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Research Article

Meristic and Morphometric Studies of African River Prawn (*Macrobrachium vollenhovenii* - Herklots, 1857) from Badagry, Lagos and Epe Lagoons, South-West, Nigeria

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ABSTRACT

Macrobrachium vollenhovenii is a decapod that has been widely identified in terms of its economic importance and recruitment into aquaculture. The racial studies of *M. vollenhovenii* collected from Badagry, Lagos and Epe Lagoons were carried out for 12 months in order to determine the variation among the populations within the interconnected lagoons. The physico-chemical parameters of the lagoons were also determined using standard methods. The result from these physico-chemical parameters reflected environmental differences as a result of the variation in salinity from the three lagoons. Eleven characters (eight morphometric and three meristic) were studied and the results showed significant differences ($P < 0.05$) in the carapace length, carapace width, egg diameter, dorsal and ventral rostrum teeth with no significant differences ($P > 0.05$) in the total length, telson length, rostrum length, 3rd abdominal somite, left cheliped length and the right cheliped length of *M. vollenhovenii*. The result gave an indication that the populations of *M. vollenhovenii* from the lagoons are morphologically inseparable. Though, the variations in the meristic and some of the morphometric features could be as a result of changes in salinity gradients from the three lagoons and maybe an indication of genetically distinct populations. Therefore, further work in the search for genetic diversification will require molecular characterization to detect probable variation among the populations. The study provided a concrete and important biological database useful in the species identification, nomenclature, rational exploitation and proper management of the prawn populations in the three lagoons.

Keywords: Lagoons, *Macrobrachium* species, Population, Racial study, Salinity, South-West, Taxonomy
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INTRODUCTION

The freshwater prawns of the genus *Macrobrachium* are distributed throughout the tropical and subtropical regions of the world and over two hundred species make up the genus (Jimoh *et al*., 2011). They are often used interchangeable in some parts of the world. They are referred to as freshwater prawns and freshwater shrimp in Australia and the United States of America (USA) respectively (FAO, 2001). *Macrobrachium vollenhovenii* (Herklots, 1857) and *Macrobrachium macrobrachion* (Herklots 1851) are the two largest and most economically important species of the entire genus *Macrobrachium* found in most Nigerian water bodies (Akinwunmi & Lawal-Are, 2019). *M. vollenhovenii* is a palaemonid prawn which is readily available in West Africa and is mostly found in inland freshwater areas including ponds, lakes, rivers and irrigation ditches as well as in estuarine environment of most water bodies (Powell, 1982; New, 2002; Akinwunmi & Lawal-Are, 2018). It is an important source of animal protein especially for coastal and riverine dwellers. There are many species of prawns which are found across the various water bodies in Nigeria belonging to family Atyidae, Alphedae, Hippolytidae and Palaemonidae; which serve as good candidates for aquaculture (Powell, 1982)

The studies on meristic and morphometric characteristics of fish species become imperative to the Biologist and at the same time play a major role

in ensuring whether there is any disparity between same species of different geographic region (Naeem *et al.*, 2012; Akinwunmi & Lawal-Are, 2019). Several works on the racial studies of some shellfish species in Nigeria have been carried out by Lawal-Are (2009) on *Callinectes amnicola*; Jimoh *et. al*. (2005) on *Macrobrachium vollenhovenii* from Ologe Lagoon; Jimoh *et. al*. (2012) on *Macrobrachium* species from Badagry creek; Adite *et. al.* (2013) on *Macrobrachium macrobrachion* from Southern Benin (West Africa); Konan *et. al.* (2017) on *Macrobrachium macrobrachion* from Côte d'Ivoire (West Africa) and Akinwunmi & Lawal-Are (2019) on *M. macrobrachion*.

Despite all these works, there is still paucity of information on the holistic racial studies of *M. vollenhovenii* from these three interconnecting lagoons. Hence, the objective of this study was to carry out the meristic and morphometric studies on *M. vollenhovenii* in the three interconnecting lagoons in order to assess the population variations.

