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Morpho-Fecundity of Berried African River Prawn (*Macrobrachium vollenhovenii)* in Asejire Reservoir, Nigeria

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Abstract
The relationship between the morphology and fecundity of African River prawn (*Macrobrachium vollenhovenii*) in Asejire Reservoir, Nigeria was evaluated between March and August, 2014. A total of 209 *M. vollenhovenii* were collected during daytime from fishermen's catch landed at Asejire Reservoir, Nigeria. Morphometric parameters and weight of each ovary were determined using graduated measuring board and OHAUS sensitive digital balance (Model CP4 13) to the nearest 0.1cm and 0.01 g respectively. Fecundity was estimated by direct counting of spawnable eggs from the ovigerous females under binocular microscope (Model XSZ-107BN). A simple linear regression analysis was used to depict the relationship between morphometric and fecundity parameters. Results indicated that the total weight of specimen collected ranged between 64.56g and 87.02g while the length ranged between 10.40cm and 15.70 cm with average of 13.98 ± 0.23cm. The number of eggs in the ovaries of the samples ranged between 66604.00 and 99178.00. Relative fecundity (weight) ranged between 4789.00 and 5151.00 while gonadosomatic index in the berried prawns ranged between 4.33 and 7.26 % with an average of 6.43 ± 0.25 %. All morphometric indices had positive relationships with fecundity parameters with the highest (98%) recorded in total length and numbers of eggs in the ovary. Total length was the best factor for predicting the fecundity of African River prawn in the study area. Hence, this result provides information for biologists and policy makers in the areas of reproduction and sustainability of *M. vollenhovenii* in Nigeria and other developing nations to further analyze its sustainability of biodiversity.

Keywords: Asejire Reservoir, *Macrobranchium vollenhovenii*, Morphology, Fecundity, Gonadosomatic Index and Reproductive Biology.

Introduction
Morphometric and fecundity study is an integral component of modern fisheries stock assessments and in turn for effective fisheries and endangered species management [8]. This assertion is also corroborated by Biswas *et al.* [12] who reported that length and weight relation parameters and condition factor provides basic information on the specific conditions under which organisms are growing and reproducing. Tracey *et al.* [40] believes length-weight relationship in fish also plays a significant role in studying the growth, rate of feeding, metamorphosis, fatness, onset of maturity, gonadal development and the amount of eggs available in the ovary.
For biodiversity abundance to be sustained, each species must be reproduced to the same extent so as to ensure same average survival from generation to generation [17]. Tracey *et al.* [40] opined that managing fisheries resources rely on having accurate assessment of fecundity to understand the recovery ability of fish populations. Apart from its biological importance, analysis of fecundity data with meristic characteristics has often been used to provide a reliable index of density-dependent factors affecting the population size.
Freshwater prawns of the genus *Macrobrachium* are important for commercial fisheries and aquaculture because they provide not only food but also revenue to many countries of the world [11]. *Macrobrachium* species commonly occur in the West African region and constitute an important part of the artisanal fishery. In Nigeria, two species of these prawns (*M. macrobrachion* and *M. vollenhovenii*) are important food items and are good items for exports when fully recruited for aquaculture.

Prawn and shrimp products are the second most important commodity export of Nigeria. FAO [16] reports that about half the country total shrimp catch (both large and small scale fishing) are exported. Due to the economic importance of the species, a number of researches have been conducted on the growth and reproductive biology of the prawn species. Anetekhai [5, 6] worked on salinity tolerance of African river prawn in Asejire reservoir; sexual dimorphism and egg production in African river prawn from Asejire dam. Food and feeding habit of *M. vollenhovenii* from Asejire reservoir, Nigeria was studied by Bello-Olusoji *et al.* [9]; Anetekhai [7] also studied moulting, meristic and morphometric characteristics of *M. vollenhovenii* from Asejire reservoir, Nigeria.

Jimoh *et al.* [23] studied the food and feeding habit of *M. vollenhovenii* from Badagry creeks, Southwest, Nigeria. Adite and Gbaguidi [1] evaluated the morphometric and meristic characteristics of *M. Macrobrachion* and *M. vollenhovenii* from the Mono River – Coastal Lagoon system, Southern Benin (West Africa); Lawal-Are and Owolabi[29] gave a comparative biology of prawns (*M. Macrobrachion* and *M. vollenhovenii*) from two interconnecting fresh/brackish water lagoon in South West, Nigeria while the bio-ecology study of freshwater prawn (*M. vollenhovenii* and *Caridina africana)* at Asejire reservoir and Erin-Ijesa waterfalls, Nigeria was conducted by Oyekanmi [32].

