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# Correlation between Morphometric and Dimorphic Variables to Characterize *Potamon ebonyicum* (Crustacea: Decapoda: Brachyura) from Ebonyi River Basin of Nigeria

**Rupert C. Akpaniteaku[1*], John N. Ofoma[2] and Richard C. Ogbonna[2]**

*[1]Department of Biological Science, Evangel University Akaeze, P.M.B. 129, Abakaliki, Ebonyi State, Nigeria.*
*[2]Unit of Mathematics, Department of Physical Science, Evangel University Akaeze, P.M.B. 129, Abakaliki, Ebonyi State, Nigeria.*

***Authors' contributions***

*This work was carried out in collaboration between all authors. Author RCA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors JNO and RCO managed the analysis of the study. All authors read and approved the final manuscript.*

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## ABSTRACT

Studies were carried out to determine relationships between morphometric and dimorphic variables of freshwater crab, *Potamon ebonyicum*. Parameter measurements were taken from side to side (left and right); and from tip to the extremity of characteristic features, to ensure that values were obtained at the widest points. The dimorphic variables showed positive correlation and linear relationship between male and female. Nonlinear relationship was recorded in most variables morphologically. Regression analyses revealed poor correlation between carapace length (CL) and weight, and between carapace width (CW) and weight. There was a positive correlation between CL and CW of both sexes. The findings could be a guide for determining condition factor. They could also be useful in field identification and further classification of freshwater crab.

**Corresponding author: Email: rupertca2004@yahoo.com;*

*Keywords: Relationship; characteristic variables; freshwater crab; Potamon ebonyicum; South East Nigeria.*

## 1. INTRODUCTION

Freshwater crabs are distributed throughout non-arid and forested areas, and dispersal abilities are such limited that they tend to be restricted to small areas [1]. They have small number of offspring when compared with marine crabs, which can release thousands of larvae [2,3]. Although taxonomically different, they are morphological similar to their marine counterparts. As one of the important components of inland aquatic ecosystem, with great diversity and wide distribution, some fundamentals to higher taxonomy are yet to be determined [2]. Majority of the freshwater crab species are point endemic because of relatively low fecundity and narrow adaptation range to environmental condition (steno habit). Diversity and distribution of most freshwater crabs across the main zoogeographical patterns of some taxa are not always reflected by this categorization [4]. Several active mud crab fisheries from Africa, through South-East Asia and into Indo-pacific have been identified [5]. Some of the characteristics may vary depending on their specific species. For most of the crabs, a general inspection of their underbellies called flap or abdomen is a good characteristic for discovering the sex. The females have a dome-shaped underbelly, more rounded than the male crabs underbelly markings. Male crabs have smaller or triangular flaps [6]. The characteristic relationships between size and weight, and length and width are useful for mathematical understanding, so that one can be converted into another [7]. The crab *(Potamon ebonyicum*) has been over exploited, and basic study of relationship between size and weight, and size and reproductive feature, could be a guide for identifying it and its relatives. This study is aimed at determining the relationships between morphometric and dimorphic variables of male and female *P. ebonyicum* for possible identification and condition investigation.

## 2. MATERIALS AND METHODS

Samples of *P. ebonyicum* used for the study were collected in the month of June from Ishieke, along Ishieke – Abakaliki expressway. The sampling community was 2 km away from the main campus of Ebonyi State University at Ishieke. The state is at latitude $6^{o}15^{'}18^{"}$ N, longitude $8^{o}$ 05' 55" E... The samples were taken from microhabitats on flood plain along Ebia stream, a tributary of Ebonyi River. The crab species was relatively abundant at the site, and were sampled every other day within working days of the month. The crabs were caught by methods [8,9]. They were rinsed insitu with water from the stream and allowed 30 minutes to desiccate in plastic container. This was to ensure clear view on the measurement variables. A total of 147 crabs comprising 79 males and 68 females were captured. They were transported dry to the biological laboratory of the university. Weight was measured at the laboratory with Paaco weighing scale to the nearest 0.01g. Flexible calibrated rule was used for size measurement to the nearest tenth of a centimeter. Individual weight of crab (WC) was obtained using specimen and trap formula:

