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Growth Characteristics of Edible Land Crab *Cardisomaarmatum* (Brachyura: Gecarcinidae) from Kribi Mangroves, Cameroon

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Abstract: The land crab *Cardisoma armatum* is traditionally overexploited for consumption issue in Cameroonian mangroves. However, the exploitation of this natural resource ignores sustainable management. Hence, the study aims to assess the availability and growth patterns of *C. armatum* in Kribi mangroves throughout some of their morphological parameters. Several individuals were captured inside traps baited once each two months from March 2019 to March 2020. Then, wellbeing, growth patterns and size at the first sexual maturity were assessed based on sex, seasons or maturity stages. Despite the fact that the condition factor (K) value overall remained below 1, females and matures individuals were in a better wellbeing compared to males and immature. In the CW-BW relationships, the allometry coefficients (b) were below 3 for both sexes, suggesting a negative allometry growth patterns which means that crabs are lighter than their body weights. In the CW-CL and CW-BH relationships, males showed a positive allometry (b>1) while females a negative allometry (b<1). Fifty percent maturity of females (CW_{50}=58.87±0.14 mm) was significantly lower than that of males (CW_{50}=62.67±0.08 mm). Immature and mature crabs were recorded throughout the sampling period indicating that this species breeds throughout the year with a peak between September and November.

Keywords: Allometry, Sex Ratio, Sexual Maturity, Size-frequency, Wellbeing

1. Introduction

Ecological roles of crabs in terms of structure and function in most aquatic ecosystems are multiples [1, 2]. They constitute one of the most important members of estuarine food chain [3]. Some crabs may be useful as biological indicators to assess the impacts of human activities on mangroves in the current degradation of these ecosystems [4] while the land crabs in particular are the major drivers of tree recruitment in tropical coastal forest ecosystems, and their conservation should be included in management plans of these forests [5]. Gecarcinid crabs are often large in size and commonly referred to as land crabs, based on the terrestrial habits shown by adults of most its species [6]. They comprise 24 species distributed among six genera, including *Cardisoma* among *C. armatum* Herklots, 1851 is a tropical species known [7, 8].

Human consumption of crabs has increased tremendously worldwide [9]. Usually, crabs are prominent sources of protein and of essential macro and micro element for local populations [10, 11]. In Cameroon in particular, edible crabs of mangroves are one that remain very little known unlike freshwater and marine crabs. However, in some West Africa countries mangrove crab *C. armatum* is known forms an important part of the diets for several coastal communities which ignores sustainable management of crab resources [12, 13]. Besides, this species also strongly suffers from impacts caused by depletion of their habitat for urbanization [4], which affects it abundance and might even lead to local extirpation [14]. Currently, *C. armatum*is primarily vegetarians but may show an opportunist omnivorous diet. The aforementioned urbanization transformed vast mature stands of *Rhizophora* spp. trees into highly degraded areas with a dramatic change in botanical assemblages [15] thus causing the lack of food.

Facing the significant demographic growth of populations, the food and nutritional needs are increasing. Therefore, Cameroon chosen some development programs to boost growth and jobs to maintain long-term food security and balance [16]. Among these programs, the promotion of aquaculture, including crab farming is prioritizing. However, this new income-generating activity is nevertheless confronted with the precariousness of techniques and an absolute ignorance of the biology of species. Faced with these shortcomings, preliminary works on the reproduction, growth, morphological and structural characterization of the new mangrove fisheries resources with high aquaculture potential such as *C. armatum* are data necessary as a prerequisite for aquaculture activities.

To assess the ecological condition of the species in the mangrove habitat, the size-frequency is one of most widely used method for growth pattern [17]. For that, several measurements frequently made on crabs concern the weight, width and length of carapace, the abdomen and the chelipeds for estimating the population size and the growth pattern [18]. Additionally, the relative condition factor (K) that was derived from the size was determined for evaluating general health, habitat conditions [19, 20]. Considering their nutritional, ecological and economic importance, the current study aims to assess the availability and growth patterns of *C. armatum* crabs in the wild based on their morphological parameters in order to improve and promote knowledge and conservation of this species in Cameroon mangroves.