MATERIALS AND METHODS

Description of Study Sites

The Badagry Lagoon (Figure 1), with source in River Queme in the Republic of Benin to the west of Nigeria, is located in Lagos State (Southwest Nigeria) and drains into the Atlantic Ocean via the Lagos harbour. It lies between longitudes 3°54′ and 4°13′E and latitudes 6°25′ and 6°35′N (Lawal-Are & Kusemiju, 2000). It is part of a continuous system of lagoons and creeks lying along the coast of Nigeria from the border with the Republic of Benin to Niger Delta, with the depth of water ranging from 1-3 m (Ndimele & Jimoh, 2011). The area is characterized by thick shrubs and small trees. The major ecological factors operating in the Badagry Lagoon have been documented by Ezenwa and Kusemiju (1985); Solarin (1998). The authors also observed an increase in salinity from July to September (rainy season) in the Badagry Lagoon due to the intrusion of salt water from the Cotonou Lagoon in the Republic of Benin.

Lagos Lagoon is located between longitudes 3°23′ and 3°53′E and latitudes 6°26′ and 6°37′N (Figure 1). It is an open tidal estuary situated withinthe low-lying coastal zone of Nigeria. This coastal terrain is dominated by a maze of estuaries, lagoons, creeks and rivers. Out of the total land area covered by Lagos State, one-quarter is water surface: lagoons, creeks and coastal river estuaries (Ndimele, 2003). These water bodies act as sinks for the disposal of wastes from about 2000 medium and large scale industries located in the Lagos metropolis (Anetekhai *et al*., 2007). The lagoon is fed in the north by Ogun River and opens into the Atlantic Ocean via the Lagos Harbour (Solarin, 1998; Lawson, 2001). Characteristically, Lagos Lagoon has a seasonal fluctuation in salinity and high brackish water during the dry season (from December to May), while freshwater condition exists in the rainy season (June – November) (Kusemiju, 1975; Ugwumba & Kusemiju, 1992; Solarin, 1998; Lawal-Are, 2006).

Epe Lagoon (Figure 1) lies between latitudes 6º29′N and 6º38′N; and longitudes 3º30′E and 4º05′E (Agboola & Anetekhai, 2008) and is fed by River Oshun. With a surface area of about 225 km^2 and a maximum depth of 6 m, the lagoon is sandwiched between the Lagos and Lekki Lagoons. The lagoon opens into the Gulf of Guinea via the Lagos harbour and it is one of the four major lagoons in Lagos State, Nigeria (Kumolu-Johnson *et al*., 2010).

Field Studies

The physico-chemical parameters (surface water temperature, salinity, pH, dissolved oxygen and transparency) of the study sites were measured from June, 2014 and May, 2015 between the hours of 8.00 and 10.00 am for Badagry, Lagos and Epe Lagoons. The surface water temperature was measured using a Mercury-in-glass thermometer by dipping it into the water 15 cm below the water surface, salinity was determined using a refractometer (Model No: RHS-10), the pH value was measured using a Hanna pH meter (Model: HI 2210), the dissolved oxygen was determined using a Hanna DO meter (Model: HI 9146) while the water transparency was measured using a 20 cm diameter black and white secchi disc. All parameters were measured in situ as described by Akinwunmi and Lawal-Are (2019).

Collection of Specimens

A total of 1435 samples of *M. vollenhovenii* were collected from Badagry, Lagos and Epe June, Lagoons between June, 2014 and May, 2015 using a basket trap (Akinwunmi & Lawal-Are, 2019) which was set near the shore of the lagoons. It was ensured that the samples were collected monthly within the same period in each lagoon. The prawns were

immediately preserved in an ice-chest for transportation to the laboratory of the Department of Marine Sciences and stored in a freezer at -20 ^{o}C before further analysis.

