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Length-weight relationship, condition factor and proportionality index of two Crabs: *Cardisoma armatum* and *Callinectes amnicola* of Ebrié lagoon of Côte d'Ivoire

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Abstract

The length-weight relationship, condition factor and proportionality index of *Callinectes amnicola* and *Cardisoma armatum* from Ebrié Lagoon, Grand-Bassam, Côte d'Ivoire, were studied. The carapace width and length were measured to the nearest millimeter (mm) while weight was measured to the nearest grams (g). The length-weight relationship of all samples collected were determined for the various sexes and mixed populations. The values of the exponent 'b' for all the sexes and mixed populations ranged from 2.01-2.69. The growth generally exhibited negative allometry in all the sexes and mixed populations. The proportionality index showed that *Cardisoma armatum* was longer and *Callinectes amnicola* was wider.

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Introduction

Crabs are commonly found in West Africa and are a major food component of the human population in that region. They are harvested through marine, coastal and lagoon fishery. According to Broughton *et al.* (1997) crabs are known to be a good source of Omega 3-poly unsaturated fatty acids and other valuable essential foods such as protein, carbohydrate, ash, and energy. The biology and ecology of the economically important crabs have been documented by (Kwei, 1978; Okafor, 1988; Anetekhai *et al*., 1994; Chindah *et al*., 2000; Lawal-Are et Kusemiju, 2011; Akin-Oriola *et al*., 2005; Lawal-Are, 2009 and Lawal-Are, 2010). Along with fish, crabs are the most consumed food component among the fishery products. They have great economic importance both in their market value as catches in Côte d'Ivoire (Charles-Dominique et Hem, 1981).

In Ivorian lagoon, two crab species are most harvested: *Callinectes amnicola,* with estimated tonnage of 7000 tons, is mainly fished in the lagoons (Grand-Lahou, Ebrié and Aby) and *Cardisoma armatum*, with the tonnage around 800 tons, is caught in Grand Lahou and Fresco (FAO, 2004). Sankaré *et al.* (2014) reported that *C. amnicola* is subject to intensive and uncontrolled fishing by artisanal fisheries. Consequently, the catch has fallen sharply with individuals of smaller size. Regarding *Cardisoma armatum*, it is much consumed by coastal populations. Despite their importance and the threat of over-fishing they face, few studies have been conducted in Côte d'Ivoireon crabs.

Previous studies related to crabs species listed above were devoted to biology (d'Almeida *et al*., 2014; d'Almeida *et al*., 2008; d'Almeida, 1999), the bio-ecology (Sankaré, 2007) and analysis of catch (Sankaré *et al*., 2014). Biological information pertaining to the crabs within these lagoons of Côte d'Ivoire is unfortunately limited. The relationship between weight and height of the individual is particularly important in studies of commercial crustaceans. Moreover, this knowledge can be used for studies on the history of species life traits, fisheries development and resource management (Bello-Olusoji *et al*., 2006).

We conducted this study to contribute to the knowledge of some biometrical features of two crabs species in the coastal region of Cote d'Ivoire. The study allows us to clearly identify species and to track the relative growth of various body proportions in order to detect the different changes that may occur during the growth of the individual crabs. In this study, we report Length-Weight relationship, the Fulton k condition factor and proportionality index of two crabs, *Cardisoma armatum* and *Callinectes amnicola,* inhabiting the brackish water near Grand-Bassam (Côte d'Ivoire).

Materials and methods

Study area

Located at the eastern end of the lagoon Ebrié (5°12'-5°14' N; 43°3'- 44°3' W) the study site is an original estuary which connects the Comoé river and lagoons around it. Ebrié lagoon joined Comoé to Moossou, Cote d'Ivoire. A few kilometers downstream, the river comes into confluence with two other smaller lagoons: the Ouladine and the Mondoukou lagoons that are actually former channels of the Comoé that migrated nearly 11km laterally before adopting a north-south flow.

Sampling Collection

The study included 137 specimens of both species, 70 specimens of *Cardiosoma armatum* (36 females and 34 males) and 67 specimens of *Callinectes amnicola* (30 females and 37 males) from commercial fishing on the lagoon Ebrié in the sector of Moossou, Côte d'Ivoire. Crabs were classified and assigned to each of the two species using photo cards and available identification keys (Schneider, 1990).

Methods

The crabs were grouped by sex within each species class. The required metric measurements were taken. Each specimen was photographed, weight measurement was done using 0.1g precision EKS ELECTRONIC weighing balance to the nearest grams

(g) while the carapace width, and length, forehead, and anterolateral edge (Fig 1) were measured using image analysis software (Imagej) to the nearest millimeter (mm).