2. Materials and Methods

2.1. Site Description

The survey was carried out in the Kribicityaround the back mangroves of Nziou (2°58’35”-2°58’44”N and 9°54’59”-9°55’07”E) (Figure 1). Wood harvesting for urban settlement and infrastructures and sand extraction are the most important factors of mangrove degeneration. The climate is of a typical equatorial regime with four seasons well individualized, marked by high and stable temperatures of about 28.7 °C. Heavy annual rainfalls reach 3,000 mm and the tidal regime reaches 1.5 m in the spring tide [21]. *Rhizophora*spp. are largely the dominant species of the flora.

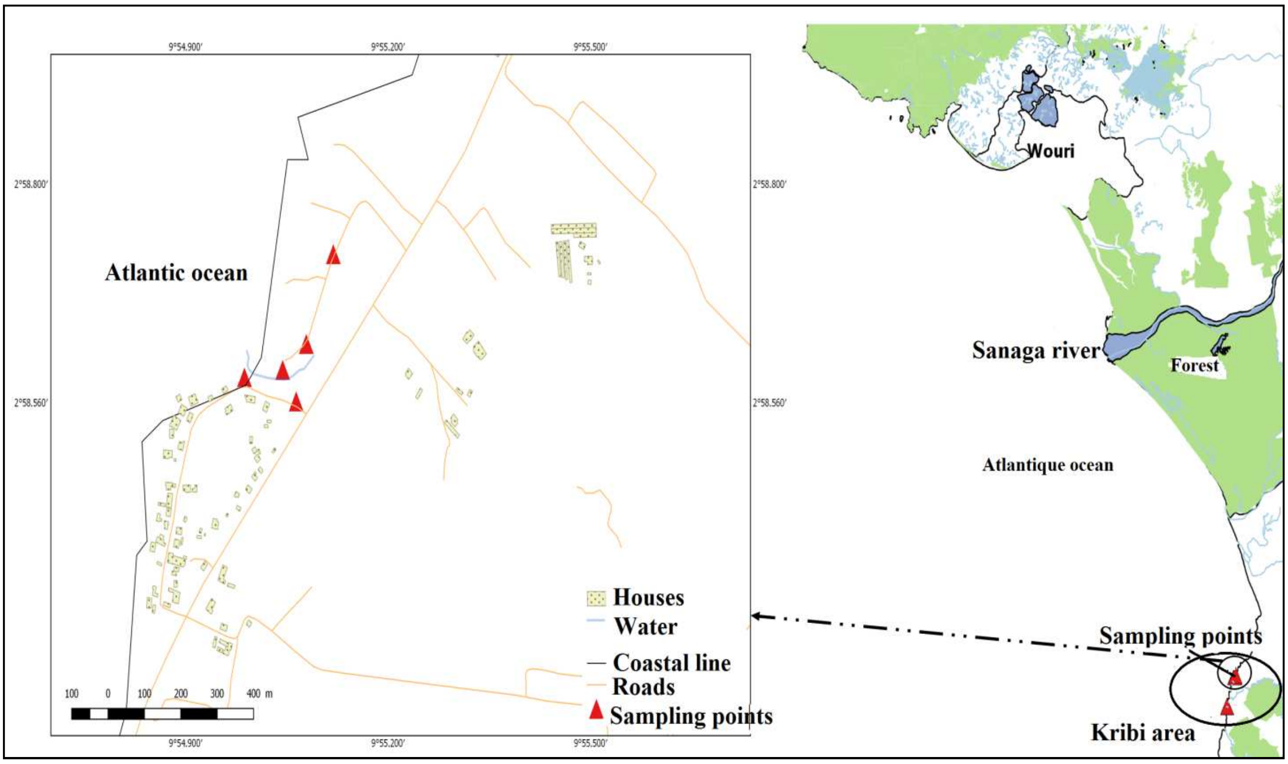

Figure 1. Location of study area.

