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Length-weight relationship and Fulton's condition factor of brackish river prawn (*Macrobrachium macrobrachion*, Herklots, 1851) from great Kwa river, Obufa Esuk beach, Cross river state, Nigeria

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ABSTRACT

Length-weight relationship (LWR) and Fulton's condition factor of Macrobrachium macrobrachion Herklots, 1851, from Great Kwa River, Obufa Esuk Beach, Cross River State, Nigeria. Shrimp samples were collected for a period of six months from February, 2006 to July, 2006. The result shows that strong positive relationship exists between the shrimp length and weight. The b values were greater than 3, hence growth in the individual sex is allometric (b<3). The result of the Fulton's condition factor (k), highest in male, female and berried female were 4.53, 5.59 and 8.00 respectively while the lowest in male, female and berried female were 0.15, 0.65 and 0.85 respectively. The implication of the estimated LWR parameters to the assessment of Macrobrachium macrobrachion stock in Great Kwa River, Obufa Esuk, revealed the suitability of the environment for this species, thus for sustainable management of this stock and also the environmental status should be maintained.

Keywords: length-weight relationship, *Macrobrachium macrobrachion*, Fulton's condition factor, Great Kwa River, Obufa Esuk Beach, Nigeria

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INTRODUCTION

The fresh water shrimp; *Macrobrachium macrobrachion* belongs to the Phylum, *Arthropoda*, Class, *Crustacea*; Subclass, *Malacostraca*; Series, *Eumalacostraca*; Order, *Decapoda*; Suborder, *Natantia*; Section, *Caridea*; Family, *Palaemonida*; Genus, *Macrobrachium*; Species, *M. macrobrachion* Powell [1980]. It can also be found in low salinity brackish water [Powell, 1985]. In the Niger Delta, Powell [1983] found that *M. macrobrachion* is more important to the artisanal catch in the tidal areas than *M. vollenhovenii*. In the Cross River estuary, it constitutes 66% by weight and 81% by number in the landings of the artisanal *Macrobrachium* fishery [Enin, 1995], confirming its dominant position as the main target species of the fishery. The prawn is fished all the year round but with peak catches during the rainy months from May to October, which constitute the main fishing season [Enin, 1997]. Spawning and recruitment of the species also take place all year round but with seasonal pulses. The major spawning peak occurs between July and September, and a secondary peak in January; while recruitment peaks occur in May and December [Enin, 1997] significant differences exist between the male and female. Mature males are considerably larger than females and the second walking leg is much thicker. The cephalothorax is also proportionally larger in the male than female while abdomen is narrower in the female. The genital pores of the male are between the bases of the fifth walking leg [New and Singholka, 1982]. Length weight relationship of a shrimp is basically a measure of the growth pattern or age. Growth is an important component of biological production, which affects overall production directly. Negative change in the growth rates may result in decreased individual health, reproductive success and increase risk of predation and mortality [Wootten, 1992]. Condition factor compares the well-being of a fish and is based on the hypothesis that heavier fish of a given length are in a better condition

[Bagenal and Tesch, 1978; Abowei and George, 2009]. Condition factor has been used as an index of growth and feeding intensity [Fagade, 1979; Abowei *et al* 2009]. Condition factor decreases with increase in length [Bakare, 1970; Fagade, 1979; Abowei, 2009, 2010a] and also influences the reproductive cycle in fish and shrimp. Incidentally, most studies on length weight relationship are on fishes from other water bodies [Abowei, 2009, 2010b]. A study on the length weight and condition factor in Great Kwa River, Obufa Esuk Beach, Calabar, will provides information to bridge the gap and management decision for the management of *M. macrobrachium* and other shrimps of Kwa River fishery and similar water bodies.

MATERIALS AND METHODS

The sample of *Macrobrachium macrobrachion* used in this study were obtained from the catches of the artisanal shrimp fishery at Obufa Esuk Beach, one of the major shrimp landing beaches of the *M. macrobrachion* fishery in the outer estuary (Figure 1) of the Cross River. The samples were collected from February, 2006-July, 2006, involving a total of 200 shrimps. The estuary receives sea water from the Atlantic Ocean and freshwater from a number of rivers including the Cross River and Great Kwa River. During the peak breeding season (May-July), the adult of *M. macrobrachion* migrates from the freshwater of the Great Kwa River into the estuary for spawning and it is normally in the estuary are densely populated with mangrove trees, bamboo trees and some species of shrubs. There is also the presence of some coconut trees. The estuary has a brownish colouration and along contains part at low tides during the dry season submerged portions of the bottom re-emerge through a short period. The estuary is located in the tropical rainforest belt of southern Nigeria and lies between latitudes $4^{o}15'$ and $4^{o}45'$N and longitudes $8^{o}5'$ and $8^{o}35'$E. The estuary has a mean salinity of 20ppt during the dry season and approximately 12ppt at the peak of the rainy season [Udo and Ekpe, 1991]

