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Species composition, length-weight relationship and condition factor of shrimps landed at Choba Jetty, New Calabar River, Rivers State

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Abstract

Nutritious commercially important shrimps abound in Nigerian waters, albeit proper management is needed for sustainability. Determining the composition, length-weight relationship and condition factor will guide shrimp management in the New Calabar River (NCR). This study was conducted at Choba Jetty of the NCR using a longitudinal survey design whereby shrimp data were collected at the Choba landing site monthly for four months (August-November, 2023). Standard method was used to determine physico-chemical parameters. The shrimps were identified with standard identification keys. The range of pH was 6.90±0.07 to 7.13±0.17, temperature, 27.8±0.59 to 28.45±0.64ºC, conductivity, 17.01±1.45 to 17.65±2.54µS/cm, dissolved oxygen, 3.02±0.69 to 3.5±0.54mg/l, total dissolved solids, 13.2±3.61 to 14.3±1.55mg/l, and BOD, 6.05±2.15 to 7.02±0.54mg/l. Two shrimp species, *Macrobrachium macrobrachion* and *Palaemontes africanus* belonging to the Family Palaemonidae were encountered. The length-weight relationship showed negative allometric growth for both species, suggesting that the rate of increase in body length is disproportionate to weight. The condition factors for *M. macrobrachion* (0.77-0.92) and *P. africanus* (0.84-0.88) do not indicate good state of well-being of the shrimp populations. The condition of NCR during the period study was not suitable for the shrimp populations.

Introduction

Shrimps are a great source of protein and they are consumed worldwide. Its global appeal and economic export value are why they are important culture candidates in aquaculture (Creed 2009; Okayi *et al* 2012). Shrimps are staple food in Nigeria, especially in riverine and coastal areas. They are found abundant in subtropical and tropical freshwater ecosystems (Nahavandi, *et al* 2010). Shrimps are relevant to the freshwater ecosystem, playing important roles in the ecosystem, such as nutrient recycling, indicator species and bait (Qureshi and Amanat 2014; Chak and Duffy 2019).

Common species include *Farfantepenaeus notialis* (pink shrimp), which is a commercially important shrimp found in Nigerian coastal and marine waters. It is known for its pinkish coloration, good taste and is sought after in the shrimp fishery (Lawal-Are and Akinjogunla 2012). *Farfantepenaeus notialis* population in Nigeria's coastal waters has come under threat due to over-exploitation, making shrimp farming a common aquaculture practice in coastal areas (Zabbey *et al* 2010; Ray *et al* 2021). The New Calabar River is a connecting river that houses a variety of different species of organisms, including shrimps, serving not only as a key component of the local ecosystem but also as a resource central to the artisanal fishing activities in the region (Utang and Akpan 2012). The Shrimp Fisheries in New Calabar River occupy an integral role in the livelihoods of the local communities, while also contributing to the broader socio-economic fabric of the area. Like other freshwater habitats of shrimps, there are a lot of anthropogenic activities going on that can adversely affect the physico-chemical parameters and resident biota of the river (Tekenah, *et al* 2014; Deekae *et al* 2016; Edori and Nna 2018). The primary problem that this research addresses is the need to investigate, and analyze the composition, and diversity of shrimp species landed at Choba Jetty to inform conservation efforts, fisheries management, and the sustainable utilization of this vital resource.

Materials and method

Study area

The study was carried out at the New Calabar River (Figure 1), situated in Port Harcourt, River State between longitude 006º53 53086'E and latitude 04º 53' 19.020'N. The river flows through different communities Choba, Iwofe, Ogbakiri, Ogbogoro, and Aluu (Benneth-Ikiroma and Omokheyeke 2020), and it empties into the Atlantic Ocean with the whole river situated between longitude of 7º60'E and latitude 5º45'N in the coastal area of the Niger Delta (Woke and Aleleye-Wokoma 2015). The river is surrounded by residential houses, markets, abattoirs, and industrial activities such as sand dredging, mining and fishing.

Study design

A longitudinal design was used for the study, whereby shrimp samples were collected at the Choba Jetty once

every month for four months, August to November 2023. The assessment of the physico-chemical parameters of three sampling stations (Choba, Ogbogoro and Aluu) of the New Calabar River (NCR) were carried out.