2.2. Data Sampling

Specimens were collected once each two months from April 2019 to March 2020 during the low tide at day time into the traps baited distributed around their holes. Additional crabs were captured randomly inside sampling area. Captured crabs were immediately transported in individual plastic bags and stored for one hour in a deep freeze in the laboratory. Then, they were thawed, washed and separated by sex (Figure 2). Crab carapace width (CW) and length (CL), body height (BH) and abdomen size (AW and AL) were measured using caliper (0.01 mm accuracy). Body weight was determined using digital scales to the nearest 0.01g. The size at first maturity (CW_{50}) which is the one reached by 50% of mature individuals of both sexes for the first time was assessed according to Giresse et al. [22]. Then, all individuals were dissected in order to identify macroscopically the gonadal development stages according to Lawal-Are [23].

Figure 2. *Ventral views and sexual dimorphism of C. armatum. A, male triangular abdomen and heterogeneous chelipeds; B, female semi-circular abdomen and homogeneous chelipeds.*

2.3. Data Analysis

A Chi-squared test (χ^2) was performed to detect significant deviations from a 1:1 sex ratio [24] as follows:

$$\chi 2 = \sum \frac{(fobs - fth)2}{fth}$$

fobs=frequency of crab observed; *fth*=frequency of crab expected

The condition factor (K) was calculated as follows:

$$K = \frac{100\ BW}{CW3}$$

K=condition factor ($g.mm^{-3}$); BW=body weight (g); CW=carapace width (mm)

The population structure was analyzed for both sexes according to the CW size classes. The one-way ANOVA test was used to compare morphometric variables and condition factor (K) of individuals among the sex, months, seasons or stages of maturity. Morphometric variables were described by the proportionality index (I):

$$I = \frac{100\ L}{CW}$$

I=proportionality index; L=morphometric variable (mm); CW=carapace width (mm)

Determination model of the relationship between the widths of the carapace and other morphological parameters using the equation according to [25]:

$$Y = aCWb$$

a=Constant; CW=carapace width (mm); b=allometry coefficient

The above equation may be a linear regression equation algorithm:

$$\ln BW = \ln a + b \ln CW \text{ or } Y = a + b X$$

Growth pattern related to value of allometry coefficient (b) was defined. Then, b value was comparing with the theoretical value 1 or 3 according to linking of the two parameters. If b=0, isometry growth; b>1 (3), positive allometric growth; b<1 (3), negative allometry [26]. The significance of b was tested using *Student's* test at 5%.

CW_{50} will be determined from the equation of the sigmoid curve of evolution of mature individuals' percentages (stages two to five) according to the carapace width (in mm). This curve is obtained by logistic transformation according to [27] and is given by the formula: $P = \frac{x}{(1+x)}$ with $x=e^{(a+bCW)}$, a and b being the model's parameters.

The logarithmic transformation of the equation has permitted to put it in the form: $\ln \frac{P}{(1-P)} = a + bCW$ and by replacing P=50% in the equation, the CW_{50} is obtained by

$$CW50 = -\frac{a}{b}$$

This function tracks sexual maturity by size and accurately estimates the widths CW_{50}, CW_{25}, and CW_{75} which are often required by most stock analysis software. The degree of adjustment of the equation is tested using the Chi-squared test (χ^2) given by the formula:

$$\chi 2 = \sum \frac{(Mi - nPi)2}{nPi}$$

Mi=mature individuals observed; *nPi*=mature individuals expected.

This logistic model of the first maturity size is determined using the StatView software (version 5.0.1).

3. Results and Discussion

3.1. Sex Ratio

Sex ratio was identified as illustrated in Table 1. In all, 111 crabs were collected 51 females (45.95%) and 60 males (54.05%). Sex was globally unbalanced (1:0.85) in favor to males but the global Chi-squared test confirms that the difference was not significant ($p>0.05$). Females were abundant than males only in September (male/female ratio 1:1.5) and November 2019 (M/F 1:1.4). In conformity with [28] survey which reported the cumulative sex ratio of *C. armatum* showed that males are higher than female and found no significant difference between the number of males and females. Also, [29] reported the calculated sex-ratio in *C. armatum* is not different from the theoretical sex-ratio but that the males are in high proportion (M/F 1:0.97).