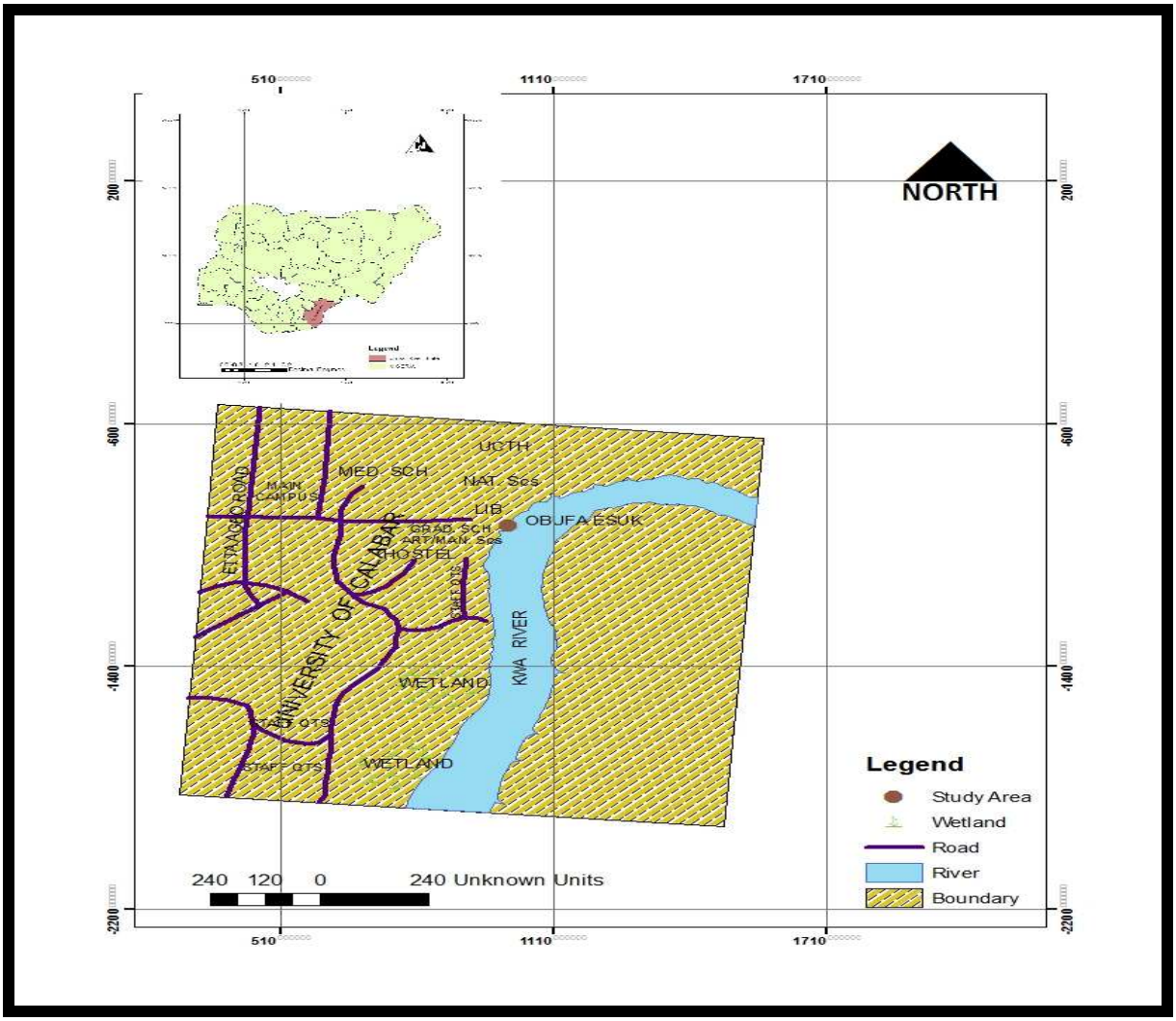


Figure 1: Map of University of Calabar showing Great Kwa River and Sampling station (Obufa Esuk Beach), (Map of Nigeria indicating Cross River State)

Specimen sampling

Samples of *Macrobrachium macrobrachion* were collected from Obufa Esuk Beach lower section of Great Kwa River Bi-monthly for six months; these samples were bought from the artisanal fishermen early in the morning between 7am and 8am. As they landed from their fishing ground, samples collected include lives as well as dead but fresh individuals and they were also sorted into male and female; females were later separated into berried (ovigerous) and non-berried (non-ovigerous). 200 species of *M. macrobrachion* comprising of nearly all size groups were in the study. They were immediately injected with 4% formalin to reduce to the minimum of any post-homous digestion [Coasta and Wanninayake, 1986] and were later transferred to the laboratory. In the laboratory, the total length (TL)cm, standard length (SL)cm, carapace length (CL) cm and body weight (gm) of the specimens measured to the nearest 0.1cm and 0.1g using a measuring board calibrated in cm and triple beam balance respectively. Total length to the nearest 0.1cm was considered to be the distance between the tip of rostrum and the tip of telson [Arringnon *et al* 1994], standard length to the nearest 0.1cm considered to be the distance between the tip of the rostrum to the end of the 5th segment of the abdomen in cm with the help of a measuring tape and carapace length (the distance from the base of rostrum to the first body segment) was measured with a Vernier caliper to the nearest 0.1mm. The shrimps were then weighed with triple beam balance to the nearest 0.1 g. Measurements were taken for each monthly collection and recorded accordingly.