However, there is paucity on current fecundity status and its relationship with the morphometric and meristic characteristics of *M. vollenhovenii* in Asejire Reservoir, Nigeria which was purposively chosen because of dominance of the species in the area. Hence, this research is aimed at providing biologists and policy makers with relevant information on the relationship between the morphometric and meristic parameters and fecundity parameters (egg weight, numbers of eggs, relative fecundity and gonadosomatic index). This will ensure the reproduction and sustainability of the species in the study area.

Methodology

Study Area

The study area (Asejire Reservoir) (07°21'N, 04°07'E) is located in the Oyo State, South-West Nigeria. The man-made reservoir was constructed over River Osun in 1972. The reservoir is Y-shaped with two unequal arms of the Y. Yem *et al.* [42] reported that the catchment area above the dam is 7,800 km^2 while the impounded area is 2,342 ha. The reservoir has gross storage of 7,403 million L with an elevation of 137 m. The reservoir is prominent in abundant freshwater prawns including *Macrobrachium vollenhovenii*, and different tilapia species.

Collection of Prawns

A total of 209 individuals of *M. vollenhovenii* were collected during daytime from the fishermen's catch landed at Asejire Reservoir, Nigeria from March to August 2014. The prawns were caught by means of two sets of traditional basket traps [44]. The traps, which were made from canes, measured 31 – 62cm in length, a mouth opening of 3 - 4cm in diameter and rectangular mesh sizes of about 3 by 0.5cm. The samples were immediately preserved in ice and transported to the Fisheries and Aquaculture research laboratory of the Federal University of Oye, Nigeria.

Identification of Prawns

In the laboratory, the prawns were identified to species level following Powell [33-34] and Holthius [21]. The sexes of individual *M. vollenhovenii* were differentiated visually based on morphological features [15]. All specimens were sexed by gonad observation under a binocular microscope (*Model 5033000 L x 200*) to identify the mature females for this study. Also, the berried females were identified and counted.

Determination of Morphometrics

Morphometric measurement were taken for total length (from the tip of the rostrum to the extremity of the telson), rostral length (from the tip to the posterior margin of the orbit), carapace length (from the posterior margin of the carapace to the extremity of the telson), and body length (from the posterior margin of the orbit to the extremity of telson), using graduated measuring board to the nearest 0.01 cm. The weight was also measured after excess water had been removed from the shrimp with OHAUS digital balance (Model CP4-13) to the nearest 0.01g. Fulton's condition factor (CF) of *M. vollenhovenii* was determined using:

$$CF = \frac{100\,W}{L3} \ldots\ldots\ldots\ldots Eq\ 1$$

Where: CF = Condition factor, W= Total Weight and TL=Total Length

Determination of Fecundity

Fecundity was estimated by direct counting of spawnable eggs from the ovigerous females under binocular microscope (*Model 5033000 L x 200*). Whole ovaries were carefully detached for each selected individual with forceps and assessed separately. Total weight of each ovary was determined using digital OHAUS balance (Model CP4-13) to the nearest 0.001 g. A sub – sample of the ovary was weighed and the eggs in each sample were spread on a filter paper and counting was done with the aid of stereomicroscope and hand – held tally counter. The number obtained was then extrapolated to determine the total number of eggs in the ovary. Relative fecundity (per unit length/weight) was calculated as the number of eggs per unit length (cm) (RF_l) or the number of eggs per unit weight (g) (RF_w) of prawns using the formula in equation 2:

$$RF_w \text{ or } RF_l = \frac{No\ of\ eggs\ in\ ovary}{Length} \text{ or } \frac{No\ of\ eggs\ in\ ovary}{Weight} \ldots\ldots\ldots\ldots\ldots Eq\ 2$$

Gonado-somatic index (GSI): The gonadosomatic index (GSI) was estimated by the formula in equation 3

$$GSI = \frac{Ovary\ Weight}{Body\ Weight} x\ 100 \ldots\ldots\ldots Eq3$$

Data Analysis

A simple linear regression analysis was used to depict the relationship between morphometric and fecundity parameters using the Statistical Package for Social Sciences (SPSS), Version 16.0 and data was tested at level ($P<0.05$) for significance.