Table 1. *Sex ratios according to gender and sampling periods. M, males; F, females.*

	Number of individuals	M	F	Sex ratio (M/F)	Chi-squared test	Significance of test
March_2019	13	8	5	1/0.63	0.11	NS
May	16	10	6	1/0.60	0.125	NS
July	18	12	6	1/0.50	0.222	NS
September	19	10	9	1/0.90	0.006	NS
November	20	8	12	1/1.50	0.08	NS
January_2020	12	5	7	1/1.40	0.056	NS
March_2020	13	7	6	1/0.86	0.012	NS
Global	111	60	51	1/0.85	0.013	NS

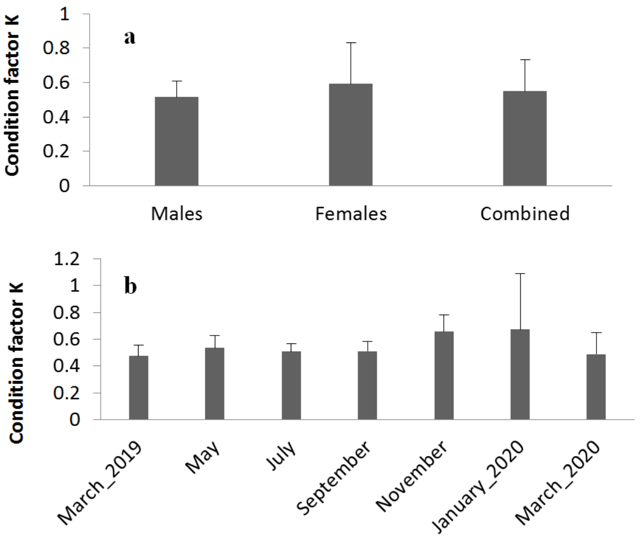

Figure 3. *Variation of condition factors by sex (a) and by sampling periods.*

3.2. Condition Factor K

Globally, Condition factor (K) ranged from 0.22 to 0.95 $g.mm^{-3}$ (mean 0.55±0.18 $g.mm^{-3}$) (Figure 3a, b). K of immature ranged from 0.22 to 0.64 and from 0.32 to 0.95 (mean 0.57±0.20) for matures individuals. Throughout the entire sampling period, (K) was below 1 means that crab is not wellbeing according to [30]. Therefore, K values obtained were very low compared to those of [28] which recorded the highest values of K for *C. armatum* (30.7) indicating favorable environmental conditions such as habitat and food availability. Like in fish, variations of K may be indicative of food abundance, adaptation to environment and gonadal development [31]. The mean K of females (0.60±0.24) was significantly ($p<0.001$) higher compared to males (0.52±0.09) suggests that females showed a better condition (welfare) than males. K higher for females was previous reported with a significant growth rate [32]. In contrast, in some brachyuran crabs, males show their K higher than females because K is strongly influenced by ecological factors, gonad development, rate of feeding (or growth), degree of parasitism and may vary among seasons, species and populations [33, 34]. The one-way ANOVA test showed the strongly different and significantly K condition factor among the sampling periods ($p<0.001$). K was not significantly higher ($p>0.05$) during dry season (mean 0.56±0.26) compared to rainy season (mean 0.54±0.11). K of matures was significantly higher ($p<0.001$) compared to immature.

3.3. Relationships Between Carapace Width and Other Parameters

The mean values of morphological parameters were illustrated in Table 2. Globally, Carapace width (CW) ranged from 46 to 93 mm. Carapace length (CL) varied from26 to 80 mm. Body weight (BW) varied from 71.9 to 400 g. Body height (BH) varied from 26 to 55 mm. Abdomen length (AL) varied from 25 to 57 mm. Abdomen width (AW) varied from 10to 42 mm. The maximum carapace length in this study was 80 mm which is low compared to 95 mm recorded in some previous studies in Table 3. This is probably due to the poor abundance of trees and the low richness in the mangrove ecosystem in the study area, in contrary to the findings of [35].