WS = WTS – WT
WS = Weight of specimen
WTS = Weight of trap and specimen
WT = Weight of trap

Measurement of the length of abdominal flap (AF) of the male and female was taken from anterior tip to extremity of the carapace. Width measurement of the AF was taken at the widest points on the fifth segment (Plate 1). Carapace length (CL) and carapace width (CW) of both sexes were measured [10]; CW was from the left side to the right side of the crab, and CL from the anterior to the posterior (Plate 2). The CL and CW of the male and female and dimorphic estimation for both sexes were expressed in centimeter. Their values were subjected to Pearson's correlation coefficient ®[11] and regression analyses. Analyses were conducted to determine and compare relationships between the male and female characteristic variables. The coefficients were squared to obtain variation percentage in the relationship between the morphometric and dimorphic variables. ANOVA was conducted at 0.05 level of probability to determine whether the variation reflected male or female.

## 3. RESULTS

Comparative values of the characteristic variables were recorded (Table 1). Weight variation was more pronounced than the variation in size. Differential in values of the morphometric variables was insignificant

($P \geq 0.05$). The value of CW and CL of the female was higher than that of the male. The differential was recorded in the dimorphic variables. The value of AF was higher in the female than in the male. Minimum weights ranged from 20 – 25g, and number of small males was higher than that of their female counter part. For the maximum weights, equal values were recorded in both sexes.

There was differential in linear relationship between the male and the female (Table 2). The coefficient of relationship varies noticeably in four out of the six variables. The regression equation indicated slight difference in the linear relationship. The correlation between CL and WC of both sexes was negative. Though negative correlation was also recorded between CW and WC, the coefficient ® was higher than that of the CL and CW. The coefficient of relationship between CL and CW of both sexes were equal. There was positive correlation between the male and female dimorphic variables. A strong correlation between AF and CL than in other estimated values was revealed. Relationship variation in the male and female characteristic variables is shown in Table 3. The female recorded highest percentage variance (92.0) in the relationship between size of AF and WC. The least variance (10.0) was also recorded by the female, in the relationship between CL and WC.

There was relative uniformity in the relationship variance of the size of AF and the CL in both sexes. Model for the regression line are presented in Figs. 1 – 6. The linear relationship between weight and size of the male and female was very weak. Some relative association existed between CL and WC of the males. There was significant ($P \leq 0.05$) association between CL and CW of both sexes.

The dependent and explanatory variable of both sexes exhibited very strong relationship. The linear trend was very visible in the association between AF and size, and AF and weight of both sexes. However, there was a stronger association between AF and CL than those of other dependent and explanatory variables.

## 4. DISCUSSION

Characteristic function of variables in identification and classification of freshwater crab is discernible in this study as all measurable distances are not strongly correlated. Estimated variables as expressed by morph-dimorphic variables may seem to be an important predictor in fisheries biology. Akintola et al. [12] reported that condition of prawn, weight of a given length and growth modeling could be deduced from length-weight parameters. In the freshwater crab, weight differential in favour of the female may seem to indicate that they are naturally heavier than the males. Content of the AF was essentially not inspected during the investigation to avoid bias in estimating size of the reproductive feature. According to Akpaniteaku [13] weight of the females could be enhanced by additional load from maturing eggs, especially during the wet season. Findings in the present study seem to exhibit differential equilibrium in the morph-dimorphic parameters.

The coefficient equality of the CL and CW may seem to indicate that growth pattern is the same as in both sexes. Despite shape and nature of the female abdomen, there was positive correlation between AF and CL probably because of the reproductive function. The strong correlation between length of AF and weight of the female may not seem to suggest that reproductive capacity depends on the WC. Akpaniteaku [8] reported that weight and size were at variance with number of eggs in the AF; and large crabs were not necessarily loaded with more eggs than the small ones.