The length - weight relationship of the shrimp was estimated using linear regression [Pauly, 1983; Wahua, 1999]. The technique is incorporated in the FAO ICLARM, Stock Assessment Tool (FiSAT) [Gayanilo and Pauly, 1997] which is used in fisheries. The length weight relationship was obtained from the relationship.

W = aLb [Pauly; 1983; Sparre *et al* 1989] ……..... (1)

Where,
W = Weight of shrimps (g)
L = Length of shrimps (mm)
a = Intercept
b = Slope

The values of a and b was given a logarithm transformation according to the following formula:

Log W = log a + blog L (Pauly, 1983) ……..... (2)

The intercept “a” in the formula was estimated with the formula:

$$a = \left[\frac{\sum y}{n} - \frac{(b\sum x)}{n}\right]$$ ……..... (3)

Or logarithm transformed as:

$$a = \left[\frac{\sum \log W^{y}}{n} - \frac{b\sum \log W^{x}}{n}\right]$$ ……..... (4)

While the slope “b” was estimated by the formula:

$$b = \frac{n\sum xy}{n\sum x^{2}} - \frac{(\sum x)(\sum y)}{(\sum x)^{2}}$$ ……..... (5)

Or log transformed as:

$$b = \frac{n\sum \log x - \log_{10} Y - (\sum \log_{10})(\sum \log_{10} Y)}{n\sum \log_{10} x^{2} - \sum \log_{10}(x)}$$ ……..... (6)

Where,
X = Length of shrimps
Y = Weight of shrimps
N = Number of shrimps (sample size)

The correlation i.e., the degree of association between the variables was determined by computing the correlation co-efficient (r) [Wahua, 1999; Ogbeibu, 2005] using the relationship:

$$r = \sqrt{r^2} \quad \text{..... (7)}$$

$$r^2 = \frac{\left(\sum xy - (\sum x)(\sum y)^2\right)}{\left(\sum x^2 - (\sum x)^2\left(\sum y^2 - (\sum y)^2\right)\right)} \quad \text{..... (8)}$$

Or log transformed as:

$$r^2 = \frac{\sum \log_{10} x \log_{10} y - (\sum \log_{10} x)(\sum \log_{10} y^2)}{n} \quad \text{..... (9)}$$

$$= \left[\sum \log_{10} x^2 - \frac{\sum \log_{10}(x)^2}{n}\right] \left[\frac{\sum \log_{10} y^2}{10} - \frac{\log_{10} y^2}{n}\right] \quad \text{..... (10)}$$

$$CF = \frac{\overline{W} \times 100}{\overline{TL^3}} \quad \text{..... (11)}$$

Where,
CF = Fulton's condition factor
W= Mean ungutted weight (g)
TL^3= Mean total length (mm)
CF was determined for each month during the study.

RESULTS

Plots of the length/weight relationship of *M. macrobrachion* in Great Kwa River, Obufa Esuk Beach, are shown in Fig. 2, 3, 4, 5, 6 and 7 A strong positive relationship was observed between the shrimp lengths and Body weight. The values of a, b, and r, are given in Table 1). The b values were greater than 3. Hence growth in the individual sex is allometric, b< 3 (shrimp changes shape as it grows larger). The results of the Fulton's condition factor, K, determined for shrimps in Cross River Estuary, Kwa river, Obufa Esuk Beach, Calabar are shown in Fig. 8. In males, the highest condition factor (K = 4.53) was recorded in July while the lowest result in male (K = 0.15) was recorded in February. In females, the lowest condition factor (K = 0.65) was in February while the highest condition factor (K = 5.59) for females was in July. In the berried females, the month of July has the highest condition factor (K = 8.00) while the lowest K value of 0.85 was recorded in February.

Table 1: Length-weight relationship parameters and Log-Log transformation of *Macrobrachium macrobrachion* from Great Kwa River, Obufa Esuk Beach, Calabar, Cross River State, Nigeria

S/N	Sample size (N)	Length (cm) -Weight (gm) relationship	Regression values				Log-Log transformation
			a	b	r	R^2	
1	200	Body weight-Standard length	0.1336	7.2843	0.9856	0.9714	Y=-0.75+0.96x
2	200	Body weight-Carapace length	0.1774	9.0517	0.9740	0.9494	Y=-0.75+0.91x
3	200	Body weight-Total length	0.1787	8.1264	0.9870	0.9742	Y=-0.87+0.86x
4	200	Standard length-Carapace length	1.2624	0.1629	0.9401	0.8838	Y=0.10-0.79x
5	200	Total length-Standard length	0.6913	1.7534	0.980	0.9609	Y=0.166+0.244x
6	200	Total length-Carapace length	0.9328	1.4846	0.9850	0.9704	Y=0.030+0.172x