Table 2. *Proportionality index (I) according to the carapace width (CW) in C. armatum.*

Metric variables	Males		Females		Combined	
	Mean±SD	I±SD	Mean±SD	I±SD	Mean±SD	I±SD
CW	70.63±9.51	100	69.50±9.40	100	70.13±9.46	100
CL	60.00±9.91	84.93±8.40	59.24±10.07	85.64±11.72	59.66±9.96	85.24±9.99
BH	37.39±6.12	52.87±4.10	37.52±6.11	54.11±5.99	37.45±6.10	53.42±5.05*
BW	191.06±82.16	261.42±83.30	191.34±78.27	269.68±89.33	191.19±80.27	265.09±85.93
AW	25.37±7.70	36.50±11.67	24.38±6.57	34.90±7.32	24.80±6.87	35.30±8.60
AL	42.28±6.66	60.16±7.76	40.23±7.42	58.60±11.59	36.18±14.46	52.60±21.01*

* Significant difference between males and females by the one-way ANOVA test

Table 3. *Distribution of morphometric parameters in C. armatum in some Africa countries.*

Authors/year	CW (mm)	CL (mm)	BW (g)	Allometric growth	Country
Present study	46-93	26-80	71.9-400	Negative	Cameroon
Oriola et al. 2005	32-58		38.07-214.60	Positive	Nigeria
Ngo-Massou et al. 2014	136-157	91-130	152.2-158.9	Negative	Cameroon
Elegbede et al. 2015	-	25-95	96-290	Negative	Nigeria
Ethian et al. 2016	49.4[a] -51.8[b]	61[a]-64.6[b]	99.71[a]-121[b]	Negative	Cote d'Ivoire
Kakouet al. 2017	64.61-68.64	-	133,4-161.53	Negative	Cote d'Ivoire
Gassanou et al. 2017; 2018	8.2[c]	-	65.50-97.70	Negative	Benin
Elegbede et al. 2018	27-94	25-93	96-290	Negative	Nigeria

[a]mean value of females; [b] mean value of males; [c] maximum value

The correlation coefficients (r) obtained for the CW and BW of males, females and combined were positive and nearly to 1 ($0.70 < r < 0.90$; $p<0.001$) indicating that a high degree of correlation was evident between CW-BW. Relative growth between carapace width and some others metrics variables were summarized in Tables (4-8). The (b) values of CW-BW relationship were below 3 which imply a negative allometry growth patterns for both sex, similar to findings for the same species in Nigeria by [35]. In the CW-CL and CW-BH relationships, males showed a positive allometry (b >1) while females a negative allometry (b<1). For CW-AL relationships, males and females showed a negative allometry (b<1) while for CW-AW relationships, both of them showed a positive allometry (b >1). Globally, the negative allometric growth suggests that crabs have a relatively slow growth rate and tend to be thinner [36] and for female crabs in particular means slow rate of growth which is scientifically attributed to the great amount of energy invested in the reproductive process at the expenses of growth [37]. The relationships between carapace width and body weight were illustrated in Figure4 below.

Table 4. *Relative growth between carapace width (CW) and body weight (BW). a and b, estimated parameters; R^2, coefficient of determination; R, correlation coefficient; ***, higher significant correlation; N, number of individuals; $Y=aCW^b$, growth equation; t_{cal}, student test calculated; t_{th}, student test standard value.*

Sex	a	b	R²	r	n	Y=aCW^b	t_{cal}	t_{th}	Allometry
Males	0.0001	2.965	0.796	0.892***	60	$Bw=0.0001CW^{2.965}$	26.98	1.671	Negative
Females	0.014	2.219	0.539	0.734	51	$BW=0.014CW^{2.219}$	7.81	1.676	Negative
Combined	0.006	2.412	0.634	0.796***	111	$BW=0.006CW^{2.412}$	8.25	1.66	Negative

Table 5. *Relative growth between carapace width (CW) and carapace length (CL).*

Sex	a	b	R²	r	n	Y=aCW^b	t_{cal}	t_{th}	Allometry
Males	0.76	1.025	0.569	0.7543***	60	$CL=0.76CW^{1.025}$	31.13	1.671	Positive
Females	0.55	0.663	0.253	0.5034***	51	$CL=0.55CW^{0.663}$	32.74	1.676	Negative
Combined	1.62	0.847	0.403	0.6349***	111	$CL=1.62CW^{0.847}$	31.82	1.66	Negative