Laboratory Analysis

The prawns were removed from the freezer and allowed to thaw, as described by Akinwunmi (2020). Excess water was removed from the specimens through mopping on a pile of filter papers (Akinwunmi & Lawal-Are, 2019). The meristic characters examined were the rostrum teeth (dorsal and ventral) and the morphometric characters such as total length (TL), telson length (TeL), carapace length (CL), carapace width (CWt), rostrum length (RL), 3rd abdominal segments, left cheliped length (LCL), right cheliped length (RCL) and egg diameter were investigated as described by Akinwunmi & Lawal-Are (2019).

The meristic characters were determined by counting the number of teeth on the dorsal and ventral side of the rostrum. The total length involved measuring the prawns from the tip of the rostrum to the end of the telson, the carapace length (from eye socket to posterior end of the carapace), the carapace width (from the tip of the right branchlostegal spine to the tip of the left branchlostegal spine) and rostral length (from the tip of the rostrum to the posterior margin of the orbit) were measured using a tape rule to the nearest 0.1 cm. The length of the telson, 3rd abdominal segment, left cheliped and right cheliped were also measured (Naiyanetr, 2001; Murphy & Austin, 2005; Akinwunmi & Lawal-Are, 2019). The egg diameter was measured with a graduated occular micrometer mounted in the eye piece of a binocular microscope.

Statistical Analysis

All data were subjected to One-way analysis of variance (ANOVA) and post-hoc (DMRT) was used to determine significant differences ($P < 0.05$) of the means from the three lagoons. The data from the egg diameter were tested for significant differences ($P < 0.05$) using the paired t-test. Further analysis was carried out using the Statistical Package for Social Scientists (SPSS) software and Microsoft Excel for windows (2007).

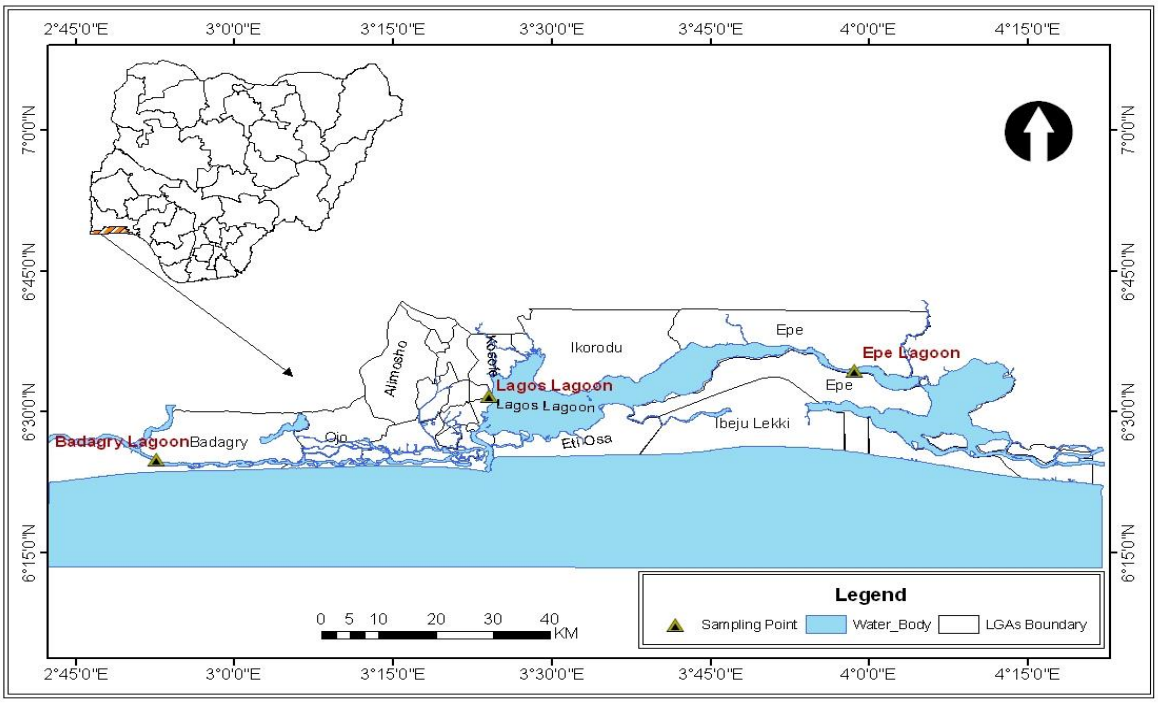

Figure 1: Sampling sites in Badagry, Lagos and Epe Lagoons
Source: Akinwunmi & Moruf (2021)