Results

Table 1 provides information on morphometric parameters of berried *M. vollenhovenii* in Asejire reservoir, Nigeria. Weight of sampled prawns ranged between 64.56g and 87.02g; the total length (TL) of prawns ranged between 10.40cm and 15.70cm with an average of 13.98 ± 0.23cm.The prawns had body length (BL) that ranged between 4.80cm and 7.70cm. The mean carapace weight (CW) was 20.94 ± 0.58g while the mean carapace length (CL) was 6.32 ± 0.22cm. *M. vollenhovenii* under study had walking legs that ranged between 0.11g and 0.54g in weight and 5.00cm -7.10cm in length. Rostral length (RL) of sampled prawns ranged between 1.10cm and 20.00cm while the average rostral weight (RW) was 0.06 ± 0.00g. The condition factor ranged between 2.49 and 3.14 with a mean of 2.89.

Fecundity parameters of *M. vollenhovenii* in Asejire reservoir is presented in Table 2. The number of eggs in the ovaries of the sampled prawns ranged between 66604.00 and 99178.00. Ovary weight ranged from 3.67g to 8.43g. The minimum and maximum egg volume was 3.85 and 8.41 respectively. The prawns had a mean relative fecundity of 875.60±14.23 per unit weight while relative fecundity (per unit length) ranged between 4789.00 and 5151.00 with a mean of 4988 ± 28.89.Gonadosomatic index (GSI) also had a minimum and maximum value of 4.33 and 7.26 respectively, with a mean of 6.43±0.25.

According to table 3, all the morphometric indices had positive relationships with the fecundity parameters. The relationship was smallest (0.41) in both body length and relative fecundity (per unit weight) (BL–RF_w) and body length and Gonadosomatic index (BL-GSI) while the highest relationship (0.99) was recorded in total length and number of eggs (TL-NE). The slope of regression between the morphological and fecundity parameters ranged between 0.12 in total length and number of eggs (TL-NE) and 2.64 in total length and ovary weight (TL-OW). Results further show that TL- NE had the highest strength of relationship (98) while the lowest (0.13) was recorded between BL-RF_w and BL-GSI respectively.

Table 1: Morphometric Characteristics of Female African River Prawn (*M. vollenhovenii*)

Parameters	Minimum	Maximum	Mean± S.E
Total Weight (g)	64.56	87.02	75.31± 1.27
Total Length (cm)	10.40	15.70	13.98± 0.23
Body Weight (g)	40.85	67.22	54.04± 1.16
Body Length (cm)	4.80	7.70	6.26± 0.12
Carapace Weight (g)	16.03	27.51	20.94± 0.58
Carapace Length (cm)	4.40	8.00	6.32± 0.22
Weight of Walking Legs (g)	0.11	0.54	0.54± 0.02
Length of Walking Legs (cm)	5.00	7.10	6.03± 0.11
Rostral Weight (g)	0.04	0.10	0.06± 0.00
Rostral Length (cm)	1.10	20.00	1.38±0.06
Condition Factor (K)	2.49	3.14	2.89±0.15

Table 2: Fecundity Parameters of *Macrobrachium vollenhovenii* in Asejire Reservoir, Nigeria

Parameters	Minimum	Maximum	Mean ± S.E
Numbers of Eggs	66604.00	99178.00	86739.95 ± 2089.82
Ovary Weight (g)	3.67	8.43	6.45 ± 0.36
Egg Volume	3.85	8.41	6.53 ± 0.32
Relative Fecundity (weight)	786.00	952.00	875.60 ± 14.23
Relative Fecundity (Length)	4789.00	5151.00	4988 ± 28.89
Gonadosomatic Index (%)	4.33	7.26	6.43 ± 0.25

Table 3: Morphological and Fecundity Relationship in Africa n River Prawn (*Macrobrachium vollenhovenii*)

Parameters	a	b	r	R^2
BL-OW	-3.45	1.43	0.83	0.71
BL-EV	0.13	2.49	0.54	0.25
BL-RF_w	-6.39	1.32	0.41	0.13
BL-NE	3.23	0.12	0.51	0.23
BL-GSI	0.13	2.50	0.41	0.13
BW-OW	-10.15	2.61	0.89	0.78
BW-EV	-9.00	2.36	0.89	0.79
BW-RF_L	7.64	0.19	0.67	0.44
BW-GSI	-3.44	1.86	0.87	0.74
BW-NE	7.07	0.94	0.77	0.56
TL-OW	-5.69	2.64	0.88	0.76
TL-EV	-4.87	2.36	0.88	0.76
TL- RF_W	5.45	0.46	0.57	0.29
TL-NE	7.81	1.24	0.99	0.98
TL-GSI	-5.55	1.61	0.76	0.57

Note: TL = Total Length; BW = Body Weight; EV=Egg Volume; GSI=Gonadosomatic Index; NE= Numbers of Eggs; OW=Ovary Weight; TL = Total Length; RF_L = Relative Fecundity (length); RF_W = Relative Fecundity (weight).