However, size differential in the dimorphic variables may seem to suggest that the female is more endowed than the male. Non linear trend in the CL and WC, and CW and WC of the male and female may seem to indicate that other influential factors are yet to be considered. Omoniyi et al. [14] reported that variation in morphological characters of fish *(Oreochromis niloticus*) could be due to geographical isolation, phenotypic plasticity and local adaption. Freshwater crabs (shell fish) may not be able to modulate morphology in response to environmental cue, and local adaptation seems to create little or no morphological variation. According to Salazar and Brooks [15], variation in morphology provides information on phylogeny which could vary from species to species. Relative assessment of the morphometric and dimorphic variables of the female crab might not contribute meaningfully to visual assessment of spawning capacity. This is because of small number of eggs found in the AF of the freshwater crab, in contrast to thousands of eggs that can be released by marine crab [8,3].

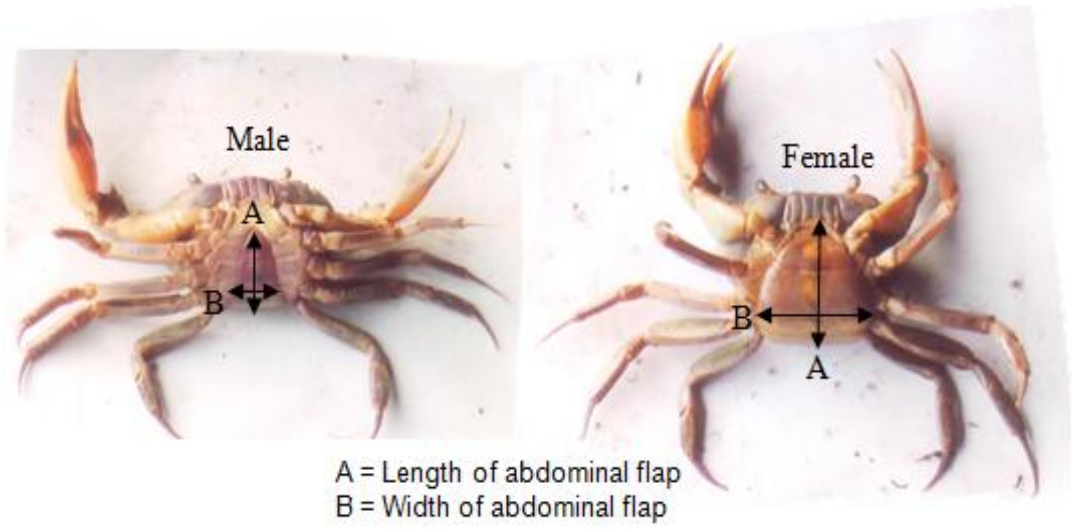


**Plate 1. Measurement of abdominal flap of male and female *P. ebonyicum***

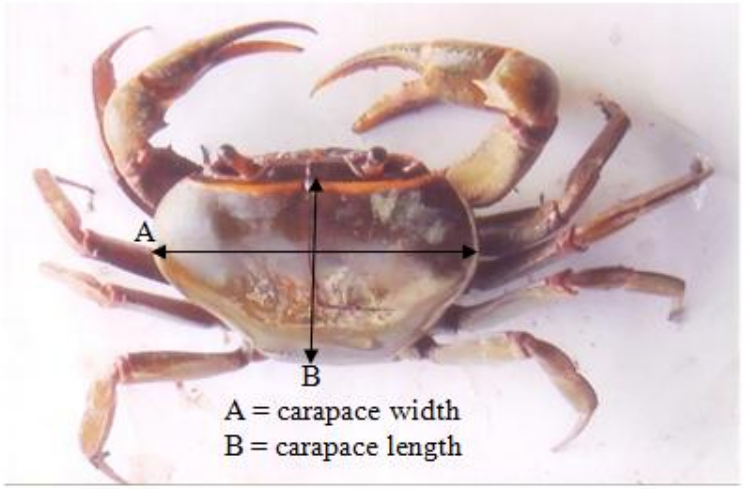


**Plate 2. Carapace measurement of *P. ebonyicum***

**Table 1. Comparative values of morphometric and dimorphic features of *P. ebonyicum* obtained during the investigation**