Table 6. *Relative growth between carapace width (CW) and body height (BH).*

Sex	a	b	R²	r	n	Y=aCW^b	t_{cal}	t_{th}	Allometry
Males	0.391	1.070	0.7904	0.8891***	60	$BH=0.391CW^{1.070}$	43.36	1.671	Positive
Females	0.226	0.733	0.4234	0.6507***	51	$BH=0.226CW^{0.733}$	37.61	1.676	Negative
Combined	0.825	0.897	0.594	0.7712***	111	$BH=0.825CW^{0.897}$	37.79	1.66	Negative

Table 7. *Relative growth between carapace width (CW) and abdomen length (AL).*

Sex	a	b	R²	r	n	Y=aCW^b	t_{cal}	t_{th}	Allometry
Males	3.594	0.570	0.2153	0.464***	60	$AL=3.594CW^{0.570}$	36	1.671	Negative
Females	1.185	0.226	0.0295	0.171	51	$AL=1.185CW^{0.226}$	35.69	1.676	Negative
Combined	7.200	0.406	0.102	0.3196***	111	$Al=7.200CW^{0.406}$	35.63	1.66	Negative

Table 8. *Relative growth between carapace width (CW) and abdomen width (Al).*

Sex	a	b	R²	r	n	Y=aCW^b	t_{cal}	t_{th}	Allometry
Males	0.327	1.011	0.233	0.4833***	60	$Al=0.327CW^{1.0119}$	11.30	1.671	Positive
Females	-0.455	1.001	0.230	0.4803***	51	$Al=0.455CW^{1.0014}$	10.75	1.676	Positive
Combined	0.347	1	0.230	0.4804***	111	$Al=0.347CW^{1}$	11.16	1.660	Isometry

Table 5 presents the correlation matrix between the morphological variables in *C. armatum*. Various others factors may be responsible of the b value variations in the CW-BW relationships such as temperature, salinity, food (quantity, quality and size), sex, and time of year and stage of maturity [38, 39]. Ovigerous females are usually heavier than non-ovigerous in many species of crabs [40, 41]. The overall low symmetrical or isometric growth of b values was less than 3 and it's due to the recruitment stock in biomass which is invariably due to the peculiarity of coastal dwelling land crabs to show irregular recruitment pattern with uncertainty of returning to a small land mass after the planktonic larval phase [42]. Observations of higher b value of *C. armatum* were linked to the higher population and standing stock biomass and condition indices [43].

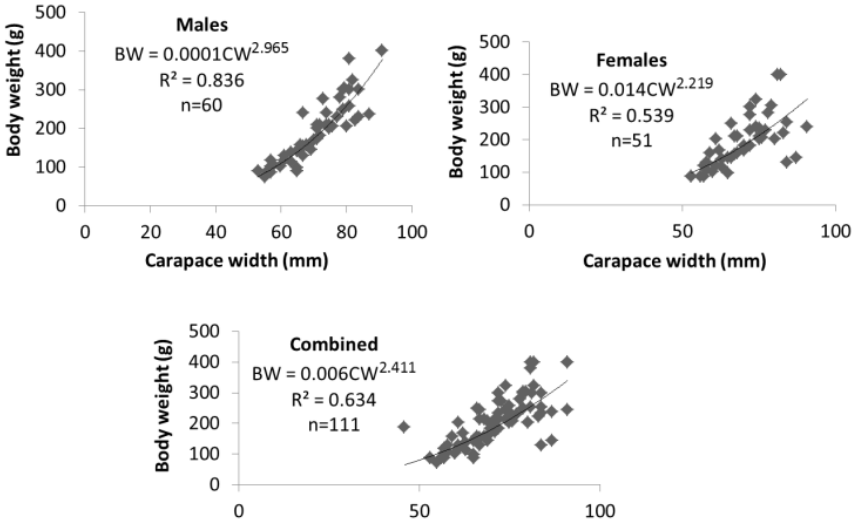

Figure 4. *Carapace width-Body weight relationships in C. armatum.*

Table 9. *Correlation matrix between some morphological parameters. Male values above and female values below the diagonal;**p <0.01; ***p <0.001.*