RESULTS

The physico-chemical parameters of the three lagoons showed that the surface water temperature, salinity, pH, dissolved oxygen and transparency ranged between 27.12 – 29.72 ºC, 0.54 – 9.81 ‰, 6.90 – 7.71, 5.87 – 6.92 mg/l and 47.39 – 67.04 cm respectively as shown in Table 1. There were no significant differences (P > 0.05) in the water temperature, pH and water transparency from Badagry and Lagos Lagoons while values obtained from Epe lagoon differs significantly (P < 0.05), considering these same parameters. The salinity values differ significantly (P < 0.05) from the three lagoons.

The meristic (count) features of *M. vollenhovenii* for the three lagoons showed that the dorsal and ventral rostrum teeth ranged within a mean value of 9-15 and 3-7 respectively as presented in Table 2. The dorsal and ventral rostrum tooth of M. vollenhovenii from Epe Lagoon is significantly different (P < 0.05) from the values obtained from Badagry and Lagos Lagoons.

The result of the morphometric characters of *M. vollenhovenii* for Badagry, Lagos and Epe Lagoons are presented in Table 3. There were significant differences (P < 0.05) in the CL, CWth, RT dorsal and the RT ventral of the species from the three lagoons with much differences in the values obtained from Epe lagoon compared to Badagry and Lagos Lagoons. It was also observed that the TL, Tel-L, RL, 3rd abdominal somite, LCL and RCL showed no significant difference (P > 0.05) from the three lagoons, as presented in Figure 2. There are significant differences (P < 0.05) in the egg diameter of *M. vollenhovenii* for the three lagoons as shown in Figure 3.

Table 1: Means (± S.E.) of physico-chemical parameters of Badagry, Lagos and Epe Lagoons (June, 2014 - May, 2015)

Parameters	Badagry Lagoon	Lagos Lagoon	Epe Lagoon
Water temperature (ºC)	27.12 ± 0.57^{a} (21.00 – 32.30)	27.70 ± 0.58^{a} (21 -32)	29.72 ± 0.43^{b} (25.3 – 32.0)
Salinity (‰)	4.13 ± 0.43^{b} (0 – 7)	9.81 ± 1.60^{c} (2 – 25)	0.54 ± 0.29^{a} (0 – 5)
pH	7.71 ± 0.23^{b} (5.00 - 9.39)	7.48 ± 0.11^{b} (6.7 - 8.7)	6.90 ± 0.14^{a} (5.5 – 8.6)
Dissolved oxygen (mg/L)	6.18 ± 0.53^{a} (3.01 – 14.00)	5.87 ± 0.46^{a} (1.5 – 10.9)	6.92 ± 0.56^{a} (3.7 – 11.5)
Transparency (cm)	47.39 ± 3.37^{a} (17.78 – 92.00)	54.20 ± 6.43^{a} (20 – 175)	67.04 ± 2.41^{b} (47.0 – 95.0)

Range in brackets. Means with the same superscript alphabets along the row are not significantly different (p>0.05).

Table 2: Mean meristic characters of *Macrobrachium vollenhovenii* from Badagry, Lagos and Epe Lagoons (June, 2014 - May, 2015)

Meristic Characters	Badagry Lagoon	Lagos Lagoon	Epe Lagoon
Rostrum Teeth (Dorsal)	12.8 ± 0.25^{b} (12 - 14)	13.1 ± 0.17^{b} (11 - 15)	11.7 ± 0.53^{a} (9 - 14)
Rostrum Teeth (Ventral)	4.4 ± 0.18^{a} (4 - 5)	4.0 ± 0.09^{a} (3 - 5)	5.1 ± 0.35^{b} (4 - 7)

Range in brackets. Means with the same superscripts along the row were not significantly different (P > 0.05)

