OCCURRENCE, SIZE COMPOSITION AND GROWTH PATTERN OF TWO CARIDEAN SPECIES FROM THREE INTERCONNECTING LAGOONS IN SOUTH-WEST, NIGERIA

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ABSTRACT
The occurrence, size composition and growth pattern of prawns, *Macrobrachium macrobrachion* (Herklots, 1851) and *Macrobrachium vollenhovenii* (Herklots, 1857) from Badagry, Lagos and Epe Lagoons were investigated for 24 months (June 2013 – May 2015). The major ecological difference in the lagoons was salinity, with Badagry and Epe Lagoons being low brackish and Lagos Lagoon to be high brackish despite their interconnections. The size ranges of *M. macrobrachion* were 4.8 – 11.8cm; 4.9 – 11.9cm and 5.1 -12.8cm, while the size ranges for *M. vollenhovenii* were 5.4 – 15.9cm; 4.5 – 16.6cm and 4.3 – 22.6cm for Badagry, Lagos and Epe Lagoons respectively. *M. macrobrachion* had the highest occurrence from the three lagoons, occurring more in both Badagry (90.73%) and Lagos (84.20%) Lagoons while *M. vollenhovenii* occurred more in Epe Lagoon (55.28%). The prawns exhibited a positive allometric (b>3) and negative allometric (b<3) growth. The b (regression coefficient) values of *M. macrobrachion* ranged from 2.76 – 3.24 while that of *M. vollenhovenii* ranged from 2.81 - 3.68 for the three lagoons. There was a strong positive correlation between total length and weight in both species, which showed that an increase in length results in increase in weight of the organism. The coefficient of determination (R^2) values for the combined sexes of *M. macrobrachion* ranged from 0.9043 – 0.9377 and 0.8867 – 0.9712 for *Macrobrachium vollenhovenii*. The implication of the estimated length-weight relationship (LWR) parameters of *Macrobrachium* species from the three lagoons confirmed that increase in length was proportional to increase in weight. The varied environmental factors (salinity) in the three lagoons could be said to have influence on the occurrence, size composition and growth of the species. Despite the variations in the salinity levels from the three interconnecting lagoons, the environment was still able to accommodate various sizes of the prawn species, thus making the lagoons suitable for existence of the species.

Keywords: *Macrobrachium macrobrachion, Macrobrachium vollenhovenii*, growth pattern, salinity, lagoons.

INTRODUCTION
The genus *Macrobrachium* are referred to as freshwater prawns in Australia and freshwater shrimp in the United States of America (USA) (FAO, 2001). Prawns, of

the genus *Macrobrachium* are decapods in Suborder-Natantia and Family-Palaemonidae. *Macrobrachium* species are found in most inland freshwater areas including ponds, lakes, rivers and irrigation ditches as well as in estuarine environment of most waterbodies (New, 2002). Most *Macrobrachium* species require brackish water in the initial stages of their life-cycle and therefore, they are found in water that is directly or indirectly connected with the sea (New, 2003). In Nigeria, Marioghae (1990) reported that *M. vollenhovenii* lives and breeds successfully in totally freshwater bodies such as Lokoja (River Niger) and Asejire (Upper Osun). *Macrobrachium* species occur throughout the West African region (Etim and Sankare, 1998; Jimoh *et al*., 2005). The African river prawn, *M. vollenhovenii* may be found in all kinds of freshwater and in the brackish water up to and sometimes above 20‰ while *M. macrobrachion* thrives only in tidal freshwaters and in low salinity waters of up to and a little above 10‰ (Jimoh *et al*., 2005).

Bello-Olusoji *et al*. (2004) reported that about 200 species make up the genus *Macrobrachium*, four (4) species have been reported in Nigeria. These are *Macrobrachium vollenhovenii* (African river prawn), *Macrobrachium macrobrachion* (Brackish Water prawn), *Macrobrachium felicinum* (Niger River prawn) and *Macrobrachium dux* (Congo River prawn). These prawns have an extensive distribution across the southern region of Nigeria (Akintola and Bakare, 2011), with *M. vollenhovenii* and *M. macrobrachion* being the two largest species based on the size of the two species. These two species have been described to possess the highest commercial potential from both Aquaculture and Capture fishery (Ajuzie and Fagade, 1992). According to Anetekhai and Fagade (1987), *M. vollenhovenii* from Asejire Lake has a maximum adult size that ranged from 182 mm (18.2 cm) to 195 mm (19.5 cm) while for *M. macrobrachion*, the maximum adult size is 138 mm (13.8 cm) (Marioghae, 1987).