Variables	CW	CL	BH	BW	AL	AW
Carapace width (CW)	1	0.75***	0.89***	0.91***	0.46***	0.48***
Carapace length (CL)	0.50***	1	0.83***	0.50***	0.50***	0.48***
Body height (BH)	0.65***	0.81***	1	0.48***	0.49***	0.42***
Body weight (BW)	0.68***	1.00	0.81***	1	1.00	0.65***
Abdomen length (AL)	0.17	0.43**	0.43**	0.43**	1	0.65***
Abdomen width (AW)	0.48***	0.48***	0.62**	0.48***	0.58	1

3.4. Sizes at First Sexual Maturity

The 111 individuals collected were grouped into 17 class sizes with class number interval (3 mm). The minimum carapace widths at sexual maturity were 58.2 mm for males and 55.7 mm for females. Fifty percent maturity (CW_{50}) was attained at 62.67±0.08 mm in males and 58.87±0.14 mm in females and according to a Chi-squared test, CW_{50} in females is significant low compared to in males ($p<0.05$). The CW_{25} and CW_{75} were 59.01 mm and 66.33 mm respectively for males and CW_{25}=56.19 mm andCW_{75}=61.55 mm for females. The CW_{50} in *C. armatum* in both males and females were close to that reported for the same species by [44] *C. armatum* was few documented, but reported for some other crab species like *Carcinus aestuarii* (male=43 mm and female=34 mm) and *Scylla serrata* (male=75 mm and female=70 mm) [45, 46]. Many factors may affect the size at sexual maturity in a crab population such as the availability of food, predation, density and as well as differences in the duration and the proportion of molting crab [47-49].

4. Conclusion

This study contributes to improve the baseline data about growth pattern of *C. armatum* crab in Cameroon. Overall, the condition factor value remained below 1; indicate that *C. armatum* does not show the good wellbeing in this natural area. Almost all CW-BW relationships showed a negative allometric growth which suggests that crabs have a relatively slow growth rate and tend to be thinner; might be attributed to the degradation of their environmental conditions. Here, the size at first sexual maturity of *C. armatum* is very close to those reported for the same species in other country. According to the low abundance of *C. armatum* recorded in the study area, the current exploitation of this crab represents a threat to the survival of this species.

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References

[1] Lee SY. 1998. Ecological role of Grapsid crabs in mangrove ecosystems: a review. Marine and Freshwater Research 49: 335-343.

[2] Cartes JE, Fanelli E, Papiol V, Maynou F. 2010. Trophic relationships at intrannual spatial and temporal scales of macro and megafauna around a submarine canyon of the Catalonian coast (western Mediterranean). *Journal of Sea Research* 63: 180-190.

[3] Hall D, Lee SY, Meziane T. 2006. Fatty acids as trophic tracers in an experimental estuarine food chain: Tracer transfer. *Journal of Experimental Marine Biology and Ecology* 336: 42-53.

[4] Din N, Ngo-Massou VM, Essomè-Koum GL, Ndema-Sombo E, Kotte-Mapoko ME, Nyamsi-Moussian L. 2017. Impact of urbanization on the evolution of Mangrove ecosystems in the Wouri River Estuary (Douala-Cameroon). In: Finkl CW, Makonsky C. (eds), *Coastal Wetlands: Alteration and Remediation*. Springer, Coastal Research Library 21. pp 867.

[5] Lindquist ES, Krauss KW, Green PT, O'Dowd DJ, Sherman PM, Smith III TJ. 2009. Land crabs as key drivers in tropical coastal forest recruitment. *Biological reviews* 84: 203–223.

[6] Cuesta JA, Liu HC, Schubart CD. 2002. First zoeal stages of *Epigrapsus politus* Heller and *Gecarcoidea lalandii* H. Milne-Edwards, with remarks on zoeal morphology of the Gecarcinidae Macleay (Crustacea: Brachyura). *Journal of Natural History* 36 (14): 1671-1685.

[7] Manning, R. B., Holthuis, L. B., 1981. West African Brachyuran Crabs (Crustacea: Decapoda). Smithsonian contributions to Zoology, number 306, p 379.