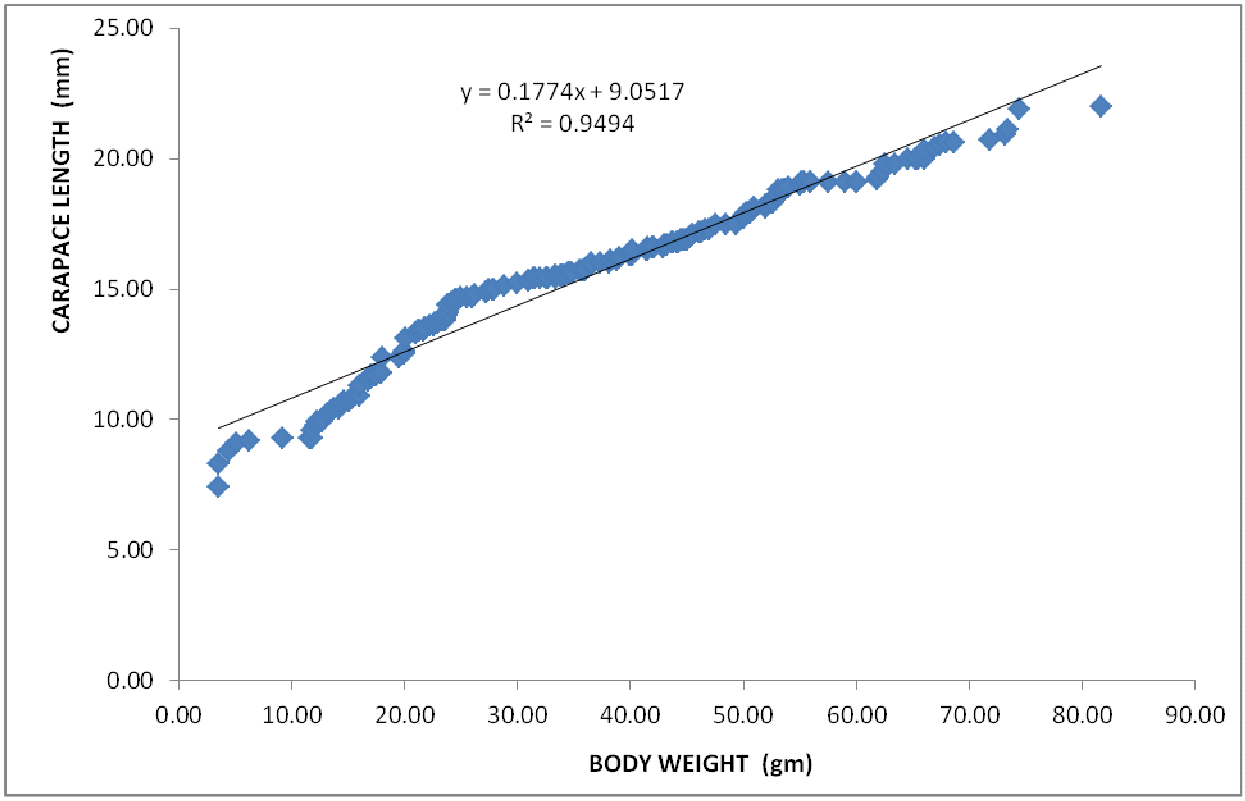


Figure 2: Carapace length (CL, mm) - Body weight (BW, gm) relationship of *Macrobrachium macrobrachion* in Great from Great Kwa River, Obufa Esuk Beach