Length-weight relationship of prawn is a good fishery management tool. The relationship is important for the estimation of weight where only length data are available (Beyer, 1987; Petrakis and Stregiou, 1995; Goncalves *et al*., 1997; Hart and Abowei, 2007). Hence, length-weight relationship of a shrimp is generally a measure of the growth pattern or age. Growth is an important component of biological production, which affects overall production directly (Wootton, 1992). Negative change in the growth rates may result in decreased individual health, reproductive success and increase risk of predation and mortality among aquatic organisms (Wootton, 1992). Most studies on length-weight relationship of *Macrobrachium* species are from Benin river (Edokpayi, 1989), Badagry creek

(Jimoh *et al*., 2012), Lagos and Lekki Lagoons (Lawal-Are and Owolabi, 2012). The study sought to provide information on the physico-chemical parameters of the lagoons, comparative study of the occurrence, size composition and growth pattern of *Macrobrachium macrobrachion* and *Macrobrachium vollenhovenii* from the three interconnecting lagoons that may help understand the ecology of the species.

MATERIALS AND METHODS

Study area

This study was carried out in Badagry, Lagos and Epe Lagoons in south west Nigeria. The Badagry Lagoon (Fig. 1) with source in River Queme in the Republic of Benin to the west of Nigeria, is located in Lagos State and opens into the Atlantic Ocean via the Lagos Harbour. It lies between longitude 3°54″ and 4°13″E and latitude 6°25″ and 6°35″N.

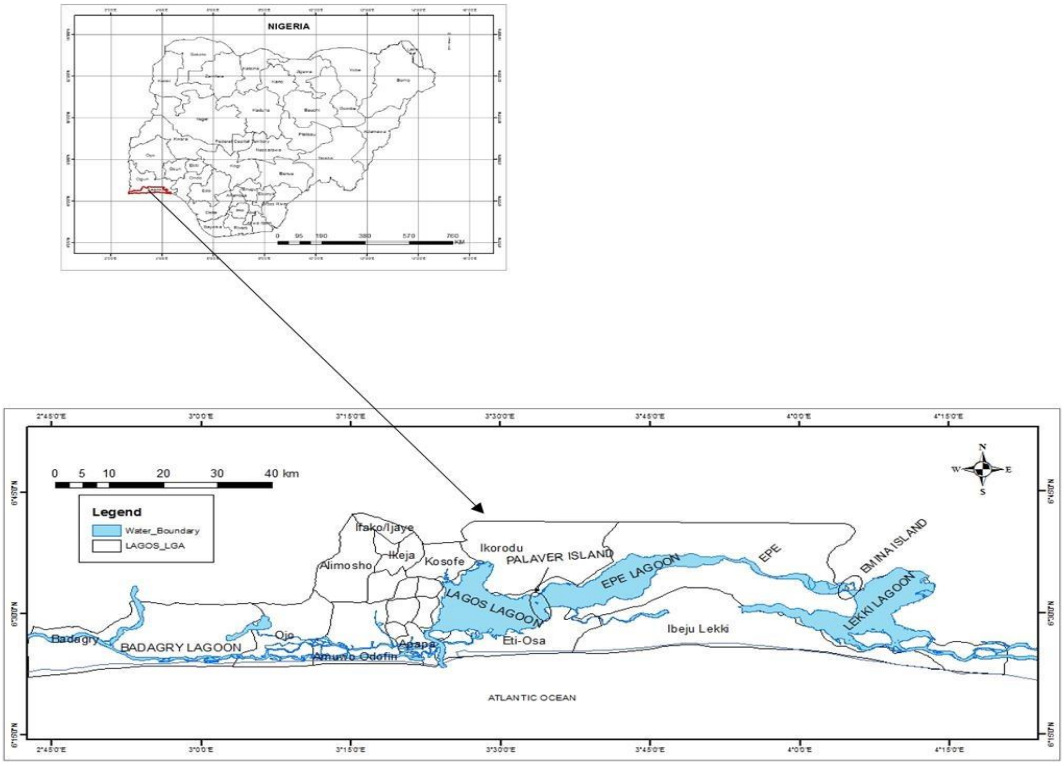

Fig. 1: Map showing Badagry, Lagos and Epe Lagoons.