Table 3: Mean morphometric characters of *Macrobrachium vollenhovenii* from Badagry, Lagos and Epe Lagoons (June, 2014 - May, 2015)

Morphometric Measurements (cm)	Mean Values and Range		
	Badagry Lagoon	Lagos Lagoon	Epe Lagoon
Total Length	10.5 ± 0.60 (8.0 - 14.1)	10.4 ± 0.37 (6.9 - 15.2)	8.89 ± 0.39 (7.9 - 10.9)
Telson Length	1.4 ± 0.08 (1.0 - 1.7)	1.3 ± 0.04 (0.9 - 1.7)	1.2 ± 0.08 (1.0 - 1.6)
Carapace Length without rostrum	3.4 ± 0.24 (2.4 - 4.8)	3.3 ± 0.14 (2.0 - 5.1)	2.6 ± 0.18 (2.0 - 3.5)
Carapace width	4.9 ± 0.32 (3.6 - 6.8)	4.9 ± 0.21 (3.0 - 6.6)	3.9 ± 0.27 (3.1 - 5.4)
Rostrum Length	2.6 ± 0.15 (2.1 - 3.5)	2.7 ± 0.08 (1.7 - 3.6)	2.5 ± 0.09 (2.0 - 2.8)
Third Abdominal segment	1.2 ± 0.05 (1.0 - 1.4)	1.1 ± 0.04 (0.7 - 1.4)	1.0 ± 0.07 (0.6 -1.3)
Left Cheliped Length	5.9 ± 1.46 (3.6 - 16.0)	6.1 ± 0.59 (2.5 - 12.6)	4.3 ± 0.47 (3.3 - 7.8)
Right Cheliped Length	5.7 ± 1.23 (3.6 - 14.2)	6.3 ± 0.60 (2.5 - 13.9)	4.4 ± 0.46 (3.4 - 7.8)
Egg diameter (µm)	567 ± 33.04 (465 – 751)	610.72 ± 16.77 (465 – 755)	678.33 ± 25.73 (530 – 780)