| CV | M | | | | F | | | |
|---|---|---|---|---|---|---|---|---|
| | Min | Max | Mean | SD | Min | Max | Mean | SD |
| Weight of crab (g) | 20.00 | 80.00 | 46.50 | 14.18 | 25.00 | 80.00 | 48.06 | 10.66 |
| Carapace length (cm) | 2.90 | 5.40 | 3.92 | 0.61 | 3.00 | 5.80 | 4.15 | 0.37 |
| Carapace Width (cm) | 4.00 | 6.80 | 5.20 | 0.69 | 4.30 | 6.80 | 5.64 | 0.63 |
| Length of Abdominal flap (cm) | 2.30 | 3.50 | 2.78 | 0.28 | 2.90 | 5.00 | 4.07 | 0.56 |
| Width of abdominal flap (cm) | 1.40 | 2.50 | 0.52 | 1.27 | 2.40 | 4.00 | 0.96 | 2.11 |

*CV = Characteristic variable, M = Male, F = Female, Min = Minimum, Max = Maximum, SD = Standard deviation, g = Gramme, cm = Centimeter*

**Table 2. Equation of regression and coefficient of the relationship between characteristic variables**

| MV | RE | | CC | |
|---|---|---|---|---|
| | M | F | M | F |
| Carapace length and weight of crab | y= 2.9 + 0.02x | y=3.2 + 0.02x | r = 0.53 | r = 0.32 |
| Carapace width and weight of crab | y= 3.4 + 0.04x | 4.2 + 0.03x | r= 0.65 | r=0.44 |
| Carapace length and carapace width | y=-1 + 1.6x | y= 5.5 +0.02x | r=0.80 | r= 0.80 |
| DV | y= 2.2 + 0.01x | y= -2 + 0.1x | r= 0.79 | r= 0.96 |
| Length of abdominal flap and weight of crab | | | | |
| Width of abdominal flap and carapace width | y= 0.2 + 0.3x | y= -0.5 + 0.6x | r= 0.78 | r= 0.84 |
| Length of abdominal flap and carapace length | y= 0.7 + 0.5x | y=-0.1 + 1.1x | r= 0.93 | r= 0.90 |

*MV = Morphometric variable; DV = Dimorphic variable; RE = Regression Equation; CC = Correlation coefficient; M = Male; F = Female*