The major ecological factors operating in the Badagry Lagoon have been documented by Ezenwa and Kusemiju (1985) and Solarin (1998).

Lagos Lagoon (Fig. 1) is located between longitudes 3°23″ and 3°53″E and latitudes 6°26″ and 6°37″N. It is an open tidal estuary situated within the low-lying coastal zone of Nigeria. Lagos Lagoon has a seasonal fluctuation in salinity with high brackish conditions during the dry season (December to May), while freshwater condition exists in the rainy season (June – November) (Ugwumba and Kusemiju, 1992; Solarin, 1998; Lawal-Are, 2006).

Epe Lagoon (Fig. 1) lies between latitudes 6º29″N and 6º38″N; and longitudes 3º30″E and 4º05″E and is fed by River Oshun with a surface area of about 225 km^2 and a maximum depth of 6 m. A large area of the lagoon is relatively shallow with a minimum depth of 1m and the vegetation surrounding the lagoon is of the mangrove swampy type (Balogun, 1987). The lagoon opens into the Atlantic Ocean via the Lagos Harbour (Kumolu-Johnson *et al*., 2010).

Collection of samples

Monthly samples of *M. macrobrachion* and *M. vollenhovenii* were collected from Badagry, Lagos and Epe Lagoons between June 2013 and May 2015. The prawns were collected from the lagoons using a basket trap (Igun). Collection of the prawns was done randomly from the traps landing which were set near the shore of the various lagoons. The prawns were immediately preserved in an ice-chest and later transported into a deep freezer at temperature of -20ºC in the Marine Research Laboratory of the Department of Marine Sciences for further studies. The physico-chemical parameters of each of the three lagoons were measured *insitu* at the three lagoons. The air and surface water temperatures were measured using a Mercury-in-glass thermometer. Salinity was determined using a hand refractometer (Model No: RHS-10). Dissolved oxygen (DO) content was determined using a Hanna DO meter (Model: HI 9146). The pH values were determined using a Hanna pH meter (Model: HI 2210) while water transparency was measured using a 20cm diameter black and white colored secchi disc. The conductivity was determined by using a Hanna conductivity meter (Model: EC 215).

Laboratory analysis

The total length (TL) of the prawns was measured to the nearest 0.1 cm from the tip of the rostrum to the end of the telson with a measuring board, while the total weight was measured on an electronic weighing balance (Model: DT 1001A) to the

nearest 0.01 gram. The length-weight relationship was estimated using the equation:

$W = a L^b$ ……. (Pauly, 1983; Edwards, 1976)

Where W= weight of the prawns in grams.
L = total length of the prawns in cm.
a = regression constant
b = regression coefficient

The values of constant a and b were estimated from log transformation values of length and weight as:

$$Log\ W = Log\ a + b\ Log\ L$$ …… (Parsons, 1988)

STATISTICAL ANALYSIS

The statistical analysis was carried out using the Predictive Analytics SoftWare (PASW) Statistics version 18 and PAleontological STatistics (PAST) version 2.

RESULTS

Physico-chemical parameters

The summary of the mean physico-chemical parameters of Badagry, Lagos and Epe Lagoons is presented in Table 1. The salinity in Badagry Lagoon was low brackish (0.0 – 7.0‰), Lagos Lagoon was high brackish (2.0 – 25.0‰) while Epe Lagoon was low brackish (0.0 – 5.0‰) as shown in Fig. 2.