Shrimp collection

Shrimps were collected every month with the help of artisanal fishermen. Following the collection, the specimens were kept in an ice-packed cooler and carried straight to the laboratory. Further observation and identification of the shrimp was conducted at the Department of Animal and Environmental Biology Laboratory, University of Port Harcourt.

Total length (distance from the tip of the rostrum to the extremity of the telson), rostral length (distance from the tip of rostrum to the posterior margin of the orbit), and body length (distance from the posterior margin of the orbit to the extremity of the telson) were measured to the nearest 0.01cm on a graduated measuring board (Chu *et al* 1995). The weight of the shrimp was measured using a digital weighing balance (BA-31212HTP), and the measurement was taken to the nearest 0.01g. Sexes were determined through morphological examination using the presence of the thelic for females and the petasma for the males.

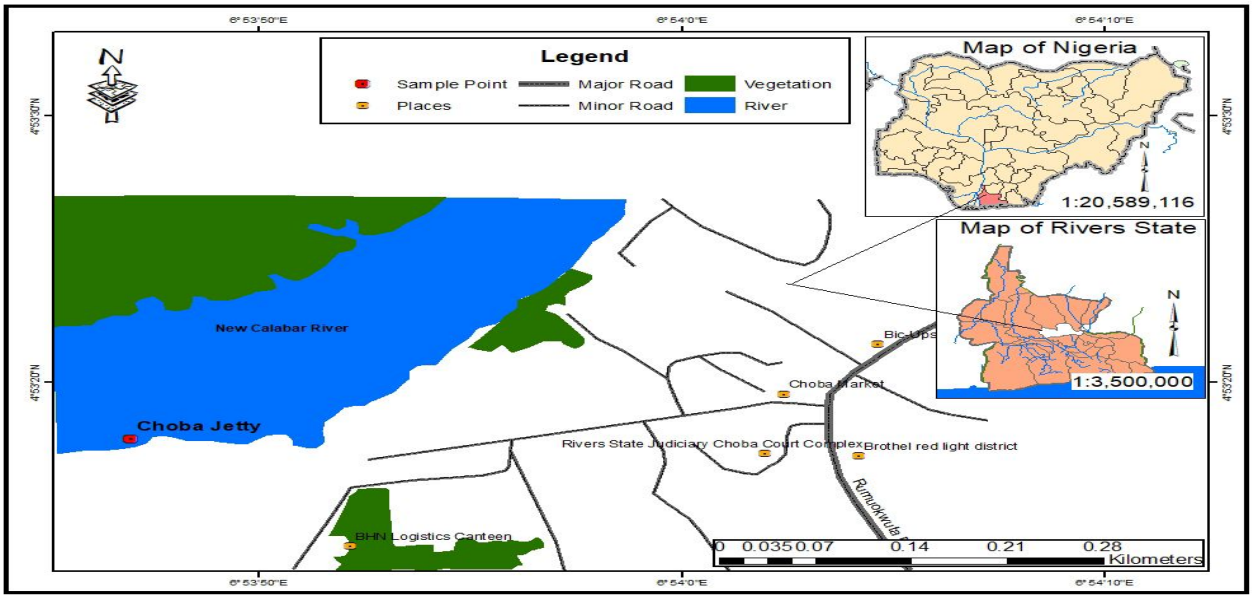

Figure1. Map of New Calabar River showing Choba Jetty

The relationship between the length and weight of shrimp species was expressed in the equation below by Pauly (1983)

$$W = L^b \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (i)$$

Where W = weight of shrimps in (g)
L = total length of shrimp in (cm)
a = constant (intercept)
b = exponent (slope)

The "a" and "b" values were obtained from a linear regression of the length and weight of shrimps. The relationship was given a logarithm transformation according to the following formula;

$$Log_{10}W = a + b\ LogL \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (ii)$$

The shrimp's state of wellbeing was calculated using Fulton's Condition Factor (K), as reported by Enin, (1995) and Gayanilo *et al* (1989).

