# A Study of Length-Weight Relationship and Condition Factor of West African Blue Crab (*Callinectes pallidus)* from Ojo Creek, Lagos, Nigeria

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## Abstract

The length-weight relationships and condition factor of the West-African freshwater blue crab, *Callinectes pallidus*, was studied from Ojo creek, Lagos Nigeria for one year. The crabs were separated into males (124) and females (126). The length-weight relationship and condition factors of the crabs were determined. Growth parameters a and b of the length-weight relationship, (LWR) $W = aL^b$, was 22.73 and 21.83 for males, females, respectively. The values of b estimated were 35.82 and 29.44 for males, females, respectively. The regression equation for the LWR are Log w = -35.82+22.73 for males, Log w = -29.44+21.83 for females in the population. The coefficient of determination of males, females and entire population were 0.366 and 0.359, respectively. The LWR was positive allometric for all crabs, the condition factor k for male k = 66.52, female is – 67.64 and for the entire population is k = 66.89. Results also show that there is a weak correlation (r2 = 0.60) between total body weight (BW)/carapace length (CL) of the crabs. The length-weight distribution pattern did not show remarkable differences between species, sexes, and populations. Significant difference (P > 0.01) in condition factors between the sexes.

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## INTRODUCTION

Crabs belong to a group of animals known as decapods crustaceans. They are one of the least exploited crustaceans in artisanal and trawler fisheries in West Africa. In this region, the target species in shellfisheries are prawns and shrimps that have high export potential (Ajana, 1996; Awosika, 2002). Although all large species of crabs are edible, most marine crabs of commercial importance belong to three families: Portunidae (swimming crabs), Xanthidae (mud crabs) and Cancridae (cancer crabs). These species support a very lucrative crab fishery in the Chesapeake Bay area (USA), Canada, Japan, Philipines and other parts of Southeast Asia (Bardach *et al.*, 1972). Commercial harvests in a good year can yield close to 100 million pounds of crab annually (Oesterling, 1990). In Nigeria, *Geryon maritae* (deep water crab), *Ocypode africana* (ghost crab), G*oniopsis pelii*, and *Sesarma* sp. (mangrove crabs), *Uca tangerii* (fiddler crabs), *Callinectes latimanus*, *C. amnicola*, *C. pallidus* and *C. marginatus* (swimming crabs), *Cardiosoma armatum* and *Gecarcinus weileri* (land crabs) are common crab species found in brackish and marine environments (Amadi, 1990; Ajayi, 1997).

Studies of relative growth are often used to presumed changes in the form and size of the abdomen, pleopods, or chelipeds during ontogeny. Knowledge of these distinguishing characters and size relationships in sexually mature individuals is of particular importance in the study of commercially valuable crustaceans. Such knowledge can be useful for further studies on the life history of the species and in the development of its fishery, resource management and culture. The mathematical length-weight relationship thus yields information on the general well-being of individuals, variation in growth according to sex, size at first maturity, gonad development, and breeding season. Study of the length-weight relationship in aquatic animals has wide application in delineating the growth patterns during their developmental pathways. Crab culture is yet to be developed in Nigeria, with the vast number of crabs present in both marine and freshwater bodies (Bello-Olusoji *et al*., 2006).

According to Radhakrishnan (2000), crabs are commonly harvested with crab pots, gill/set nets, and traps by local fishermen from streams, ponds, reservoirs and rivers. In many areas throughout Southeast Asia, crab production is a significant industry especially in the Philippines, Vietnam, Indonesia, Sarawak and elsewhere in Southeast Asia. They are easily bred in captivity, though the main constraint is the reliable supply of crab-lets.

In population studies, morphometric analysis provides a powerful complement to genetic and environmental stock identification approaches (Cadrin, 2000) and length-weight relationships allow the conversion of growth-in-length equations to growth-in-weight for use in a stock assessment model. Information about individual body weight-length/width relationships in populations is important for estimating the population size of a stock, specifically for the purpose of its exploitation. In this study, the interrelationships between various morphometric characters, carapace width/length and chelar propodus length/height in males, and carapace width/length and abdominal width/length in females were analyzed and are here presented. The results will be useful in comparing the different stocks of the same species at different geographical locations. The study is also perceived to establish precise mathematical equations between the length and weight, width and weight, so that if one is measured, the other dimension could be computed. There have been many investigations on length-weight relationship of fin-fishes. However, information available on such a portunid species is very much fragmentary (Sukumaran, K.K. and B. Neelakantan, 1997). However, there is a scarcity of information on length-weight relationships on the swimming crabs from Ojo creek specifically from the Lagos lagoon complex, for the evaluation of its ecology with a view to effectively manage the resources for sustainable supply to the citizenry.