Discussion

Morphometric Characteristics of African Freshwater River Prawn

Berried African River prawns collected from Asejire Reservoir, Nigeria were similar in length (13.98cm) to female *M. macrobrachion* reported by Oyekanmi [32] which had an average total length of (16.5cm). The average weight (75.31g) of prawns in this study is however larger than the weight (66.14g) reported for female *M. vollenhovenii* by Oyekanmi [32]. Jimoh *et al.* [23] obtained a lower body weights (5.65g and 4.22g) and length (7.80cm and 7.50cm) in female *M. vollenhovenii* and *M. Macrobrachium* respectively from Badagry creek, Nigeria. This could be attributed to the reproductive state of the prawns under study. However, Adite *et al.* [3] documented a lesser body weight (15.74g) for berried *M. Macrobrachium in* mono-river coastal lagoon system in the republic of Benin.

This is further reflected in the condition factor (2.89) recordedin the present study. Meye and Arimoro [30] recorded a lesser value for *M. dux* in Odogboro River, Nigeria. Olawusi-Peters *et al.* [31] also observed values lesser than the range of this study for *N. hastatus* (0.57) and *P. atlantica* (0.49) in the coastal waters of Ondo State, Nigeria. The values obtained for condition factor in this study is however lower than the values (2.12- 7.98) estimated by Lawal-Are and Owolabi [29] for *M. vollenhovenii* and *M. macrobrachion* from Lagos and Lekki lagoons in south-west Nigeria. Olawusi-Peters *et al.* [43] opined that reduced or low condition factor indicates either a period of unfavourable ecological conditions or a period which the

species might have undergone stress from low food availability and/or reproductive processes. This agrees with the opinion of Vazzolar [41] that low K values during the more developed gonad stages is an indication of resource transfer to the gonads during the reproductive period. Olawusi-Peters *et al.* [31] was also of the opinion that species in their reproductive period may likely have lesser K. This might have been the case during this study.

Fecundity Parameters

Results from this study further show that the number of eggs found in the ovary of *M. vollenhovenii* is greater than those recorded by several researchers. Rahman and Miah [35] reported fecundity of 881-1182 eggs in experimental fin Guchibaim (*mastacembelus pancalus*). Haddy *et al.* [20] documented that barking crayfish (*Linuparus trigonus)* in the Queensland East coast trawl fishery had between 20,000 and 100,000 eggs. Oyekanmi [32] estimated an average of 1740 eggs for *M. vollenhovenii* in Asejire Reservoir while same study documented an average of 148.50 eggs for *Caridina africana.* George *et al.* [18] observed about 4,420 eggs per brackish river prawn from Great Kwa River, Cross River, Nigeria. Kingdom and Eroudu [25] reported 24,764 eggs for *M. vollenhovenii* in lower Taylor Creek, Niger-Delta, Nigeria.

However, the average number of eggs (86,739.95 ± 2089.82) in the ovary of prawns in this study is less than the number (173,000) recorded by Anetekhai [4] in *M. vollenhovenii* caught in Asejire Reservoir, Nigeria. New and Singholka[45] also got a higher number of eggs (100,000-700,000eggs) for *M. rosenbergii* while Czerniejewski and Marcello[14] reported a higher value (461,100 eggs) for Chinese mitten crab (*Eriocheirsinesis*) in Szczecin lagoon, Italy.

The mean value (6.43 ± 0.25%) of gonadosomatic index estimated in this study is lower than the value (14.53) reported by Kingdom and Eroudu [25] for *M. vollenhovenii*. Also, Indira *et al.* [22] reported a higher GSI (34.46%) for red jewel cichlid (*Hemichromis bimaculatus*) with an absolute fecundity of 3426 eggs. Lashari *et al.* [28] estimated a higher GSI (12.9) for reared carp (*Girhinuseba*) in Jacobabad, Sindh, Pakistan while Shinkafi and Ipinjoju [38] reported a lower GSI (2.01) for *Auchenoglanis occidentalis* in River Rima, North West, Nigeria. The gonadosomatic index is an indicator of the state of gonadal development and maturity of fish. Czerniejewski and Marcello [14] opined that a large part of the benthic fauna associated with estuarine and marine waters is formed by crustaceans which is suggested to be caused by high fecundity of the phylum. This fact could be the reason for the high fecundity of *M. vollenhovenii* in the study area.