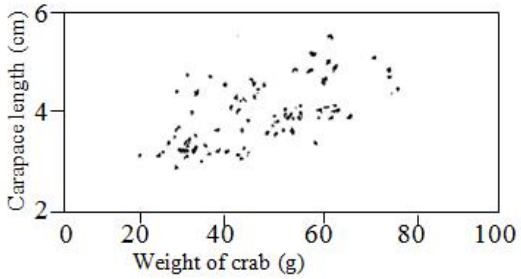


**Fig. 1a. Relationship between carapace length and weight of male *P. ebonyicum***

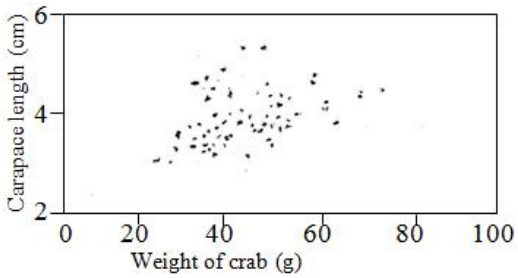


**Fig. 1b. Relationship between carapace length and weight of female *P. ebonyicum***

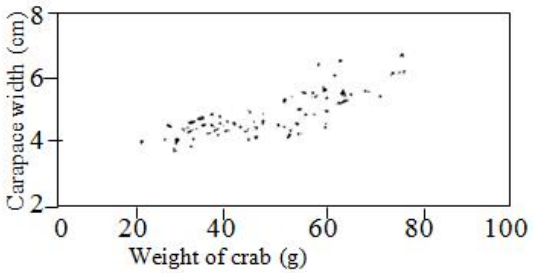


**Fig. 2a. Relationship between carapace width and weight of male *P. ebonyicum***

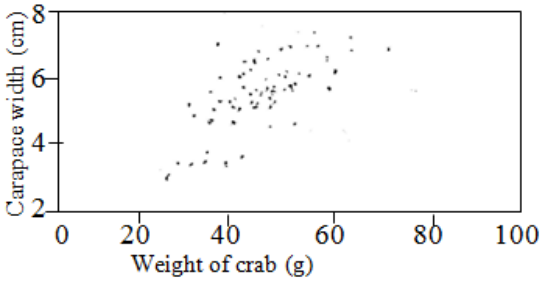


**Fig. 2b. Relationship between carapace width and weight of female *P. ebonyicum***

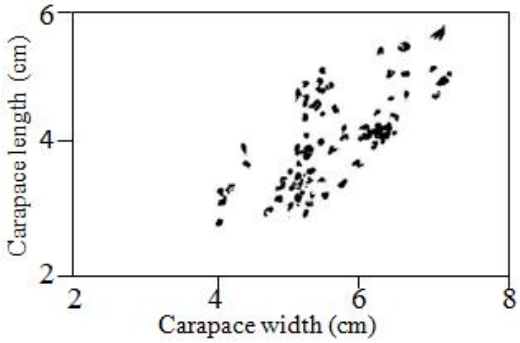


**Fig. 3a. Relationship between carapace length and carapace width of male *P. ebonyicum***

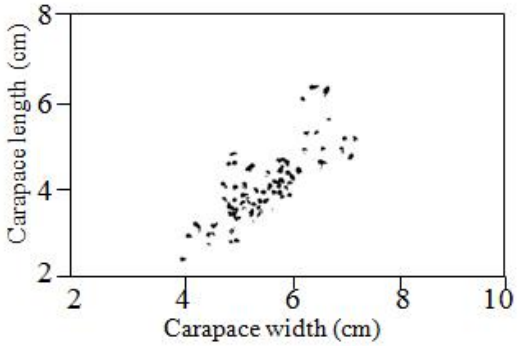


**Fig. 3b. Relationship between carapace length and carapace width of female *P. ebonyicum***

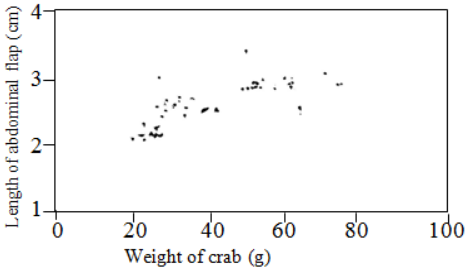


**Fig. 4a. Relationship between length of abdominal flap and weight of male *P. ebonyicum***

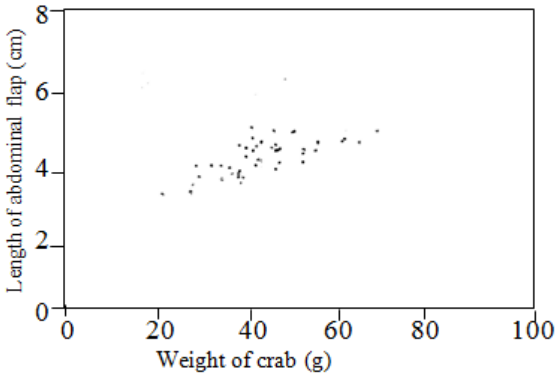


**Fig. 4b. Relationship between length of abdominal flap and weight of female *P. ebonyicum***

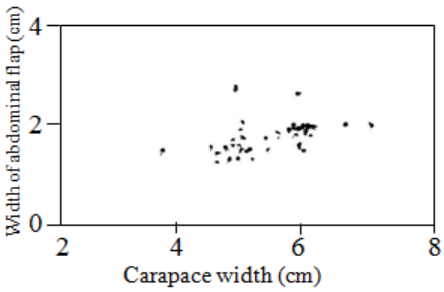


**Fig. 5a. Relationship between width of abdominal flap and carapace width of male *P. ebonyicum***

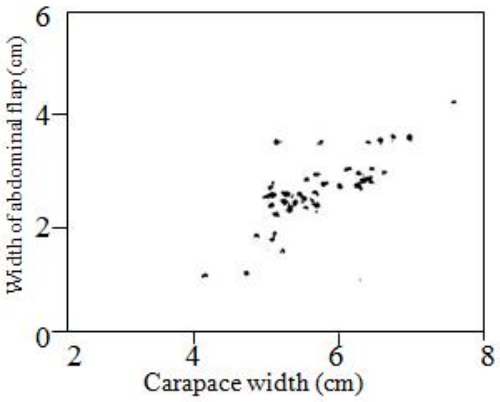


**Fig. 5b. Relationship between width of abdominal flap and carapace width of female *P. ebonyicum***

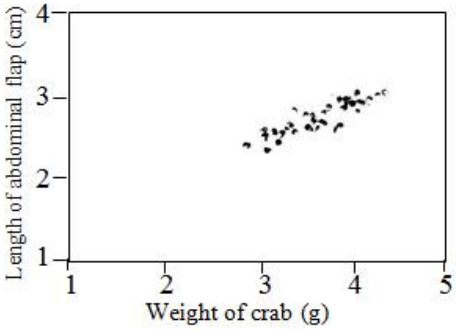


**Fig. 6a. Relationship between length of abdominal flap and carapace length of male *P. ebonyicum***

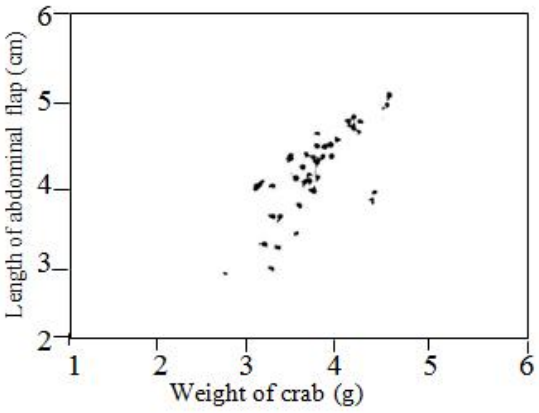