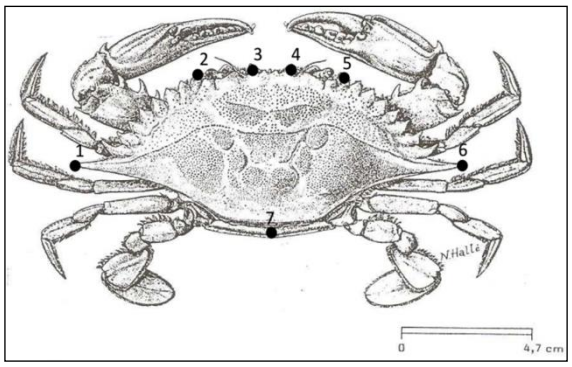

Fig. 1. Location of the 7 anatomical landmarks of each specimen of crab. (1) edge of the first lateral thorn; (2) first lateral orbital angle; (3) first end front edge; (4) second end front edge; (5) second lateral orbital angle; (6) edge of the second lateral thorn; (7) the middle of the posterior edge.

Data analysis

The length-weight relationship of all samples collected were determined for the various sexes by the expression defined by Pauly (1983) and given as follows:

$$W = aL^b$$

Where:

W = the derived weight (a)

L = the carapace length (mm) or width

a = the intercept of the regression curve

b = the regression coefficient (slope)

The parameters 'a' (intercept) and 'b' (slope) are easily estimated by the linear regression based on the logarithmic transformation of the above expression:

Log W = Log a + b logL

The pattern of growth (isometric or allometric) of the species was determined from the value of 'b' in the equation:

$W = aL^b$

This regression coefficient b was tested for significance at the level α=0.05 using the Student's *t* test in accordance with Spiegel (1991).

Each morph metric character was described by proportionality index (I) separately for females and males with the following expression:

I = (C×100) /L

I: proportionality index

C: character measured in millimeter

L: width in millimeter

The Fulton's condition factor (K) was estimated from mean length and mean weight in the sample using the relationship defined by Gayanilo et Pauly (1997):

$K = 100\ P/L^3$

Where:

K = Condition factor

W = mean weight of crab (g)

L = mean length of crab (mm)

The data were analyzed for significant differences between groups by the *t*-test and Tukey post-hoc test.

Results

Length-Weight Relationship of two species

Results obtained are reported in table 1. The average value of the weight (w) ranged from 100.53 to 190.58g for *C.amnicola*. Regarding *C. armatum*, the weight ranged from 133.4 to 161.53g. HSD Tukey test showed a significant difference ($p < 0.05$) between the average female and male values of *C. armatum*. However, no significant difference was observed in *C. amnicola* regarding the average weight of the two genders. As for the values of the width of the shell (S), they ranged from 64.61 to 68.64mm respectively for female of *C. armatum* and combined sexes. For *C. amnicola*, the mean of the width varied from 104.53mm to 107.58mm.

The statistical analysis (Tukey HSD) of these values indicated no significant difference between genders taken in pairs. The correlation coefficients (r) obtained were high among both sexes. However, the lowest value is obtained in female *C. armatum* (r = 0.61). *C. armatum* condition factor K for two the species indicated high value.

The results of the Student 's t test are given in table 2. The b values are all less than 3. The value of the statistical test for each of the species and the values of b being less than 3 showed that we have a lower bound allometry between the two characters for the two separate sexes. In other words the two parameters followed a minoring allometry in both species for each of the two sexes when separated by gender. Mixed populations of both species describe a lower bound allometry because the values of Student's t test are higher for *Callinectes amnicola* and lower for *Cardiosoma armatum*, and b values are less than 3.

Proportionality index (I)

In this study, three morphometric characters were considered. Of a total of 137 individuals examined, we calculated the index of proportionality (I) of the characteristics compared with the width of the shell in males and females separately. All results are shown in table 3. *C. armatum* is longer. The ratio length to width of the carapace is respectively 1.09 and 1.13 for male and female. While lengths of forehead and anterolateral edge were less than half of the width. In *C. amnicola*, length in male and female represented 1/3 of carapace width. This species is wider. Anterolateral edge is less than 1/3 of width.

Table 1. Relative growth of the weight (w) relative to the shell width (L) in male and female *Callinectes amnicola* and *Cardiosoma armatum* species. (W: weighth, L : length, K : condition factor).