## MATERIAL AND METHODS

### *Study area*

The Ojo creek in Badagry, Lagos State is an extension of Badagry creek, which is one of the marginal estuaries' characteristics of the West African coastline (Amadi, 1990). It is surrounded by many fishing villages and is a central point for the sales of fin- and shell- fish (figure 1). There is a distinct two-season climate regime: The dry season (November – March) with maximum temperatures above 30$^{o}$C, low rainfall and low relative humidity and the wet season (April –October) with reduced temperatures, higher precipitation and relative humidity. During the off-season, mats, ropes, palm oil and coconuts brought from nearby villages are sold predominantly along with freshwater crabs, *Callinectes pallidus*.

### *Sampling*

Crabs used in this study were purchased monthly from fishmongers in Ojo beach between April 2001– March 2002. A total of two hundred and fifty crab specimens were examined. The crabs were caught with traditional gear such as earthen clay pots, basket traps and surrounding net. Live crabs were transported to the laboratory of Department of Zoology and Environmental Biology, Lagos State

University in clean cooler boxes with some water. Identification was carried out using an illustrated guide (Schneider, 1992). The position of the bigger cheliped and its percentage occurrence in each species was determined. Also the number of teeth on the bigger cheliped and the sex of each crab were determined. Samples collected were transported to the laboratory and kept in plastic tanks filled with water at room temperature (26.5–29.4 0C) for analysis. The male and female sexes were identified after Barnes (1974).

***Length-weight determination***

Body weight was measured to the nearest 0.1 g using a Mettler balance (PM400) while carapace length and chelae diameter were measured with a vernier caliper to the nearest 0.1 cm. The length-weight relationship was estimated using the equation:

$$\mathbf{W = aL^b}$$

where W is the weight, *a* is the intercept, L is carapace length and *b* is the slope. The parameters *a* (intercept) and *b* (slope) were estimated by linear regression based on logarithms:

$$\mathbf{Log\ (W) = Log\ (a) + b\ Log\ (L).}$$

where W = weight (g) of the crabs, L = horizontal carapace length (using the linear regression routine of Microsoft Office Excel in PC windows (2003). The significance of regression was assessed by analysis of variance (ANOVA). Equations expressing the width/length-weight relationships of *C.pallidus* were calculated in relation to sex. For testing possible significant ($P > 0.01$) differences between the sexes Student's t test was used for comparison of the two slopes. Regression equations were calculated assuming an allometric growth equation ($Y = a + bX$), to determine relations between different morphometric characters in males and females. The values of the correlation coefficient (r) were calculated to know the pattern of association between propodus/abdomen and carapace dimensions (Snedecor & Cochran, 1967), with the objective of establishing a mathematical relationship between the variables, so that if one variable is known, the other could be computed approximately. The Fulton's condition factor (CF) was calculated according to Bagenal (1978) with the formula;

$\mathbf{K = 100W/L^3.}$ Where K is the condition factor (cf), W is the total body weight (BW), L is the carapace length (CL) and 3 is a constant.