**Fig. 6b. Relationship between length of abdominal flap and weight of female *P. ebonyicum***

**Table 3. Variation percentage of the relationship between morphometric and dimorphic variables of *P. ebonyicum***

| MV | M | | F | |
|---|---|---|---|---|
| | CC | $r^2$ | CC | $r^2$ |
| Carapace length and weight of crab | 0.53 | 0.28 | 0.32 | 0.10 |
| Carapace width and weight of crab | 0.65 | 0.42 | 0.44 | 0.19 |
| Carapace length and carapace width | 0.80 | 0.64 | 0.80 | 0.64 |
| DV | 0.79 | 0.62 | 0.96 | 0.92 |
| Length of abdominal flap and weight of crab | | | | |
| Width of abdominal flap and carapace width | 0.78 | 0.61 | 0.84 | 0.70 |
| Length of abdominal flap and carapace length | 0.93 | 0.86 | 0.90 | 0.81 |

*MV = Morphometric variable; DV = Dimorphic variable; M = Male; F = Female; CC = Correlation coefficient; $r^2$ = Squared coefficient of correlation*

## 5. CONCLUSION

The study on relationship between morphometric and dimorphic characteristics of *P. ebonyicum* revealed some comparative and measurable values in the male and female crab. Size differential was recorded in all the variables. Carapace length and carapace width could increase at the same rate in both sexes. There was linear relationship between carapace length and length of abdominal flap. The dependent and explanatory variables might be used to model well being and growth. Findings from the research could be a guide to identification and classification of freshwater crab.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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