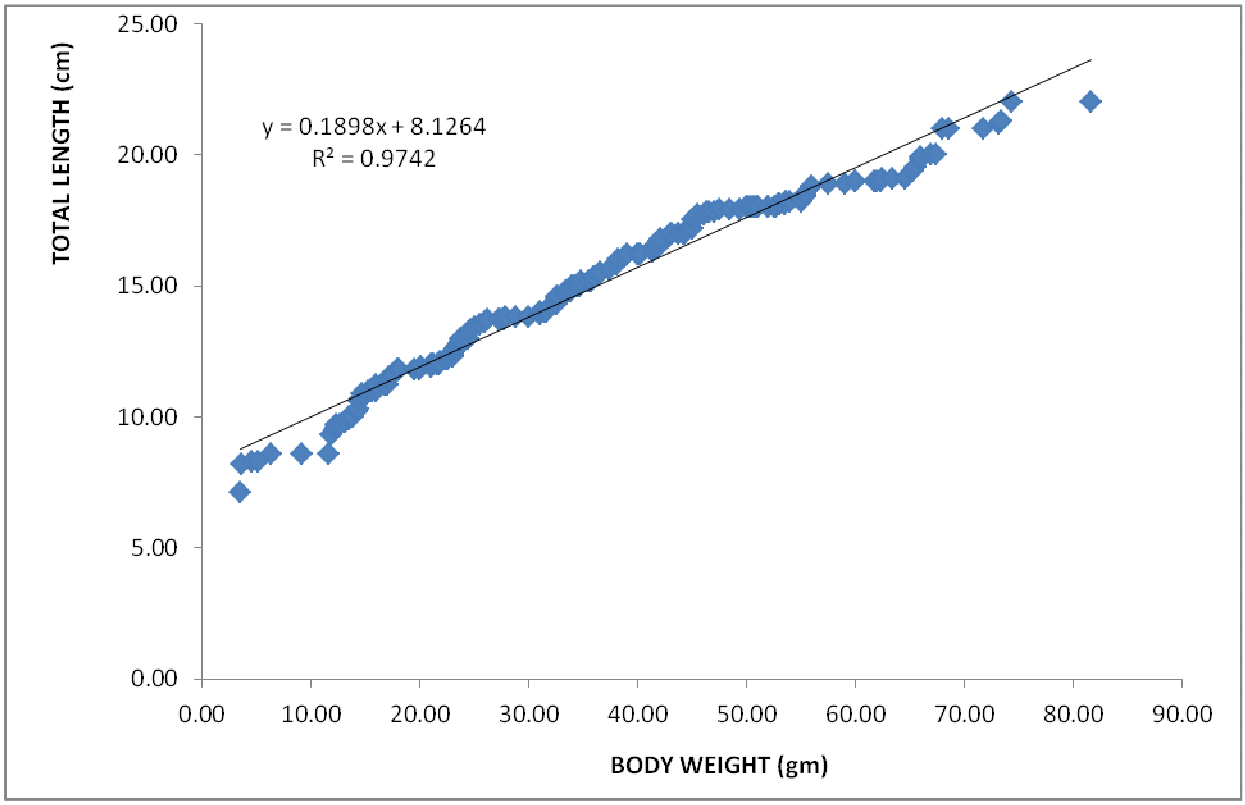


Figure 3: Total length (TL, cm) - Body weight (BW, gm) relationship of *Macrobrachium macrobrachion* from Great Kwa River, Obufa Esuk Beach

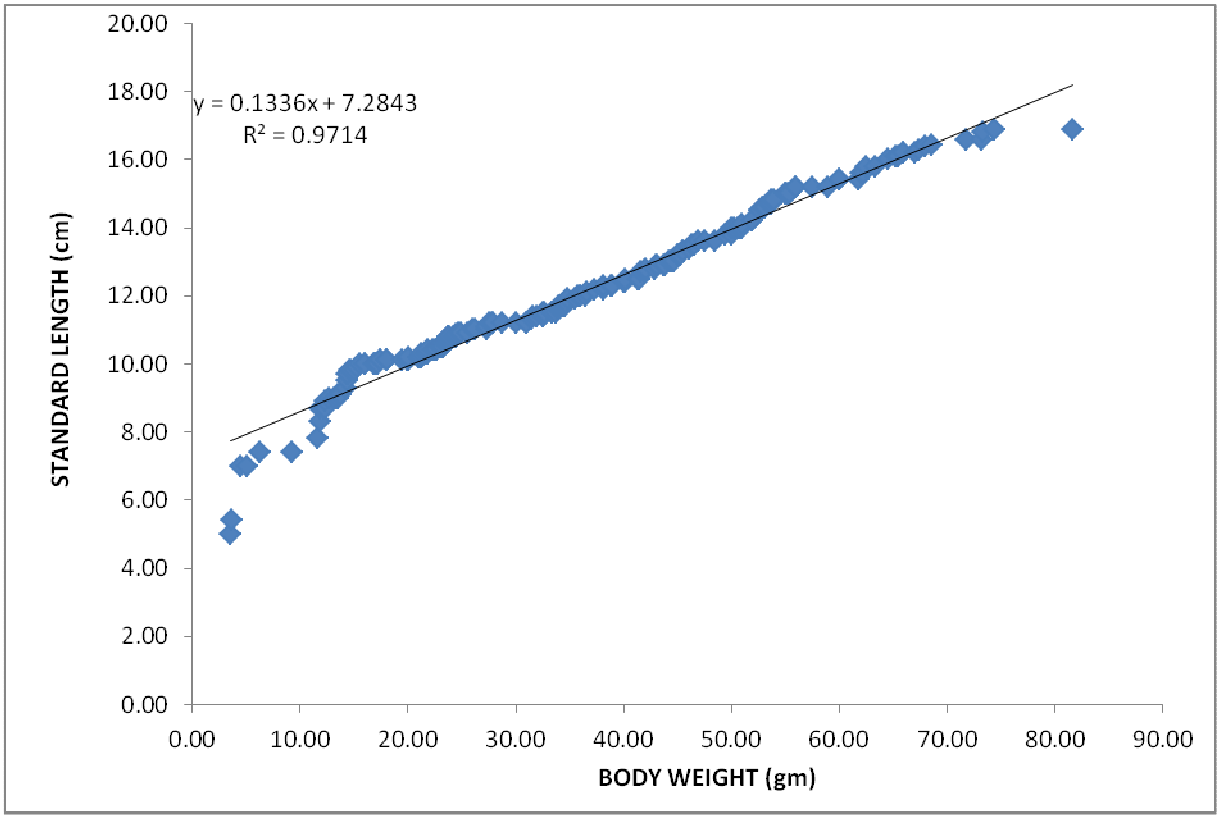


Figure 4: Standard length (SL, cm) - Body weight (BW, gm) relationship of *Macrobrachium macrobrachion* from Great Kwa River, Obufa Esuk Beach