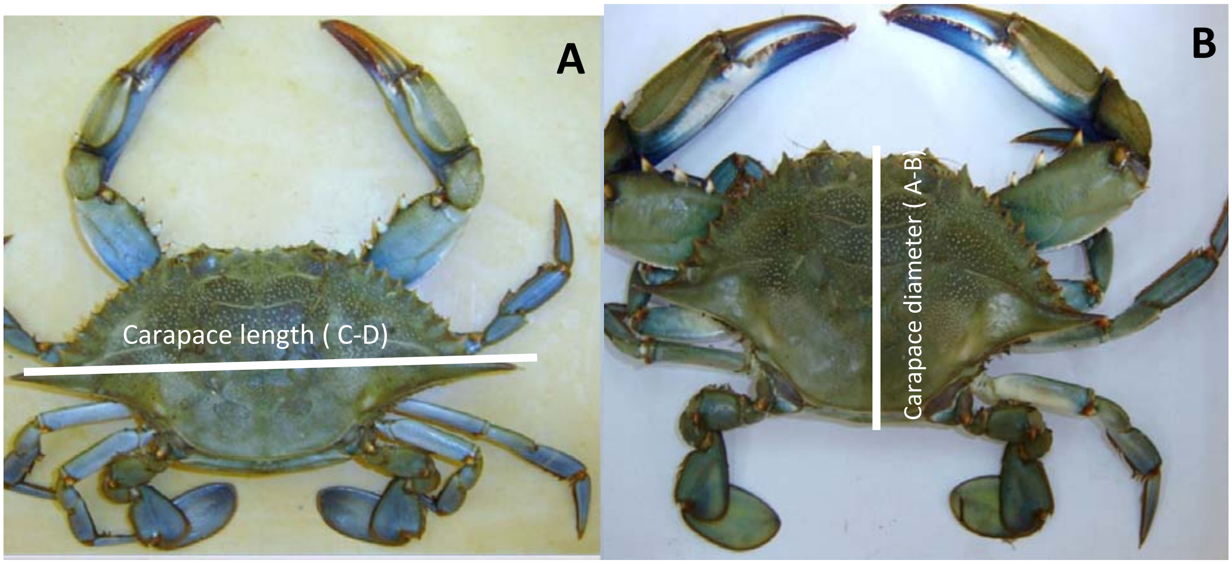


Plate 1: Dorsal view of *Callinectes sapidus*, adult female and male (A, B).

## RESULTS

### *Length-Weight relationship*

The carapace width-frequency (CW) and length-frequency (CL) distributions of the blue crab are shown in Figure 1 & 2. The width of the 250 crabs ranged from 3.2 to 6.3cm and the weight ranged from 26.0 to 143.4 g (Table 1). Width/length-weight relationship, minimum, maximum and mean carapace widths (cm), carapace lengths (cm), and weights (g) (± SD) used in the analysis are also given in Table 1. The parameters of width-weight relationship, length-weight relationship and the condition factors [K] data are presented in Tables 2 for the combined sexes, male, and females. The linear regressions between width or length and crab weight were highly significant ($P < 0.01$). The c

Plate 2: Ventral view *of Callinectes sapidus*, adult female and male (C, D) from Ojo creek lagoon, Lagos

significant c combined sexes, males and females in respect to *Callinectes pallidus* was obtained by plotting the length against weight and width against weight of individual crabs (Figures 3-8). From the closeness of the scatter and from the parabolic nature of the plot, it is clear that there exist a good relationship between width and weight and between length and weight, as also the suitability of fitting the exponential formula, $W=aL^b$ to the data.

The logarithm equations derived are as follows: combine sexes (carapace length-weight): Log w = -32.84+22.32, Males (carapace length-weight): Log w = -35.82+22.73 and Females (carapace length-weight): Log w = -29.44+21.83. Also the combine sexes (carapace width-weight): -77.27+31.39, males (carapace width-weight): Log w = -75.44+30.89, and females (carapace width-weight): Log w = -79.03+31.87. The coefficient of correlation (r) obtained for the carapace length -weight and carapace width -weight of Combined sexes, males and females were lesser or equal to 1 (0.362, 0.366, & 0.359 and 0.591, 0.611 & 0.569 respectively) indicating that the values were significant and hence, a high degree of positive correlation existed between width-weight and length-weight in these crabs. The length-weight relationship for *C. pallidus* gave a positive value of b that is greater than 3 for both sexes and for individual gender. On the other hand, body weight, and condition factor of females *C. pallidus* are higher than those of males.