For allometric growth

$$K = \frac{100W}{L^{3.5}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (iii)$$

Where K = Condition factor
W = Wet weight of sampled shrimp (g)
L = Total length of the shrimp (cm)

Physico-chemical parameters determination

Every month, the following physico-chemical parameters were determined from the three sampling stations in the river: pH, temperature, conductivity, Dissolved Oxygen (DO), and Total Dissolved Solids (TDS) were measured in the field (*in-situ*). Biological Oxygen Demand (BOD) was determined in the laboratory. Surface water samples for BOD were collected from the sites using a 1-litre BOD bottles. The bottles were cleaned with the water to be sampled before being collected; care was taken to keep air bubbles out of the bottles. Once the water samples were obtained, the bottles were securely wrapped in black polythene to keep the sun from shining through. In the lab the samples were incubated at 20°C for 5days.

A multi-parameter water quality meter (860033 Model) was used to measure temperature, DO, pH, conductivity and TDS *in-situ* at each station following the procedure in the meter's manual. The BOD was calculated from DO following APHA (2012) as follows:

$$\text{BOD} = \frac{(\text{DO1} - \text{DO5}) \text{x vol of BOD bottle}}{\text{vol(ml) of sample used}}$$

where: DO1 is initial DO and DO5 is final DO after 5days incubation

Data analysis

Data on physico-chemical parameters and species composition were analysed using descriptive statistics with SPSS 17.0. Regression analysis was used to determine the length and weight relationship at $p < 0.05$ significant level.

Results

Physico-chemical parameters

The pH ranged from 6.9±0.07 to 7.23±0.10, temperature 27.8±0.59ºC to 28.45±0.64ºC, DO 3.02±0.69mg/l to 3.5±0.54mg/l, TDS 13.2±3.61mg/l to 13.9±2.06mg/l, conductivity 17.01±1.45µS/cm to 17.65±2.54µS/cm, and BOD 6.05±2.15mg/l to 7.02±0.54mg/l as shown in Table 1. The pH values were within WHO recommended limit. All the other parameters measured were below WHO recommended limits.

Species composition

Two species, *Macrobrachium macrobrachion* and *Palaemontes africanus* both of the Family Palaemonidae were encountered during the sampling period as shown in Table 2**.**

Length-weight relationship of *M. macrobrachion*

The highest mean weight (2.03g) for the *M. macrobrachion* was in August with a corresponding mean length of 6.26cm. The length-weight relationships (Figures 2 and 3) showed that, there is a high significant correlation between the total length and the total weight of both sexes of *M. macrobrachion* of the New Calabar River. Coefficient of correlation of length-weight relationship in female shrimp ranged from 0.86 to 0.90 and male shrimp ranged from 0.82 to 0.99 (Table 3).

Length-weight relationship of *P. africanus*

The mean weight for *P. africanus* from September to November was between 0.16g to 0.21g respectively, the mean length was between 2.68cm to 2.92cm. The length-weight relationship of *P. africanus* also showed significantly high correlation between the total length and total weight with r-values that ranged from 0.68 to 0.93 (Table 4). This positive correlation shows that length and weight increase proportionately.

Condition factor of *M. macrobrachion*

Condition factor ranged from 0.83 to 0.99. However, the best condition factor (0.97) was recorded in October as shown in Table 5.

Condition factor of *P. africanus*

The condition factor ranged from 0.88 in September to 0.84 in November while the highest condition factor was 0.88, the lowest was 0.84 (Table 6).

Table 1: Physico-chemical parameters (mean values ± SD) of the New Calabar River

Parameter	Station 1	Station 2	Station 3	Mean	WHO (2011)
pH	6.9±0.07	7.23±0.10	7.13±0.17	7.08±0.09	6.5 – 8.5
Temperature (ºC)	28.22±0.28	28.45±0.64	27.8±0.59	28.15±0.19	30
Conductivity(µS/cm)	17.65±2.54	17.01±1.45	17.55±2.01	17.40±0.03	500
Dissolved oxygen (mg/l)	3.5±0.53	3.5±0.54	3.02±0.69	3.33±0.15	6
Total dissolved solids (mg/l)	13.2±3.61	14.3±1.55	13.9±2.06	13.8±0.05	250
Biological Oxygen Demand (mg/l)	7.02±0.54	6.95±1.05	6.05±2.15	6.67±0.31	10