Range in brackets

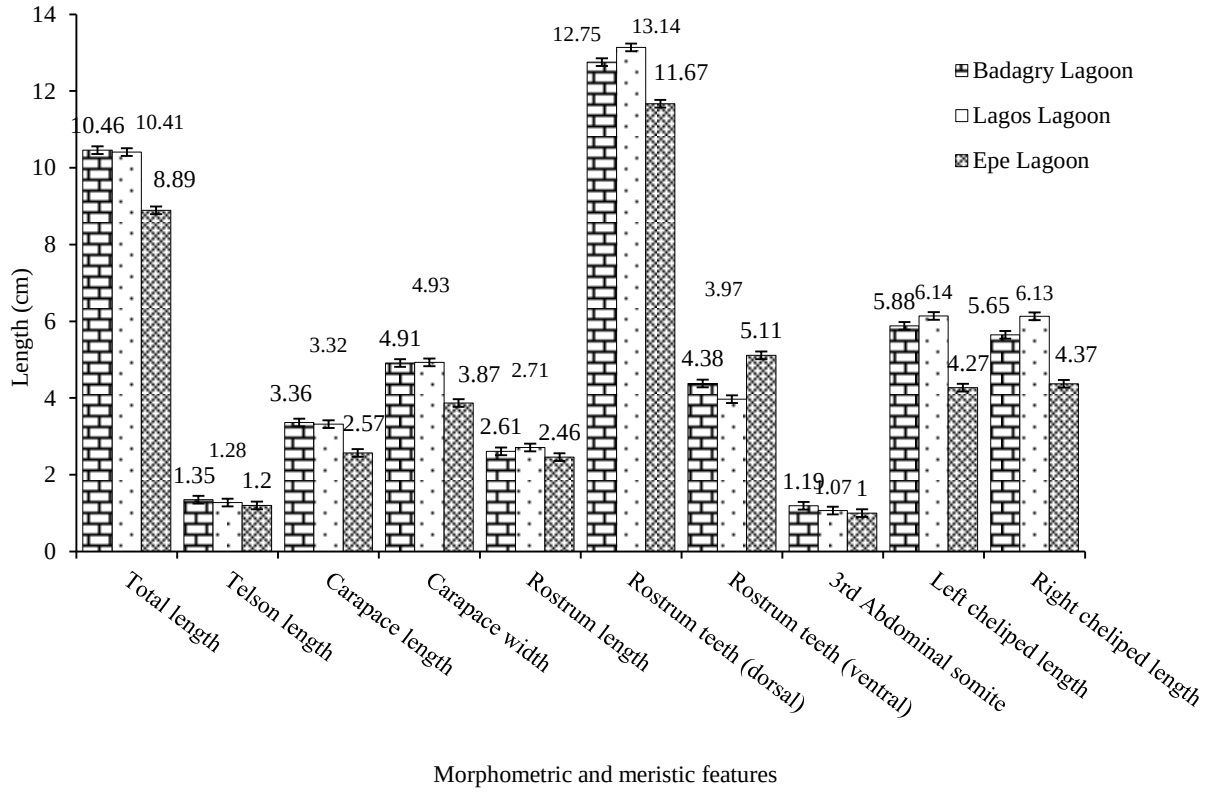

Figure 2: Level of significance of the meristic/ morphometric characters of *Macrobrachium vollenhovenii* from Badagry, Lagos and Epe Lagoons (June, 2014 - May, 2015)

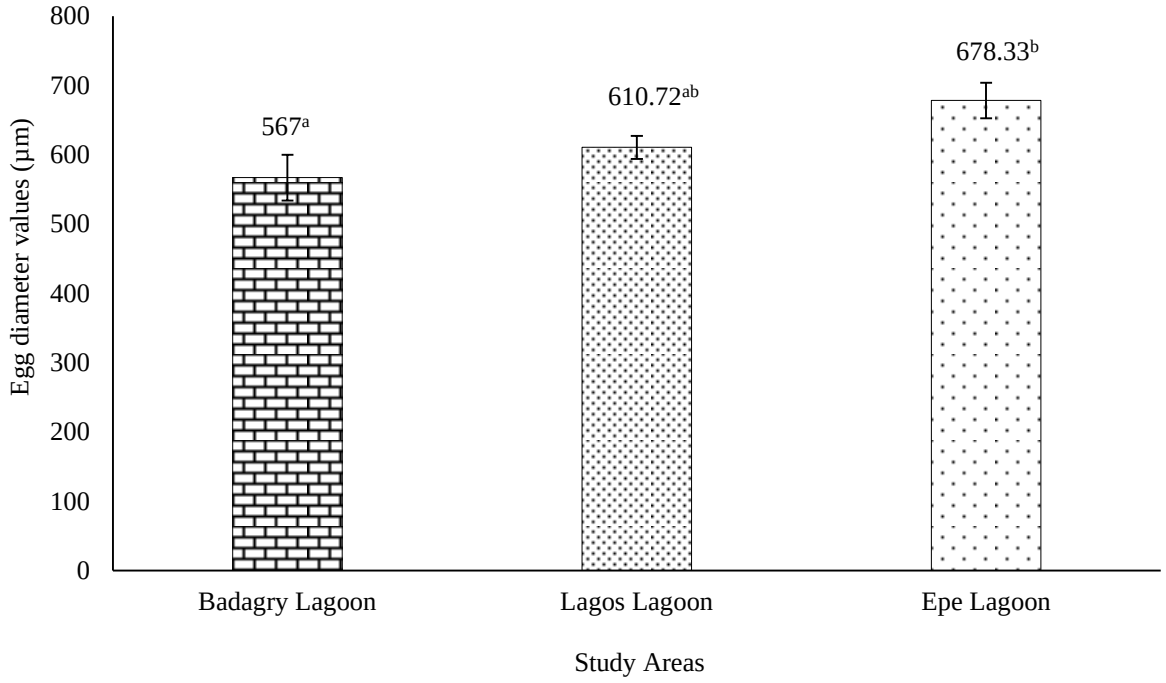

Figure 3: Level of significance of the egg diameters of *Macrobrachium vollenhovenii* from Badagry, Lagos and Epe Lagoons (June, 2014 - May, 2015)