	Callinectes amnicola			*Cardiosoma armatum*		
	Males	Females	combinedsex	Males	Females	Combinedsex
Equation	y = 2.01L -1.72	y = 2.25L - 2.68	y = 2.04L - 1.78	y = 2.12L - 1.54	y = 2.69L - 2.59	y = 2.42L - 2.12
b	2.01	2.25	2.04	2.12	2.69	2.42
R	0.80	0.84	0.80	0.92	0.61	0.72
K	0.017	0.016	0.017	0.067	0.075	0.072
W (g)	276.16	300.53	290.58	261.53	204.33	233.4
L (mm)	117.26	122.34	119.54	72.91	64.61	68.64

Table 2. Results of Test *t*.

	tcal	tth	b	N	Allometric
Male *C. amnicola*	26,83	1,96	2,01	37	Negative
Female *C. amnicola*	17,08	1,96	2,25	30	Negative
Female *C. armatum*	0,55	1,96	2,69	34	Negative
Male *C. armatum*	1,39	1,96	2,12	36	Negative
mixed populations *C. armatum*	1,91	1,96	2,13	70	Negative
mixed populations *C. amnicola*	2,56	1,96	2,03	67	Negative

Table 3. Proportionality index (I) of differents characters.

Characters	*Cardisoma armatum*				*Callinectes amnicola*			
	Male		Female		Male		Female	
	N	I	N	I	N	I	N	N
Length (l)	34	79.01	36	82.8	37	41.87	30	44.52
Anterolateral edge (Dm)	34	35.81	36	27.22	37	33.40	30	40.10
Forehead (Fr)	34	24.68	36	26.17	37	16.45	30	18.58

Discussion

The observed values of the regression coefficient (b) for the males, females and mixed populations for two species are the indication of negative allometric growth. This is in agreement with the results for *C. amnicola* reported by Lawal-Are (2003) and Olakolu and Fakayode (2014).

However, these results are contrary to what was observed on *C. amnicola* by Emmanuel (2008) and on *C. armatum* by Akin-Oriola *et al.* (2005). who reported b>3 (positive allometric growth). Lawal-Are (2003), Emmanuel (2008), Abowei & George (2009), Patil & Patil (2012), Silva *et al.* (2014).

Gives a rough idea of this situation, indicating that allometric growth is negative (b <3) if the animal becomes relatively thinner as it develops. This negative allometric growth means that the crabs were lighter than their body weight (Okon & Sikoki, 2014).

The correlation analysis revealed a high correlation in all the sexes and mixed populations. This observation is indicative of a very positive correlation between carapace length and total weight in the two species. The high values of the correlation coefficient suggest that the width of the carapace (lc) is a good predictor of the weight and for the width of the body. According to Konan *et al.* (2014), Olakolu & Fakayode (2014), these strong values indicate a positive correlation between the weight and the width of the carapace. This result on *C. amnicola* corroborates those found by Lawal-Are (2003) and Emmanuel (2008), but it disagrees with the assessment of Akin-Oriola *et al.,* (2005) on *C. armatum*. They said that R^2 value may not be an ideal parameter for weight estimation.

The condition factor "k" for males, females and mixed populations for the two species ranged from 5.70 to 41.67. Similar values were reported by Lawal-Are (2003) and Kusemiju (2000).

In the current study, the carapace length obtained for males, females and mixed populations were respectively 72.91mm, 64.61mm and 68.64 for *Cardisoma armatum* and 107.58 mm, 106.16mm and 104.53mm for *C. amnicola*. Fischer *et al* (1981) reported that maximum carapace length was 9.5cm for *C. armatum* in the gulf of Guinea. d'Almeida *et al.* (2014) found a maximum carapace length of 8.5cm for females and 10.5 cm for males on the same species. For *C. amnicola*, the result found in this study agrees with the one reported by Olakolu and Fakayode (2014) in Lagos lagoon, Nigeria. The differents condition factor observed relate to conditions in the habitat (Olalekan & Lawal-Are, 2013).

Proportionality index of *C. armatum* indicates that this species is longer while *C. amnicola* is wider. For *C. amnicola*, the finding in this study is in agreement with Fischer *et al.* (1981). This fact is due to conformation of the carapace of both species. Indeed *C. armatum* has an apple-shaped shell and a surface of the anterolateral edge imperforated as described by Oriola-Akin *et al.* (2005). *C. amnicola* has an elongated shell with the antero-posterior edges that end with thorns.

Conclusion

In our study, the species studied showed negative allometry (b <3). Species (*C. amnicola* and *C. armatum*) are growing less quickly they grow. Condition factor (K) is high for both species. As the index of proportionality, it showed that *Cardisoma armatum* is a species that has longer shell while *Callinectes amnicola* is a species whose carapace width is twice its length.

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