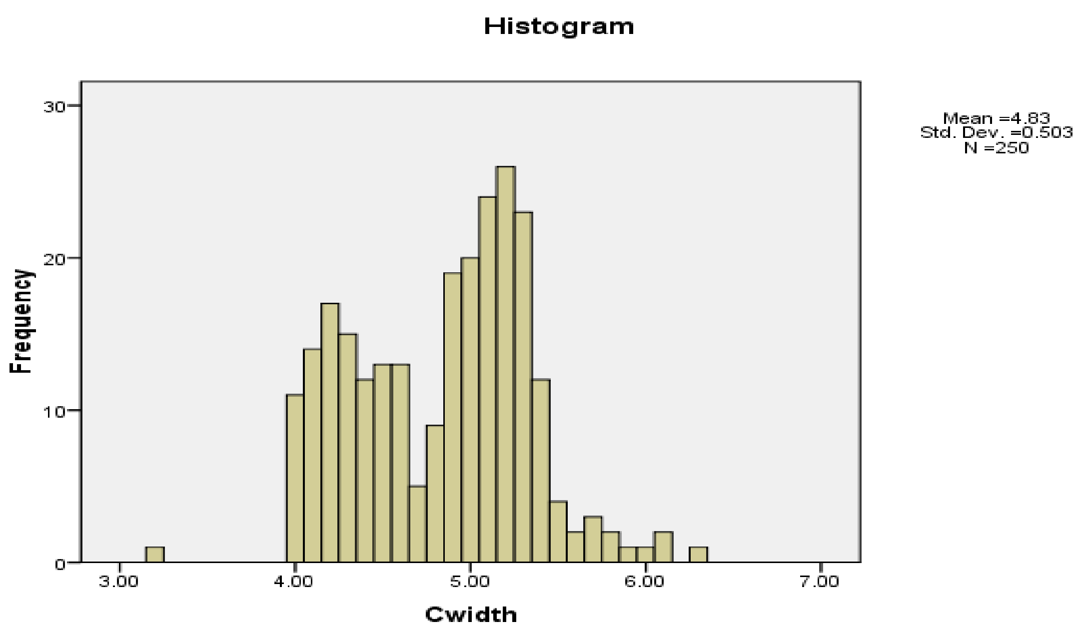


Figure 1: Carapace width-Frequency distribution of *Callinectes pallidus* from Ojo creek

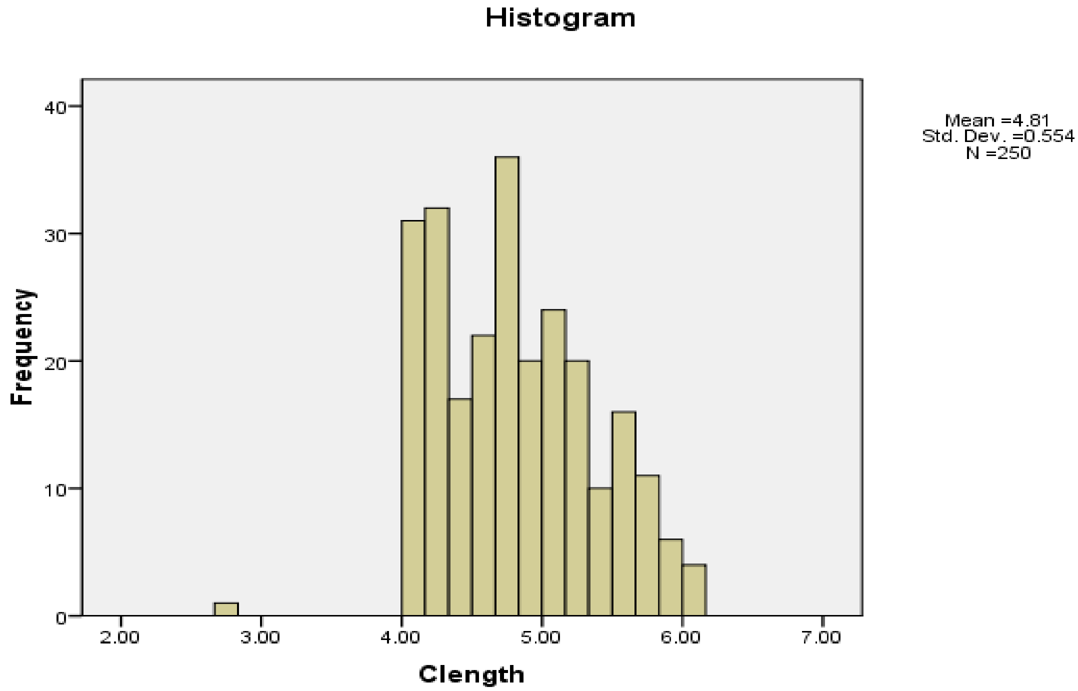


Figure 2: Carapace length-Frequency distribution of *Callinectes pallidus* from Ojo creek

Table 1: Summary of Measurement Characteristics for the Blue Crab (*Callinectes pallidus)* caught in Ojo creek, Lagos Nigeria.

