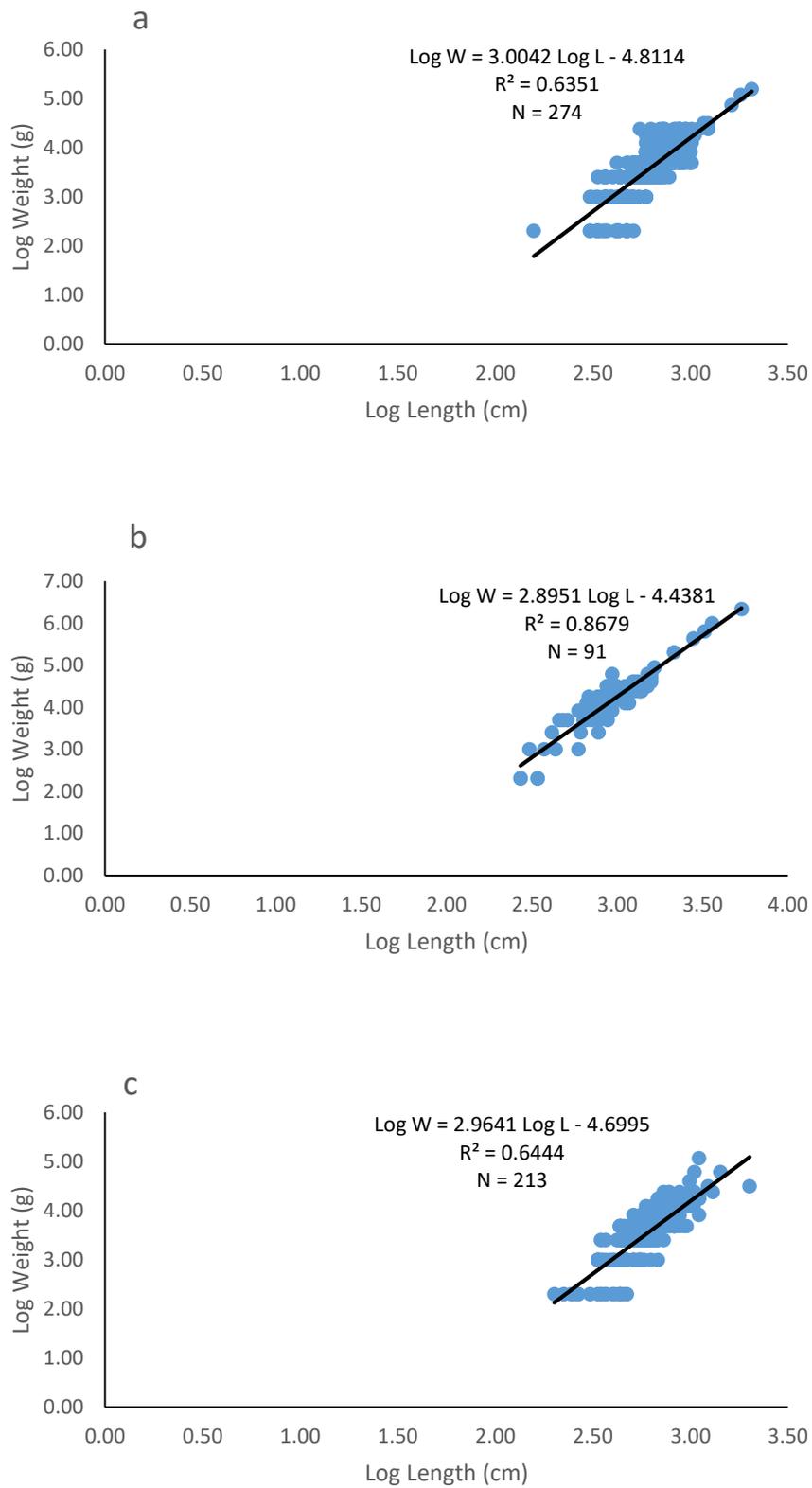


Figure 2. Growth patterns of (a) *Neochelon falcipinnis*, (b) *Parachelon grandisquamis*, and (c) *Mugil cephalus* in the New Calabar River.