Table 1: Shrimp species encountered during the sampling period

S/N	Month	No species	Name of species
1	August	1	*Macrobrachium macrobrachion*
2	September	2	*Macrobrachium macrobrachion* *Palaemontes africanus*
3	October	2	*Macrobrachium macrobrachion* *Palaemontes africanus*
4	November	2	*Macrobrachium macrobrachion* *Palaemontes africanus*

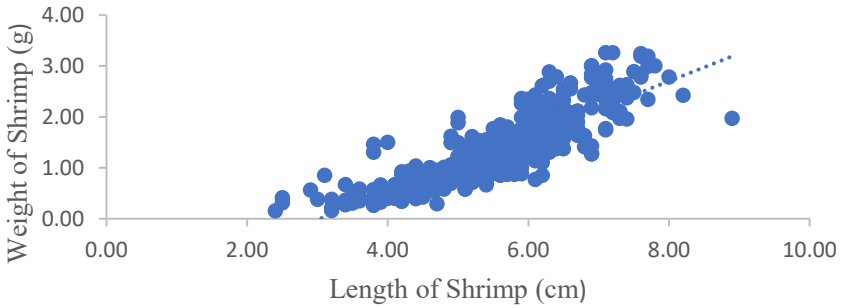

Figure 2. The length-weight relationship of female *Macrobrachium macrobrachion* in the New Calabar River.

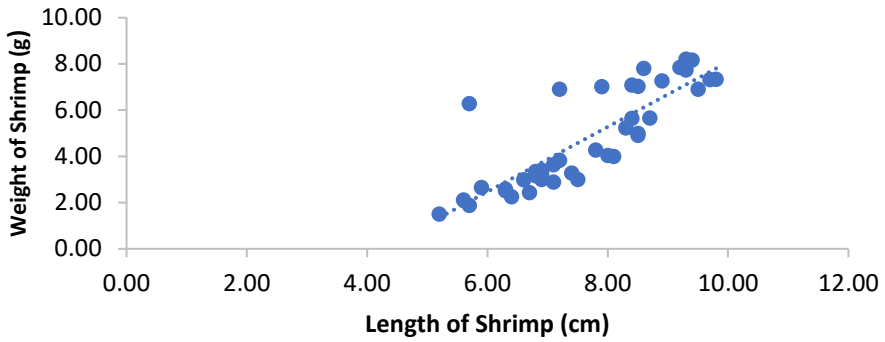

Figure 3. The length-weight relationship of male *Macrobrachium macrobrachio*n in the New Calabar River.

Table 3: Regression coefficients of the length-weight relationship of the male and female *Macrobrachium macrobrachion* of the New Calabar River

		Female					Male				
S/n	Month	N	A	b±SD	95% Cl of b	r	N	A	b±SD	95%Cl of b	r
1	August	137	-2.18	0.62±0.03	0.57-0.68	0.88	25	-5.67	1.35±0.19	0.95-1.75	0.82
2	September	137	-1.00	0.41±0.02	0.36-0.44	0.86	6	-5.73	1.34±0.21	0.74-1.94	0.95
3	October	97	-2.76	0.78±0.04	0.70-0.86	0.90	5	-6.27	1.40±0.07	1.19-1.61	0.99
4	November	106	-1.86	0.58±0.03	0.52-0.65	0.86	5	-5.83	1.35±0.23	1.10-1.19	0.98

N is Sample Size, **a** is the intercept of regression, **b** is the slope of regression, **Cl** is the class interval and **r** is the coefficient of correlation

Table 4: Regression coefficients of length-weight relationship of *Palaemontes africanus* of the New Calabar River

S/N	Month	N	A	b ±SD	95% CI of b	r
1	September	62	-2.33	0.15±0.01	0.11 – 0.18	0.76
2	October	29	-0.57	0.27 ±0.02	0.22-0.31	0.93
3	November	63	-0.06	0.11±0.02	0.08-0.14	0.68

N is Sample Size, **a** is the intercept of regression, **b** is the slope of regression, **Cl** is the class interval and **r** is the coefficient of correlation.