Size composition, occurrence and growth pattern

A total of 4729 specimens of *M. macrobrachion* and *M. vollenhovenii* were collected from the three Lagoons. The numbers of *M. macrobrachion* and *M. vollenhovenii* collected respectively were 1606 and 164 from Badagry Lagoon; 778 and 146 from Lagos Lagoon; 910 and 1125 from Epe Lagoon as shown in Table 2. The ranges of the total length and weight for *M. macrobrachion* and *M. vollenhovenii* respectively were 4.8 – 11.8 cm and 5.4 – 15.9 cm (1.10 - 22.60 g and 2.90 – 73.50 g) in Badagry Lagoon; 4.9 – 11.9 cm and 4.5 – 16.6 cm (1.10 - 21.90 g and 1.10 – 140.00 g) in Lagos Lagoon and 5.1 – 12.8 cm and 4.3 – 22.6 cm (1.40 - 40.10 g and 1.30 – 76.40 g) in Epe Lagoon as presented in Table 3.

The length-frequency distributions of *M. macrobrachion* and *M. vollenhovenii* in the three lagoons are shown in Figures 3 - 4. The total length frequency polygon of *M. macrobrachion* showed that size group 7.5 – 8.4cm (30.3%) was most abundant in Badagry Lagoon; the size group 6.5 – 7.4cm (35.0%) was most abundant in

Lagos Lagoon while the size group 7.5 – 8.4cm (29.0%) was most abundant in Epe Lagoon. The total length frequency polygon of *M. vollenhovenii* showed that size group 7.5 – 8.4cm (25.6%) was most abundant in Badagry Lagoon; the size group 10.5 – 11.4cm (19.2%) was most abundant in Lagos Lagoon while the size group 7.5 – 8.4cm (22.5%) was most abundant in Epe Lagoon.

PARAMETERS	BADAGRY LAGOON		LAGOS LAGOON		EPE LAGOON	
	Range	Mean	Range	Mean	Range	Mean
Air temperature (°C)	20.50 – 38.00	26.73 ± 1.08^{ab}	21 - 29	25.09 ± 0.51^{a}	21.0 – 34.0	28.57 ± 0.67^{b}
Water temperature (°C)	21.00 – 32.30	27.12 ± 0.57^{a}	21 -32	27.70 ± 0.58^{a}	25.3 – 32.0	29.72 ± 0.43^{b}
Dissolved oxygen (mg/L)	3.01 – 14.00	6.18 ± 0.53^{a}	1.5 – 10.9	5.87 ± 0.46^{a}	3.7 – 11.5	6.92 ± 0.56^{a}
pH	5.00 - 9.39	7.71 ± 0.23^{b}	6.7 - 8.7	7.48 ± 0.11^{b}	5.5 – 8.6	6.90 ± 0.14^{a}
Salinity (‰)	0 - 7	4.13 ± 0.43^{b}	2 - 25	9.81 ± 1.60^{c}	0 – 5	0.54 ± 0.29^{a}
Transparency (cm)	17.78 – 92.00	47.39 ± 3.37^{a}	20 - 175	54.20 ± 6.43^{a}	47.0 – 95.0	67.04 ± 2.41^{b}
Conductivity (µS/cm)	134 - 4670	964.70 ± 275.50^{a}	298 – 39600	11734 ± 2917.78^{b}	65.4 – 720.0	188.50 ± 31.63^{b}

Means with the same superscript alphabets along the row are not significantly different (P>0.05).