| Sex | n | Width Characteristics | | | | Length Characteristics | | | | Weight Characteristics | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mean | SD | Min | Max | Mean | SD | Min | Max | Mean | SD | Min | Max |
| Combined | 250 | 4.83 | 0.5 | 3.2 | 6.3 | 4.81 | 0.55 | 2.8 | 6.0 | 74.44 | 20.5 | 26.0 | 143.4 |
| Male | 124 | 4.81 | 0.52 | 3.2 | 6.1 | 4.79 | 0.55 | 2.8 | 5.9 | 73.09 | 20.8 | 26 | 133.3 |
| Female | 126 | 4.86 | 0.48 | 4.0 | 6.3 | 4.82 | 0.55 | 4.0 | 6.0 | 75.77 | 20.2 | 40.4 | 143.4 |

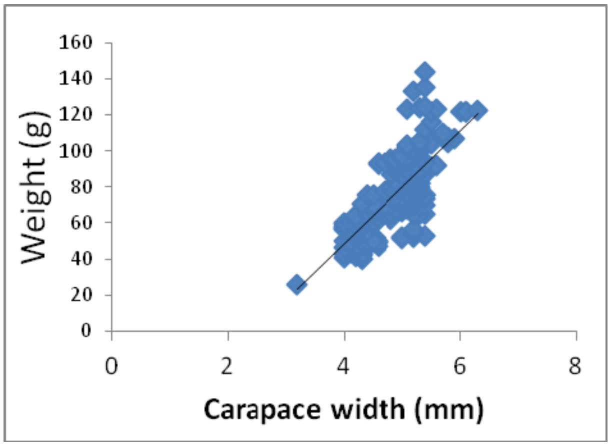


Figure 3: Logarithmic relationship between carapace width–weight of combined sexes of *C. pallidus*

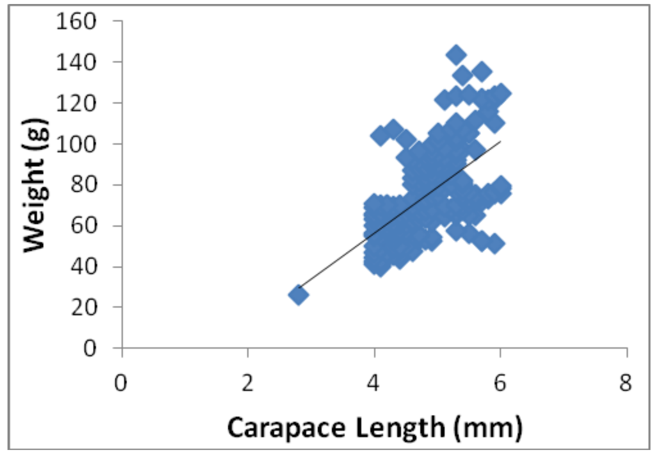


Figure 4: Logarithmic relationship between carapace length–weight of combined sexes *C. pallidus*

| | Parameters of width-weight relationship | | | | | Parameters of length-weight relationship | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Sex | a | b | SD | $r^2$ | [K=(W*100)/ $CW^3$] | a | b | SD | $r^2$ | [K=(W*100)/ $CL^3$] |
| Combined | -77.27 | 31.39 | 0.503 | 0.591 | 65.87 | -32.84 | 22.32 | 0.554 | 0.362 | 68.33 |
| Male | -75.44 | 30.89 | 0.528 | 0.611 | 65.67 | -35.82 | 22.73 | 0.555 | 0.366 | 67.54 |
| Female | -79.03 | 31.87 | 0.478 | 0.569 | 66.07 | -29.44 | 21.83 | 0.555 | 0.359 | 69.11 |

Table 2: Parameters of the relationship ($W = a L^b$) between Weight-Carapace width (CW) and Weight -Carapace length (CL) and Condition factor (K) for the Blue Crab *(C. pallidus)* caught in Ojo creek