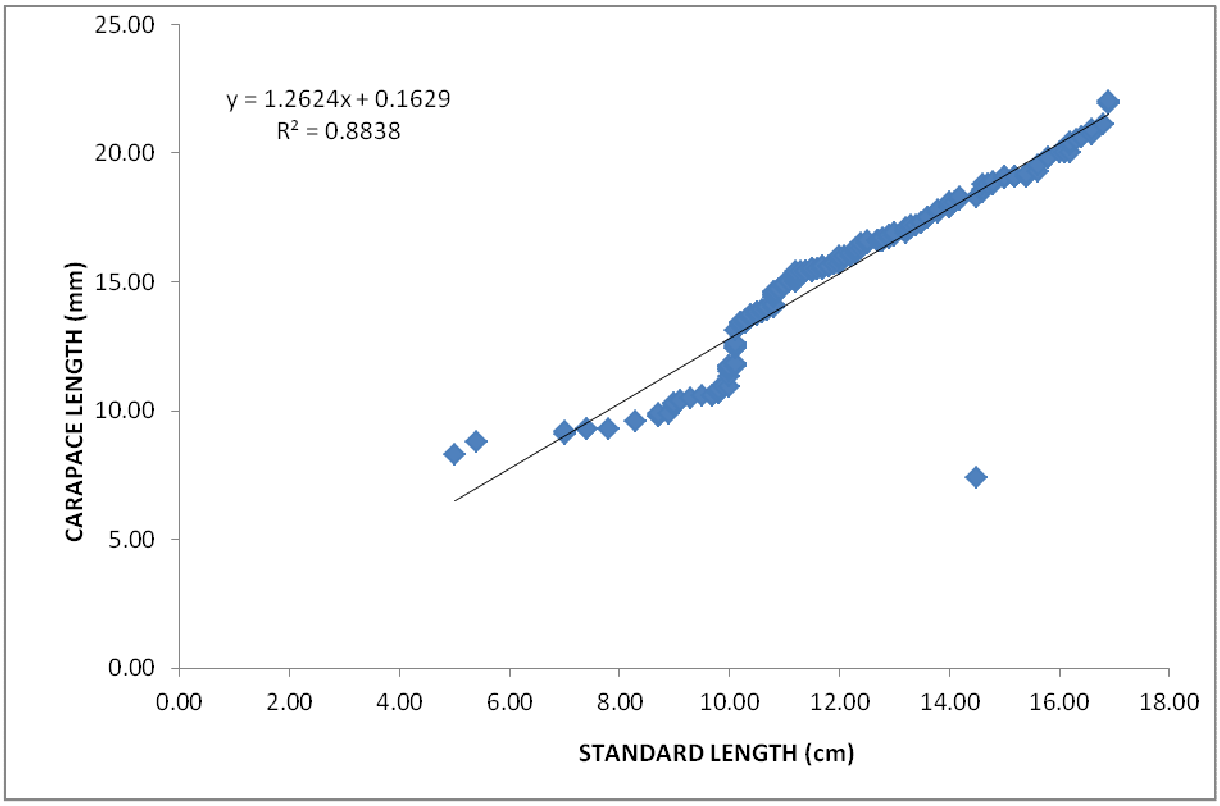


Figure 5: Carapace length (CL, mm) - Standard length (SL, cm) relationship of *Macrobrachium macrobrachion* from Great Kwa River, Obufa Esuk Beach