Morphological and Fecundity Relationships

All the morphometric indices had positive correlation with the fecundity parameters. This indicates that both fecundity and morphometric features are increasing in the same direction and magnitude. This relationship was highest (r=0.99, R^2=0.98) between body length and number of eggs while the least (r=0.57, R^2=0.29) was recorded between body length and the relative fecundity. Similar positive correlation (0.91) between body weight and fecundity was reported by Haddon [19] in O*valipescatharus;* Sharma and Subba [37] on the freshwater prawn *Macrobrachium lamarrei* showed positive relationship between body weight and fecundity but with low r^2. Ravi *et al.* [36] observed a positive correlation (r=0.83) between fecundity and body length of *Portunus pelagicus* caught in Kerala, India. The positive curvilinear relationship between morphometric parameters and fecundity in *M. vollenhovenii* in this study is similar to those described for barking crayfish [20] and spiny lobsters [13].

Similar fecundity study by Czerniejewski and Marcello [14] reported that all morphometric characteristics in Chinese mitten crab (*Eriocheirsinesis*) had positive correlation with fecundity; it was also reported that carapace width was the best morphometric character for predicting the fecundity of Chinese mitten crab. Similar study by Bello-Olusoji *et al.* [10] on rocky freshwater revealed a weak relationship (r^2=0.34) between fecundity and body weight with a relatively stronger relationship (r^2 = 0.64) between fecundity and total length.

Kingdom and Eroudu [25] on fecundity and morphological relationships in *M. vollenhovenii* in lower Taylor Creek, Niger-Delta, Nigeria estimated positive correlations between fecundity-total length, fecundity-gonad weight and fecundity-body weight, the study showed that gonad weight gave the best predictive value for evaluating fecundity. Khemeleva and Goloubev [24] observed that many crustaceans have highly variable absolute fecundity even in females of similar size. This was supported by Haddy *et al.* [20] who reported that the number of eggs in the brood is size dependent. This assertion is also supported by Albertoni *et al.* [2] in *M. acanthurus* and *M. macrobrachion* [15].

Indira *et al.* [22] noted that fecundity in *Hemichromis bimaculatus* increased with increase in body length, body weight, ovary length and ovary weight. Rahman and Miah [35] said relationship between total length, body weight and ovary weight of experimental Guchibaim (*mastacembelus pancalus*) were highly correlated. The increase in the number of egg per increase in female size of prawn suggests that there are differences in the allocation of food energy by the prawns at different sizes [39].

Ravi *et al.* [36] recorded that fecundity is highly related (r^2 = 0.86) with carapace width in *Portunus pelagicus*. Similar study was observed by Kookalya *et al.* [26] in *Cancer pagurus.* Kumar *et al.* [27] reported a rise in fecundity by 83.9% with an increase in the carapace width. George *et al.* [18] also reported a positive correlation between body weight, standard length, carapace length, and numbers of eggs. Fecundity was linear and a function of the body weight and body length.

Results from this study showed that body weight and total length had positive and strong relationship (r^2 = 0.74, r^2=0.57) while the body length exhibited weak relationship (r^2 = 0.13) with the gonadosomatic index. This implies that body weight is the best morphometric factor for predicting the GSI of *M. vollenhovenii*. The study of fecundity of any species is important to have a full understanding of its biology and population dynamics [22]. Result from this study indicated that total length is the best factor for predicting the fecundity of *M. vollenhovenii*. Therefore fecundity–morphological relationship presented in this study should be viewed as a general relationship for *M. vollenhovenii* population in Asejire Reservoir, Nigeria and other reservoirs around the world.

Conclusion

Berried *M. vollenhovenii* from Asejire Reservoir, Nigeria were highly fecund, producing between 66604 and 99178 eggs per reproductive cycle. All morphometric indices had positive relationships with fecundity parameters with the highest (98%) recorded in total length and numbers of eggs in the ovary. In general, total length is the best factor for predicting the fecundity, while body weight is the best morphometric factor for predicting the GSI of *M. vollenhovenii* in the study area. Thus, biologists and policy makers especially in the areas of reproduction and sustainability in Nigeria and other

developing nations should further analyse the sustainability of *M. vollenhovenii* for aquaculture practices and biodiversity.

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