DISCUSSION

In this study, variations in *M. vollenhovenii* from Badagry, Lagos and Epe Lagoons were described using meristic and morphometric characters. Similar approach was used by Kinsey *et. al*. (1994) and Akinwunmi & Lawal-Are (2019) in which morphomeric (meristic and morphometric characters) differences were used to determine variations among population structure of the Spanish sardine (*Sardinella aurita*) and Brackish water prawn (*M. macrobrachion*) respectively.

The result of the physico-chemical parameters showed that the values obtained are within the optimal levels to support diverse aquatic populations in their natural water systems. Much of the observed variation in these parameters, among groups of *M. vollenhovenii* from the three lagoons probably reflected the impact of environmental differences as a result of the variation in salinities of the three lagoons. This was evidenced in Badagry being low brackish, Lagos being high brackish and Epe being fresh water body. Therefore, this environmental differences might be a factor responsible for the varied meristic and morphometric characters. This was in agreement with the work of Ajado *et. al.* (2005) on the morphometric and comparative studies of *Chrysichthys nigrodigitatus*; Omoniyi & Agbon (2007) on the morphometric variation of *Sarotherodon melanotheron*; Akinwunmi & Lawal-Are (2019) on the racial studies of *M. macrobrachion.*

In the current study, it was observed that the number of spines on the dorsal rostrum teeth is more than the values recorded for the ventral side. The average number of rostrum teeth on the dorsal and ventral side of the species is 13 and 5 respectively. These values are more, compared to the values (the average number of spines on the dorsal side is 10 with an average of 6 on the ventral side) posited by Akinwunmi & Lawal-Are (2019) on *M. macrobrachion*. These findings showed that *M. vollenhovenii* had more rostrum teeth than *M. macrobrachion*, which could be due to its large size (Akinwunmi & Lawal-Are, 2018). This report is also in conformity with the work of Jimoh *et. al*. (2012), as they recorded more dorsal and ventral spines for *M. vollenhovenii* compared to *M. macrobrachion* from Badagry Lagoon. The work done by Jimoh *et. al*. (2005) on *M. vollenhovenii* from Ologe lagoon, reported the values of 12 and 4 as the average dorsal and ventral spines respectively, which is similar to the findings from this study.

Out of the 11 characters that were examined in this study, only 5 (carapace length, carapace width, egg diameter, dorsal and ventral rostrum teeth) showed significant differences ($P < 0.05$) while 6 (total length, telson length, rostrum length, 3rd abdominal somite, left cheliped length and the right cheliped length) showed no significant differences ($P > 0.05$) which could be an indication that the populations of *M. vollenhovenii* from the three lagoons are morphologically inseparable. However, the significant differences and/or variations in the meristic and some of the morphometric features could be as a result of changes in salinity gradients from the three lagoons (Akinwunmi & Lawal-Are, 2019) and may be an indication of genetically distinct populations. This finding of genetically distinct populations is contrary to the report of Adite *et al.* (2013) on *M. macrobrachion* from the Mono River Coastal Lagoon system, Southern Benin, which might be due to difference in species and location.

Meristic and morphometric differences were used to elucidate the variations in *M. vollenhovenii* from Badagry, Lagos and Epe Lagoons. The physico-chemical parameters of the three lagoons reflected environmental differences as a result of the variation in salinity from the three lagoons. The result from this study gave an indication that the populations of *M. vollenhovenii* from the three lagoons are morphologically inseparable. Though, the variations in the meristic and some of the morphometric features could be as a result of changes in salinity gradients from the three lagoons and an indication of genetically distinct populations. Therefore, the search in genetic diversification may require molecular characterization to detect probable variation among the populations. The study provided a concrete and important biological database useful in the species identification, nomenclature, rational exploitation and proper management of the prawn populations in the three lagoons.

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