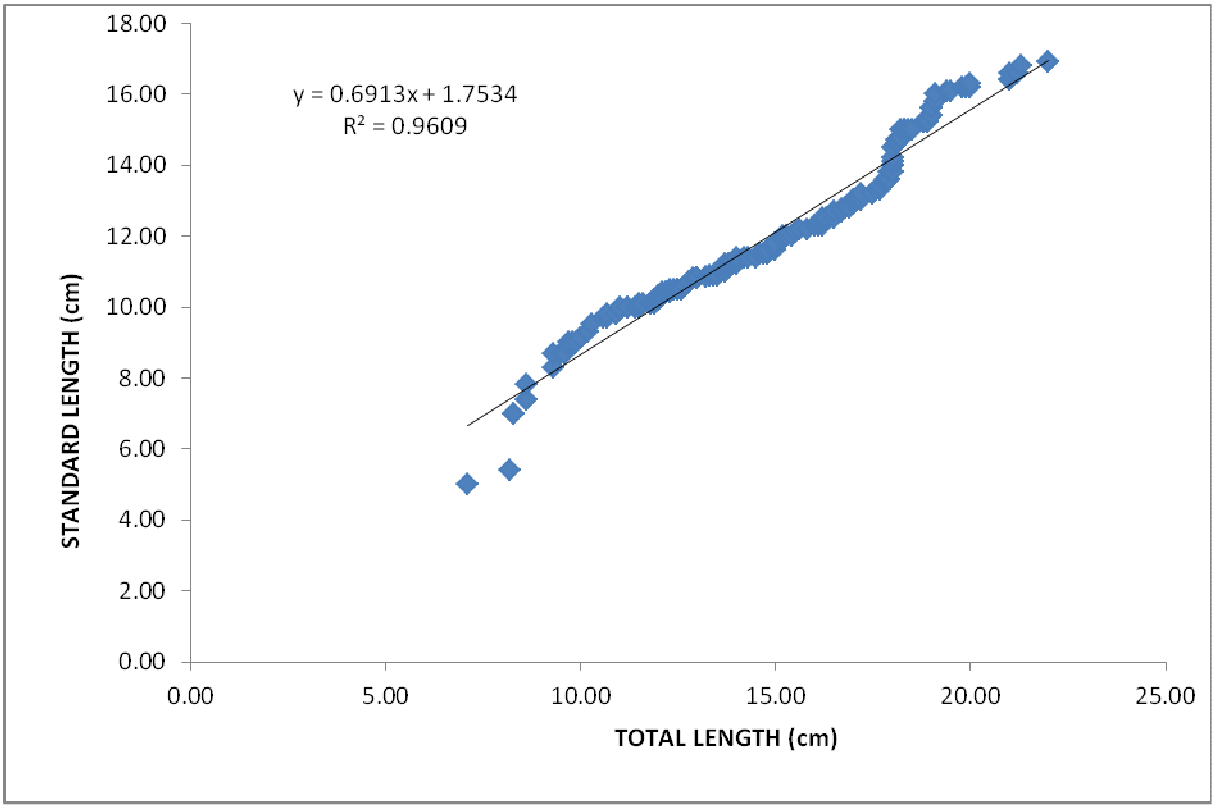
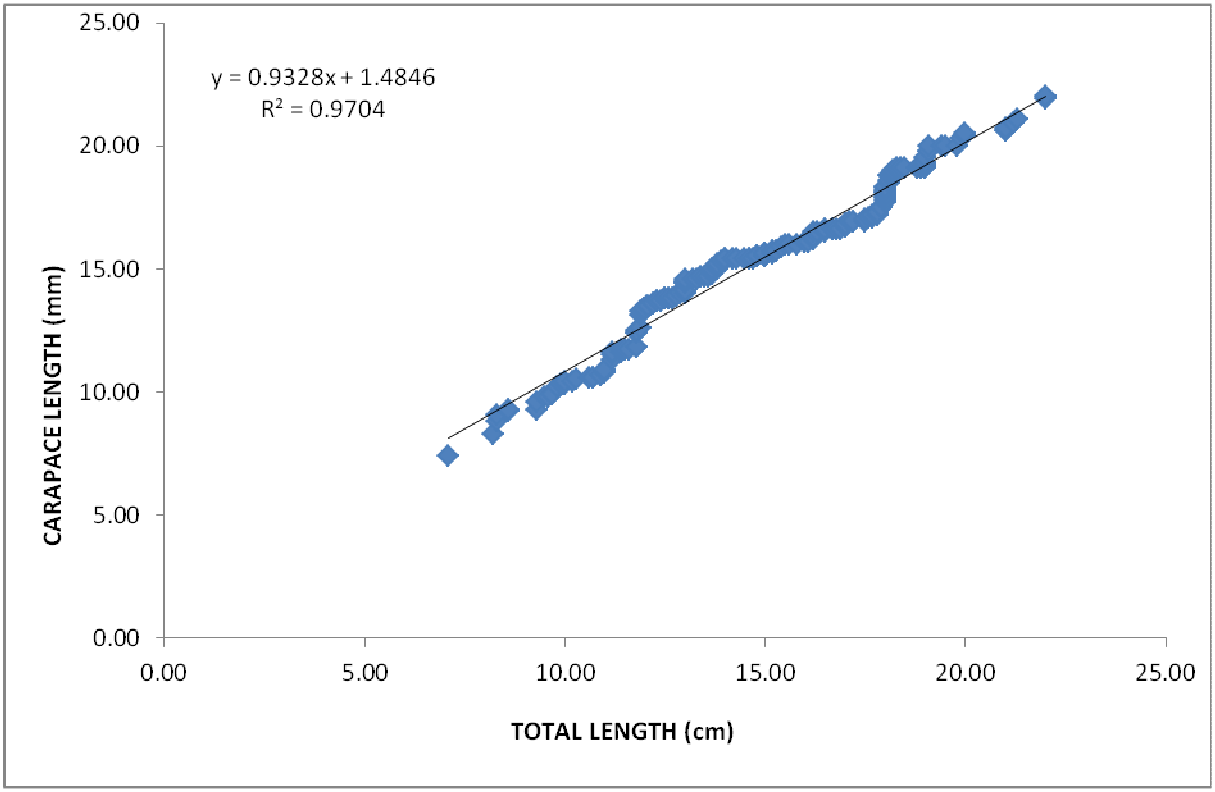


Figure 6: Standrd length (SL, mm) - Total length (TL, cm) relationship of *Macrobrachium macrobrachionin* from Great Kwa River, Obufa Esuk Beach



Figute 7: Carapace length (CL, mm) –Total length (TL, cm) relationship of *Macrobrachium macrobrachion* from Great Kwa River, Obufa Esuk Beach