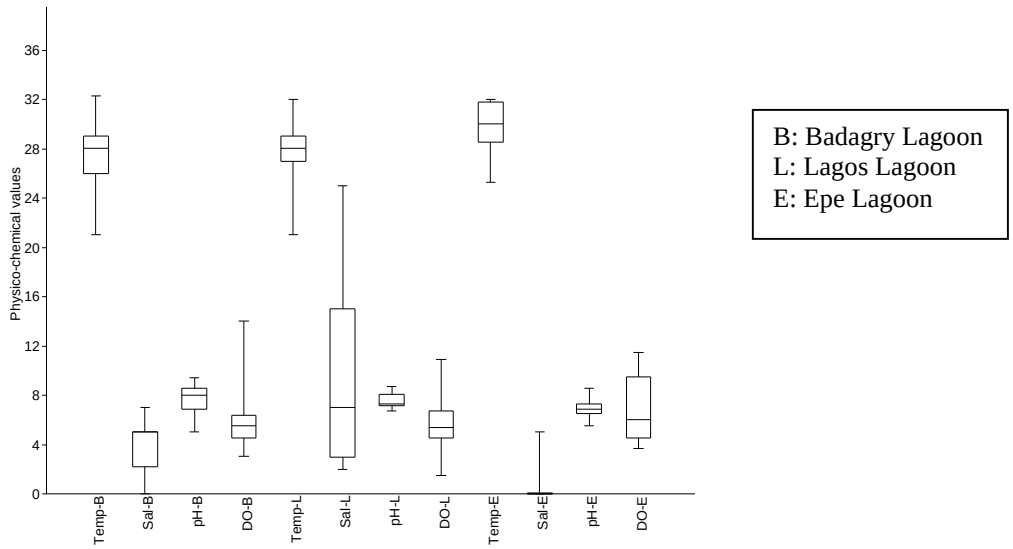

Fig. 2: Mean (± S.E) of the physico-chemical parameters of Badagry, Lagos and Epe Lagoons

(June 2013 – May 2015)

The growth pattern of *M. macrobrachion* from the three lagoons showed a positive allometric growth except for the females from Lagos and Epe Lagoons which showed a negative allometric growth. The growth pattern of *M. vollenhovenii* from the three lagoons showed a positive allometric growth except for the males from Badagry Lagoon. The males, females and combined sexes from Epe Lagoons showed a negative allometric growth. The relationship between Log total length and Log total weight for combined sexes of *Macrobrachium macrobrachion* and *Macrobrachium vollenhovenii* from Badagry, Lagos and Epe Lagoons is illustrated in Figures 5 - 6.

Table 2: Size composition of *Macrobrachium macrobrachion* and *Macrobrachium vollenhovenii*
from Badagry, Lagos and Epe Lagoons (June 2013 – May 2015)

SPECIMENS	BADAGRY LAGOON	LAGOS LAGOON	EPE LAGOON	TOTAL
M. macrobrachion	1606	778	910	3294
M. vollenhovenii	164	146	1125	1435
TOTAL	1770	924	2035	4729

Table 3: Size groupings of *Macrobrachium macrobrachion* and *Macrobrachium vollenhovenii*
from Badagry, Lagos and Epe Lagoons (June 2013 – May 2015)

		Macrobrachium macrobrachion		*Macrobrachium vollenhovenii*	
		Total length (cm)	Total weight (g)	Total length (cm)	Total weight (g)
Badagry Lagoon	Minimum	4.8	1.10	5.4	2.90
	Maximum	11.8	22.60	15.9	73.50
Lagos Lagoon	Minimum	4.9	1.10	4.5	1.10
	Maximum	11.9	21.90	16.6	140.00
Epe Lagoon	Minimum	5.1	1.40	4.3	1.30
	Maximum	12.8	40.10	22.6	76.40