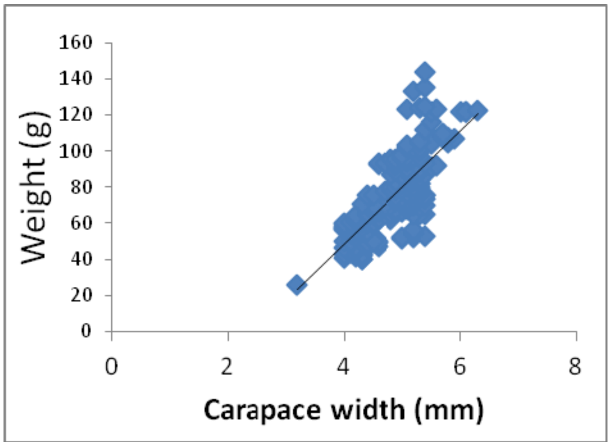


Figure 3: Logarithmic relationship between carapace width–weight of combined sexes of *C. pallidus*

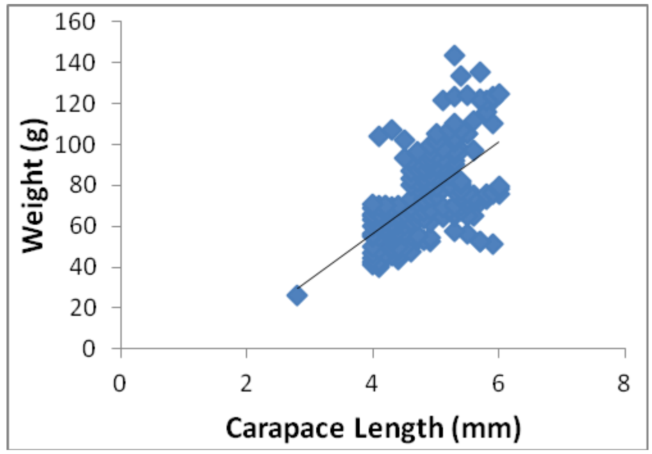


Figure 4: Logarithmic relationship between carapace length–weight of combined sexes *C. pallidus*

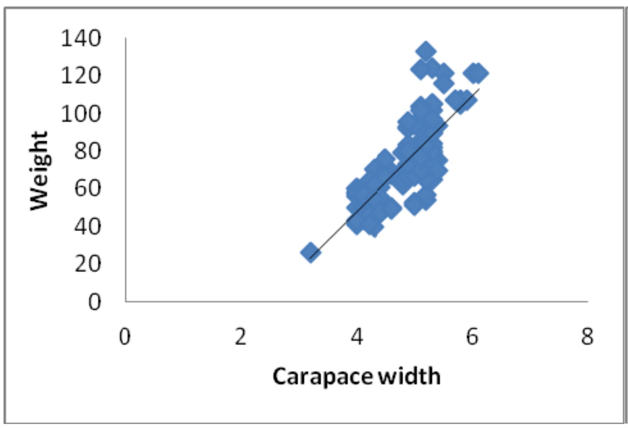


Figure 5: Logarithmic relationship between carapace width–weight of male *C. pallidus*

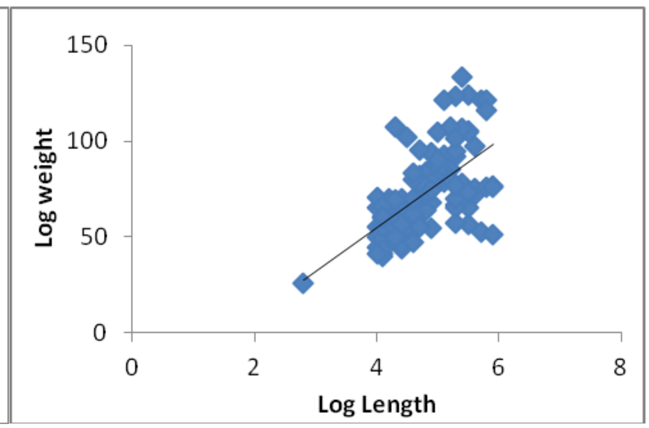


Figure 6: Logarithmic relationship between carapace length–weight of male *C. pallidus*

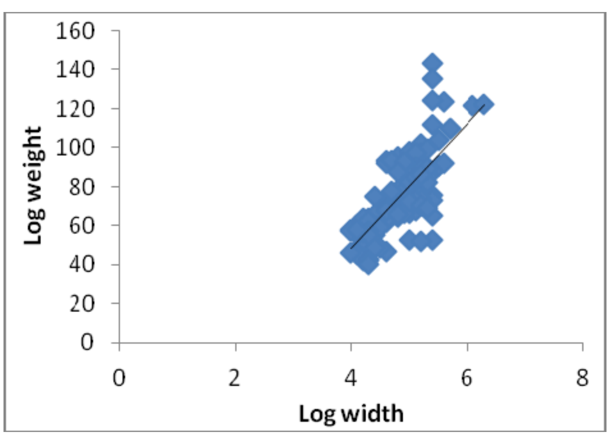


Figure 7: Logarithmic relationship between carapace width–weight of female *C. pallidus*