carried out at other locations revealed a mean length of 16.37 cm and a mean weight of 71.19 g was observed for *Mugil cephalus* as well as a mean length of 17.76 cm and a mean weight 76.88 g for *Neochelon falcipinnis* in the Ologe Lagoon, Lagos (Kumolu-Johnson & Ndimele, 2010). Kolawole-Daniels *et al.*, (2017) observed a mean weight of 49.89g and 81.76 g for *M. cephalus* and *N. falcipinnis*, respectively with a length range of 12.5–28.7 cm and 12.5–21.5 cm for both *M. cephalus* and *N. falcipinnis*, respectively in Lagos Lagoon. Comparing the information gathered above to that of the present study, it can be said that the different mean total length (TL) and weight fell below the values recorded by King *et al.*, (2017). Mulletts are known to be semi-catadromous, with the recruitment of its juveniles to lagoons and estuaries, following a period of offshore spawning (Ditty & Shaw 1996). Akinrotimi *et al.*, (2010) reported adult fish species at the Buguma creek, Niger delta for *P. grandisquamis* and *N. falcipinnis* in which the author attributed this occurrence to the fact that adults prefer water bodies with high salinities as they live mostly and spawn readily in the sea even as we understand that the New Calabar River is also part of the Niger delta region.

The results revealed that *N. falcipinnis*, *P. grandisquamis* and *M. cephalus* exhibited isometric, negative allometric and isometric growth pattern with “b” values of 3.0, 2.895 and 2.964, respectively. The negative allometric growth pattern obtained for *P. grandisquamis* implied that the species became slenderer as it increased in length (Riedel *et al.*, 2007). A negative allometric growth pattern was observed for *N. falcipinnis* (2.991) and *M. cephalus* (2.823) in the Ologe lagoon Lagos (Kumolu-Johnson & Ndimele, 2010). Kolawole-Daniels *et al.* (2017) which is in contrast to the findings of this study. Olopade *et al.* (2019) further observed a negative allometric growth for *M. cephalus* (2.77) and *N. falcipinnis* (2.38). However, an isometric growth pattern was recorded for *N. falcipinnis* (3.18) at the Lagos lagoon and *N. falcipinnis* (3.0) in waters around Port Harcourt (Allison *et al.*, 2008), which is in agreement with the findings of this present study. There are factors, which lead to differences in “b” values in fish specimen, namely shape and fatness of the species, temperature, salinity, food, sex and stage of maturity (Pauly, 1984; Sparre & Venema, 1992). According to Dienye and Woke (2015) the physico-chemical parameters of the sampled sites along the New Calabar River showed that pH of the river ranged between 6.3 and 6.72, temperatures

ranged from 26.02 to 26.53 °C, and the dissolved oxygen (DO) ranged from 4.49 to 6.45 mg/L. The mean values for salinity ranged from 1.08 to 5.93 mg/L, chemical oxygen demand (COD) ranged from 1.74 to 2.67 mg/L, and biological oxygen demand (BOD) ranged from 0.17 to 0.23 mg/L.

The study area exhibited temporal variation which could be attributed to the mixing of the upper and lower reaches and pollution as a result of industrial activities going on in and around the river (Dienye & Woke, 2015). It is also inferred that higher “b” values imply relatively productive environmental conditions (Gopakumar *et al.*, 1991), and if observed properly, the growth patterns of the studies listed above all vary among themselves. Differences between these findings and the results of this study may be due to differences in ecological conditions of water bodies (Nehemia *et al.*, 2012), and as King (1991) observed, the inland waters of Nigeria have fish population, which are dominated by population having negative isometric growth pattern.

The mean condition factors in this study ranged from 0.83 ± 0.25 (*M. cephalus*) to 0.92 ± 0.27 (*P. grandisquamis*). The slight differences in K values could be attributed to the differences in habitats, food availability, gonad development and gender of the fish (Quilang *et al.*, 2007; Zhu *et al.*, 2008; Hussain *et al.*, 2010; Ndome & Eteng, 2010). Other factors that influence the condition of a fish include the number of specimens examined, season and area, spawning, degree of stomach fullness, healthy or diseased condition, differences of fishing gear and/or mesh size sizes, preservation techniques employed, and differences in the observed length ranges of the specimens (Borges *et al.*, 2003; Andrea-Soler *et al.*, 2006; Verdiell-Cubedo *et al.*, 2006). The mean condition factors of all species was greater than 1 with K value ranging from 2.53 ± 0.34 to 3.45 ± 0.29 , which indicates that the three species were in a good state of well-being.

CONCLUSION

The results revealed that *N. falcipinnis*, *P. grandisquamis* and *M. cephalus* exhibited isometric, negative allometric and isometric growth pattern with “b” values of 3.0, 2.895 and 2.964, respectively. The condition factors of all the three species ranged from 0.30–1.71 to 0.34–1.73 indicating that the three species were in good state of well-being. The maximum mean size

observed in this study indicated that most species were juveniles and are not allowed to grow to adults in the environment due to exploitation of these fish species at the landing sites of the study area. The results of this study can be an effective tool to develop management strategies for these Mullet species with ultimate aim of conservation of the most preferred food fishes of the states and a healthy mullet fishery can be expected in the river when fishery regulations are enforced.

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