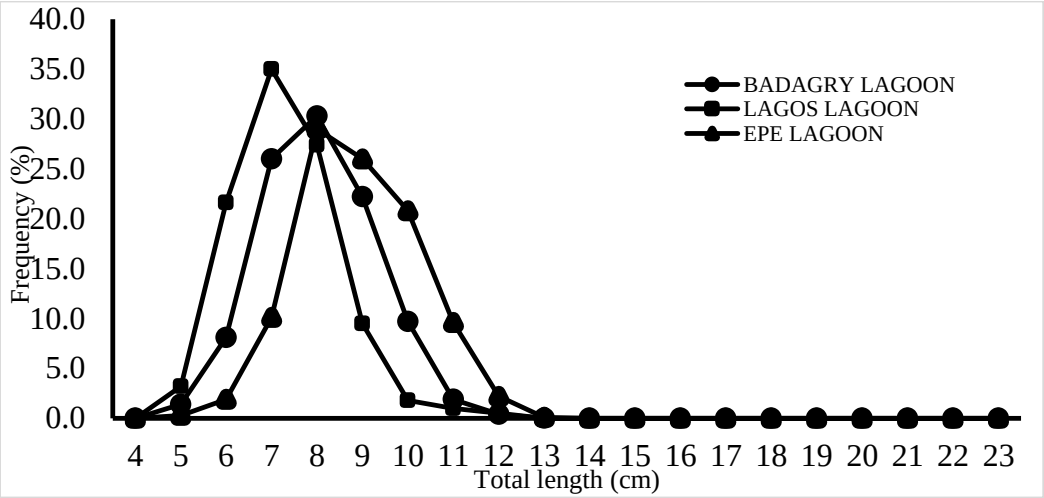

Fig. 3: Total length frequency distribution of *Macrobrachium macrobrachion* from Badagry, Lagos and Epe Lagoons (June 2013 – May 2015)

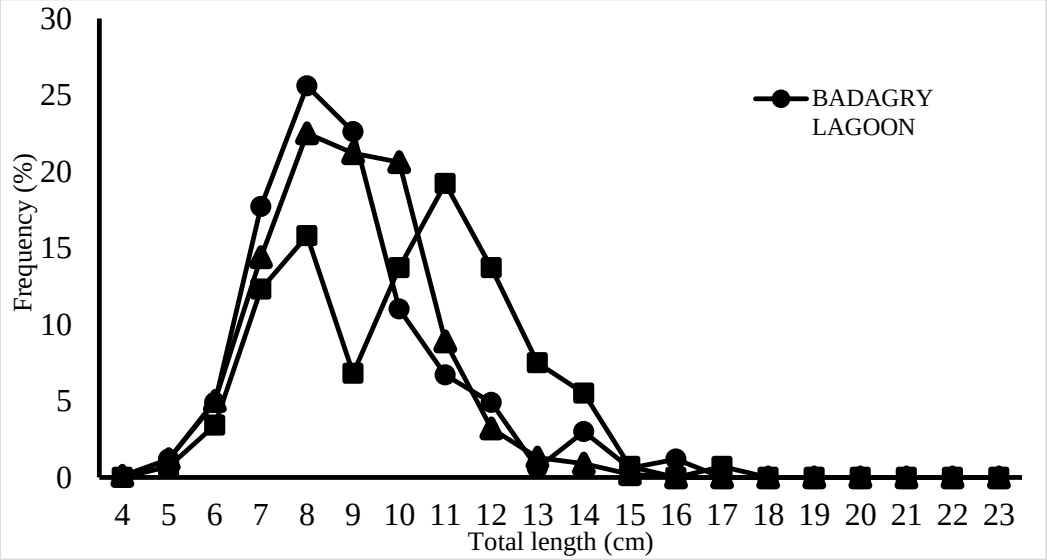

Fig. 4: Total length frequency distribution of *Macrobrachium vollenhovenii* from Badagry, Lagos and Epe Lagoons (June 2013 – May 2015)