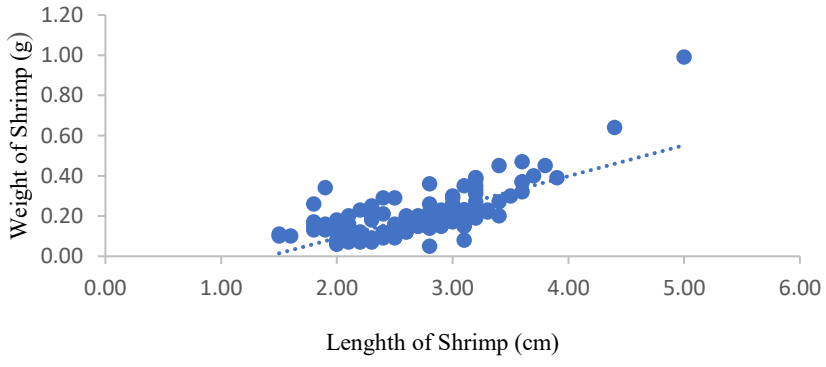

Figure 4. The length-weight Relationship of *Palaemontes africanus* of the New Calabar River.

Table 5: Condition Factor of *Macrobrachium macrobrachion* in the New Calabar River

S/N	Month	Mean Weight(g)	Mean length (cm)	Condition Factor(K)
1	August	2.03	6.26	0.83
2	September	1.10	5.23	0.77
3	October	1.58	5.47	0.97
4	November	1.60	5.59	0.92

Table 6: Condition factor of *Palaemontes africanus* in the New Calabar River

S/N	Month	Mean Weight(g)	Mean length (cm)	Condition Factor(K)
1	September	0.16	2.68	0.88
2	October	0.24	3.05	0.85
3	November	0.21	2.92	0.84

Discussion

Dissolved Oxygen being so low at critical level of about 3.0 will adversely affect survival; low dissolved oxygen also indicates possible pollution in the river. Total dissolved solids and conductivity were low and these will adversely affect the productivity of the water. Therefore, it is not surprising that condition factor was poor in the study area during the period of study.

The two species of shrimps from the New Calabar River, *Macrobrachium macrobrachion* and *Palaemontes africanus* are generally found in Africa, and they inhabit brackish and fresh waters. *P. africanus* is usually smaller compared to *M. macrobrachion* (Deekae *et al* 2013). *M. macrobrachion* is generally found in freshwater and is an economically important shrimp species in Nigeria (Lawal-Are and Owolabi 2012).

The length-weight relationship of both shrimp species showed a high significant correlation between length and weight, and in both, b value (the slope) is < 3, which indicates negative allometric growth; meaning that the weight of the shrimps have a disproportionally smaller growth than the length (Olawusi-Peter *et al* 2014; Kaka *et al* 2019). Dimensional inequality recorded can be used to explain the slenderness and stoutness of the shrimps, which are a reflection of the negative allometric growth. Therefore, the rates of increase in body length of both shrimp species obtained from the New Calabar River are not proportional to the weight of the shrimps (Davies and Ekperusi 2021). Komi and Francis (2017) reported negative allometric growth in *Penaeus monodon* in the Andoni Creeks.

The shrimp's condition factor is its plumpness. It determines the state of wellbeing of shrimp species in a specific body of water. A condition factor is generally considered good when it is ≥ 1. Condition factors of *M. macrobrachion* (0.77-0.92) and *P. africanus* (0.84 - 0.88) were <1. This implies that the shrimps were not in a good state of wellbeing during the period of study, though *M. macrobrachion* was in a better condition. Shrimps in the present study were in a better condition than those reported by Moslen and Miebaka (2018), Olawusi-Peters *et al* (2014) and Udoinyang *et al* (2019) in coastal waters of Ondo State and estuaries in Niger Delta.

Conclusion

Two shrimp species, *M. macrobrachion* and *P. africanus* were encountered in the New Calabar River in this study. The length-weight relationship revealed that both species exhibited a negative allometric growth with strong positive correlations between length and weight. Condition factor of both species showed that the species were not in good state of wellbeing in the river during the study period since the average condition factor was less than one. Data on physico-chemical parameters showed that parameters like DO, TDS and conductivity were far below recommended standards, pointing to the need for adequate environmental management strategies. Further study of longer duration is recommended to include the assessment of nutrient and productivity of the New Calabar River.

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Conflict of interest

The authors hereby declare no conflict of interest

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