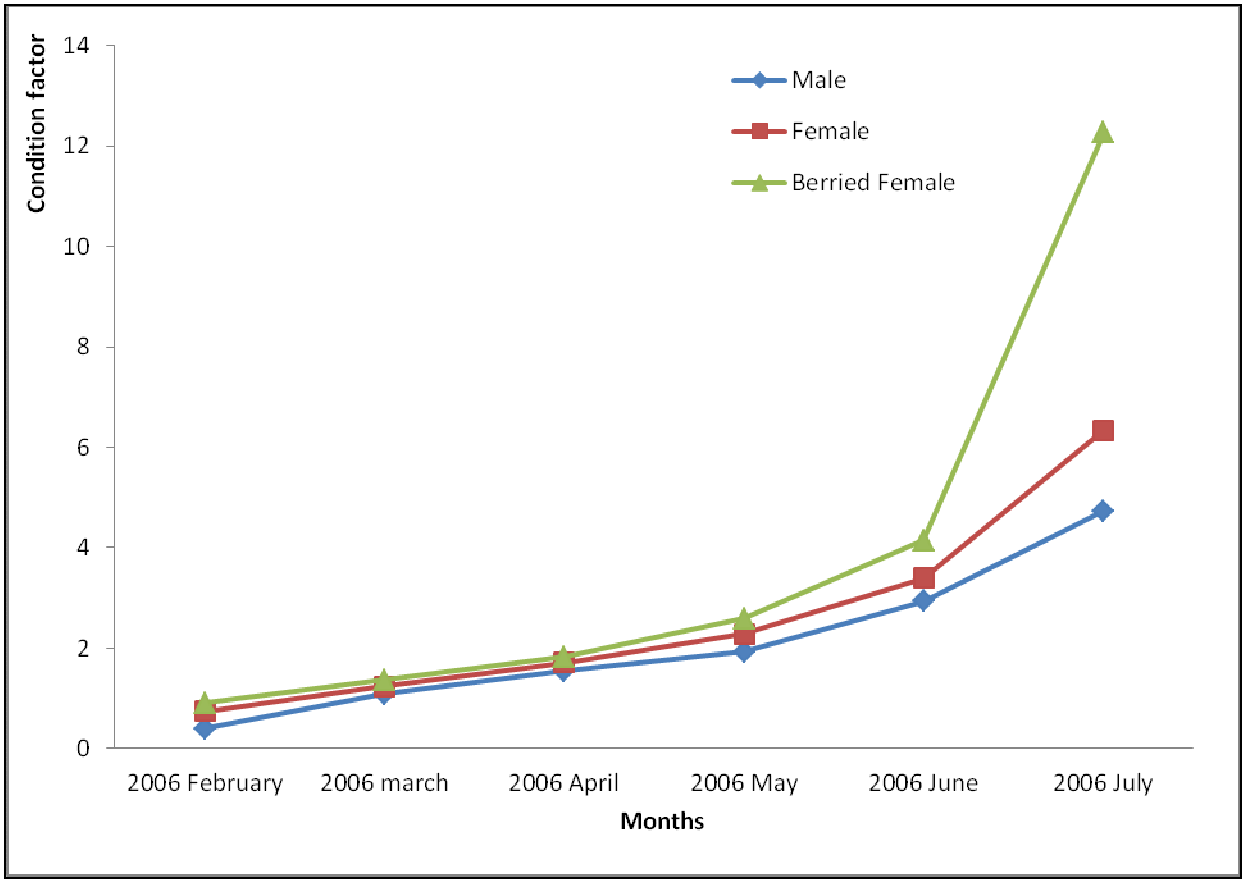


Figure 8: Variation of condition factor of *Macrobrachium macrobrachion* from Great Kwa River, Obufa Esuk Beach

DISCUSSION

The values obtained from the length/weight relationship (LWR) of *M. macrobrachion* in Great Kwa River, Obufa Esuk Beach, showed that there was a high and significant correlation between the total length and weight. The b values (0.163-9.052), r values (0.940-0.987) and r^2 values (0.884-0.971) obtained in this study were not within the range obtained by Enin (1994) for Cross River estuary (b = 3.28, r^2 = 0.968), but the slight variation in the values of b and r in this study is understandable because length - weight relationship of a species could vary according to locality and season [Medina-Reyha, 2001; Prasad, 2001]. Marioghae [1982] similarly reported positive relationship between the carapace length and weight of *M. macrobrachion* in the Lagos Lagoon area. The high correlation coefficient r of 0.987 obtained in this study showed that there is a strong association between length and weight. This means that as the length of fish increases the weight increases in the same proportion. Coefficient of determination r^2 was also high (0.971) which indicated that the model used for the analysis fits the data, confirming the fitness of the model. The mean condition factor obtained from this study was for both sexes dependent. There were significant variations between sexes. The difference in condition factors was in male and females may be attributed to the presence of ovigerous females. Branco and Masunari [2000] reported differences in condition factors of males and female *Callinectes donae* from Conceicao lagoon system, Santa catarina, Brazil. They observed that it was probably due to higher weight of the females gonads of the crabs. However, also Lawal-Are and Kusemiju [2000] observed differences in the condition factor of the different sexes of *Cllinectes amnicola* in Badagry Lagoon, Lagos lagoon and its adjacent creeks. The non-significant variations between sexes was related to food regime of fish species utilizing food resources and accumulating a large quantity of flesh as was observed by Ikomi and Sikoki [2001].

CONCLUSION

I. *Macrobrachium macrobrachion* growth in Great Kwa River, Obufa Esuk Beach, for both sexes was allometric.
II. The correlation coefficient 'r' was high, an indication of a strong association between length and weight. This means that as the length of fish increases the weight increases in the same proportion.
III. Co-efficient of determination r^2 was also high which indicated that the model used for the analysis fits the data, confirming the fitness of the model.

IV. *Macrobrachium macrobrachion* length-weight relationship parameters and condition Great Kwa River, Obufa Esuk Beach, revealed the suitability of the environment for this species, thus for sustainable management of this stock and the environmental status should be maintained.

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