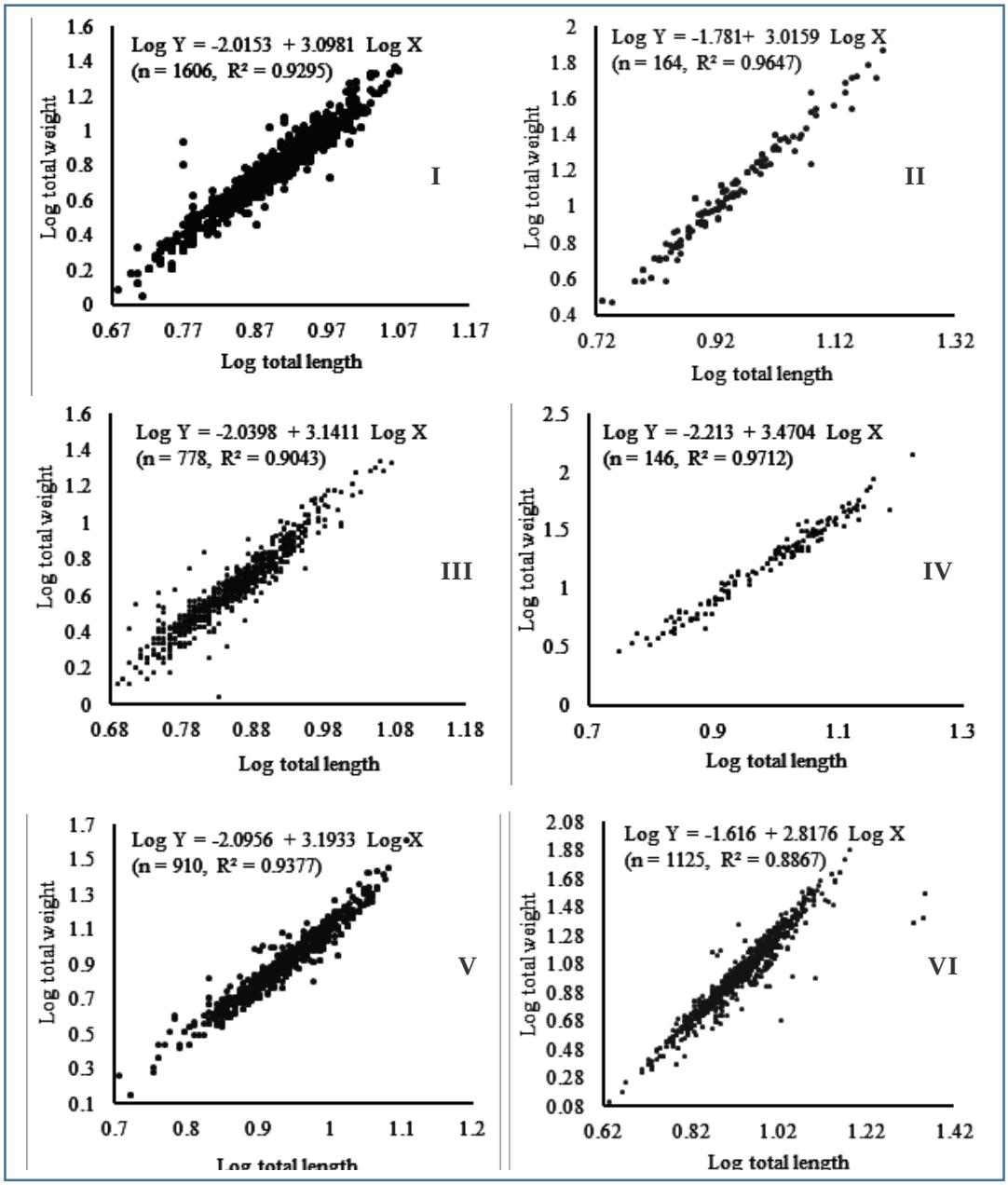

Fig. 5 (I, II, III): Log total length – Log weight relationship of *Macrobrachium macrobrachion* from Badagry, Lagos and Epe Lagoons (June 2013 – May 2015)

Fig. 6 (IV, V, VI): Log total length – Log weight relationship of *Macrobrachium vollenhovenii* from Badagry, Lagos and Epe Lagoons (June 2013 – May 2015)

DISCUSSION

The conditions of the physico-chemical parameters recorded in the three lagoons from this study showed that temperature, dissolved oxygen, pH, transparency and conductivity recorded are not significantly different from one another and the values recorded has not changed drastically from the result obtained from previous authors. The result documented for Badagry Lagoon were similar to those reported by Soyinka *et al.* (2010), Lawal-Are and Kusemiju (2011), Ndimele and Kumolu-Johnson (2011), Agwu and Oluwagunke (2014), while that for Lagos Lagoon were similar to those reported by Lawal-Are and Kusemiju (2011) and the parameters for Epe Lagoon were similar to those reported by Soyinka and Ebigbo (2012). Hence, it can be concluded that these physico-chemical parameters have no impact on the occurrence, size composition and growth of the species from the three lagoons since the environment has not changed from what it used to be, except for the salinity difference which was due to the influx of freshwater dilution during the wet season. The major ecological variation in the three lagoons was salinity and despite the variations in the salinity levels from the three interconnecting lagoons, the environment was able to accommodate various sizes of the prawn species. This supports the work of Lawal-Are and Kusemiju (2011) on *Callinectes amnicola* and the result showed that salinity was the major variation of the species from Badagry, Lagos and Lekki Lagoons.