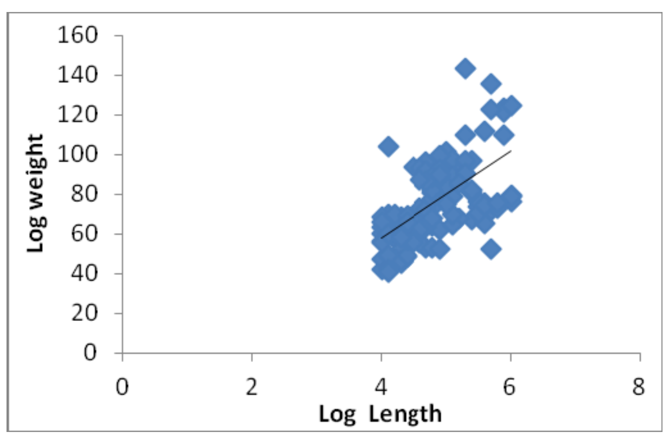


Figure 8: Logarithmic relationship between carapace length–weight of female C. *pallidus*

## Discussion

In studying spiny crab species, such as the blue crab, measuring the length of the crabs is often somewhat difficult, and during attempts to measure them, either the extremities of the crab can be broken or the investigator can be injured by the crab. It is therefore convenient to be able to convert into length (width) when only the weight is known or length-weight regression may be extensively used to estimate length from weight. These relationships are often used to calculate the standing stock biomass, condition indices, the ontogenetic changes and several other aspects of fish or crustacean population dynamics. In addition, for the management of the population crabs caught can be weighed by groups or individually by fishermen, then catches under the size limits can be returned to the habitat. Allometric equations with respect to males and females of *Callinectes pallidus* are indicated in results above. The allometric relation between the set of characters studied suggested that in most cases the relationship was positive and highly significant (figs.3-8). The study has shown that females are marginally heavier than males (40.4 - 143.4g). From the data presented, a distinct relationship was found between width and total weight, as judged from the closeness of the scatter dots, as well as from the parabolic nature of the plot. The exponential values (b) of the length-weight relationship of male and female were 22.73 and 21.83 whereas in width-weight relationship of male and female crabs were 31.87 and 30.89 respectively, indicating an isometric pattern of growth. The results of the analyses of covariance shows that the difference between slopes (F = 193.01; $P < 0.01$) and the difference between elevations (F = 71.10; $P < 0.01$) were both highly significant, indicating that there is a significant difference between the sexes in respect to this carapace width-weight relationship. Also in the case of the carapace length-weight relationship, a significant difference was found both between slopes (F = 163.90; $P <0.01$) and between elevations (F = 69.45; $P <0.05$).

Knowledge of the distinguishing characteristics and size relations of sexually mature individuals is of particular importance in the study of commercially valuable crustaceans. The allometric regression found describes changes in soft tissue content (or total animal weight for crustaceans) relative to carapace width/length. This result is consistent with general trends of scaling with body size in animals (Peters, 1983; Schmidt-Nielsen, 1984). In the present study, I did not examine any potential seasonal changes in carapace allometry and body weight, since a uniform climate (typical tropical-dry) prevailed in the area throughout the period of study.

Consequently, the aim of the length/width-weight relationships presented here is to enable crab biologists derive length estimates for blue crabs that are weighed but not measured. In the study, the sex ratio of the crabs was almost 1:1, indicating that males were found mostly going in search for food and mating because of the reproductive period which is seasonal during the onset of rainfall. The length-weight relationship showed that the crab's growth was allometric, indicating that, as the weight increases, there is corresponding increase in length, while the length range showed it as an early maturing species. The LWR showed that *Callinectes pallidus* is a good candidate for aquaculture though other factors need to be considered apart from reproductive biology. It is also essential for proper assessment and management of resources in the West African freshwaters. The crab, *Callinectes pallidus,* can be bred in captivity, which means that selective breeding (e.g. for rapid growth) can take place to forestall extinction of the population in the near future.

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