From the total of 4729 prawns collected from the three Lagoons, *M. macrobrachion* had the highest occurrence of 69.66% (30.34% for *M. vollenhovenii*). *M. macrobrachion* occurred more in Badagry Lagoon (90.73%) and Lagos Lagoon (84.20%) while *M. vollenhovenii* occurred more in Epe Lagoon (55.28%). These findings of more *M. macrobrachion* in Badagry Lagoon was in agreement with the work of Jimoh *et al*. (2012) who recorded larger collection of *M. macrobrachion* from Badagry creek. This result also agrees with the findings of Marioghae (1982) and (1990), who reported that *M. macrobrachion* forms about 60% of all prawn landings from the Lagos Lagoon (a brackish environment) since the species can be found in both low and high brackish environment (Jimoh *et al.*, 2005).

The largest size specimens of *M. macrobrachion* and *M. vollenhovenii*, which were males were found in Epe Lagoon and they were 12.8 cm and 22.6 cm in total length respectively, with *M. vollenhovenii* larger than *M. macrobrachion*. This might be due to the low saline conditions of Epe Lagoon compared to Badagry and Lagos Lagoons. Jimoh *et al.* (2012) reported in their study that *M. vollenhovenii* was observed to be larger than *M. macrobrachion* with the males of both species been larger than the females. New (2002) also described *M. vollenhovenii* as one of the largest species of *Macrobrachium* species known. The result from this study is also

in conformity with the report of Anetekhai (2002). He reported that male prawns are usually bigger than the females. The implication of the females been smaller than the males could be due to the female converting its weight gain in gonadal development and spawning.

However, the findings on the size composition for *M. macrobrachion* and *M. vollenhovenii* in this work is contrary to the work documented by Saifullah *et al*. (2005) from the North east and North west regions of Bangladesh and the work of Jimoh *et al*. (2005) from Ologe Lagoon, that both species attain and rarely exceed a total length of 182 mm (18.2 cm) and 120 mm (12.0 cm) respectively. While Marioghae (1995) reported that *M. vollenhovenii* and *M. macrobrachion* from the Niger Delta region of Nigeria, attain maximum adult sizes of 19.0 cm (190 mm) and 13.5 cm (135 mm) respectively.

The total length-weight relationship of the *Macrobrachium* species showed an allometric growth in the three lagoons indicating that the total length grows wider with increasing weight. According to Wootton (1992), *M. macrobrachion* and *M. vollenhovenii* became plumber as they grew larger. These findings were in agreement with the work of Jimoh *et al.* (2012) on *M. macrobrachion* and *M. vollenhovenii* from Badagry creek with a "b" value of 2.58 and 3.11 respectively; Anetekhai and Fagade (1989) on *M. vollenhovenii* from Asejire Lake with a "b" value of 5.8 and Jimoh *et al.* (2005) on *M. vollenhovenii* from Ologe Lagoon who reported a "b" value of 6.32. High correlation values of the species showed a strong indication that an increase in total length of the prawns gave a corresponding increase in body weight, which was observed to be in conformity with the work of Jimoh *et al.* (2012) on *M. macrobrachion* and *M. vollenhovenii* from Badagry creek; Meye and Arimoro (2005) also recorded a positive correlation between total length and body weight for males and females of *M. dux* in Orogodo river of Niger Delta.

CONCLUSION

The study provided the prevailing physico-chemical parameters of Badagry, Lagos and Epe Lagoons which determines the occurrence, distribution and growth of the species except for salinity being the major ecological variations and could be said to be a factor influencing the occurrence and growth of the species from the three lagoons. This research therefore provided concrete baseline data useful in the rational exploitation, fisheries, conservation and proper management of the prawn populations through closed season, closed area and selective harvesting of *M. macrobrachion and M. vollenhovenii* in the three lagoons.

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