[8] Davie PJF, Guinot D, Ng PKL. 2015. Anatomy and functional morphology of Brachyura. In: Castro P, Davie PJF, Guinot D, Schram F, Von Vaupel Klein C. (eds), *Treatise on Zoology-Anatomy, Taxonomy, Biology-The Crustacea, complementary to the volumes translated from the French of the Traité de Zoologie,* 9 (C) (I), Decapoda: Brachyura (Part 1). pp 11-163.

[9] Fagbuaro O, Oso JA, Majolagbe FA, Oladapo AO. 2013. Quality Analysis of Freshwater crab *Cardisoma armatum* and Marine blue crab *Callinectes amnicola* Collected from Yaba Lagos, Nigeria. *Natural Sciences* 11 (8): 22-29.

[10] Sankaré Y, Konan KJ, Amalatchy NJ, Soro MB. 2014. Swimming crab *Callinectes amnicola* (Decapoda-*Portunidae*): capture analysis of a Lagoon with high continental influence (Aby Lagoon, Côte d'Ivoire, West Africa). *Wyno Academic Journal of Biological Sciences* 2 (2): 9-19.

[11] Elegbede IO, Lawal-Are AO, Titilade PR. 2015. Size and growth of *Cardisoma armatum* and *Cardisoma guanhumi* as ecological parameters for mangrove ecosystem. *Journal of Marine Science Research and Development* 5 (2): 1-7.

[12] Elegbede IO, Fashina HA. 2013. Proximate and mineral compositions of common crab species (*Callinectespallidus* and *Cardisomaarmatum*) of Badagry Creek, Nigeria. *Poultry, Fisheries and Wildlife Sciences* 2: p. 110.

[13] Ngo-Massou VM, Kenne M, Dongmo AB. 2016. Effect of anthropogenic activities on mangrove crab diversity in Cameroon Atlantic coast. *International Journal of Research Studies in Biosciences* 4: 1-12.

[14] Maia RC, Coutinho R. 2013. The influence of mangrove structure on the spatial distribution of *Melampus coffeus* (Gastropoda: Ellobiidae) in Brazilian estuaries. *Pan-American Journal of Aquatic Sciences* 8 (1): 21–29.

[15] Nfotabong-Atheull A, Din N, Koum LGE, Satyanarayana B, Koedam N, Dahdouh-Guebas F. 2011. Assessing forest products usage and local residents' perception of environmental changes in peri-urban and rural mangroves of Cameroon, Central Africa. *Journal of Ethnobiology and Ethnomedicine* 7 (1): 41.

[16] DSCE 2009. Strategy Document for Growth and Jobs. *Reference framework for government action for the period 2010-2020*. p 170.

[17] Vogt G. 2012. Ageing and longevity in the Decapoda (Crustacea): A review. *ZoologischerAnzeiger - A J. Comparative Zoology* 251 (1): 1-25.

[18] Gaddes SW, Sumpton WD. 2004. Distribution of barnacle epizoites of the crab *Portunuspelagicus* in the Moreton Bay region, Eastern Australia. *Marine and Freshwater Research* 55: 241-248.

[19] Le Cren ED. 1951. The length-weight relationship and seasonal cycle in gonad weight and condition in the Perch (Percafluviatilis). *Journal of Animal Ecology* 20: 201–219.

[20] Schneider JC, Laarman PW, Gowing H. 2000. Length-weight relationships. Chapter 17. In: Schneider JC. (Ed.), *Manual of Fisheries Survey Methods II: With Periodic Updates*. Michigan Department of Natural Resources, Fisheries Special Report 25, pp 1-18.

[21] Giresse P, Megope-Foonde JP, Ngueutchoua G, Aloisi JC, Kuete M, Monteillet J, 1996. Carte sédimentologique du plateau continental du Cameroun à 1: 200000. ORSTOM, Paris, France.

[22] Delathiere S. 1990. Biologieet exploitation du crabe de palétuviers *Scylla serrata*. Thèseprésentée à l'Université de Bretagne Occidentale pour l'obtention du grade de Docteur en Océanographiebiologique. pp 194.

[23] Lawal-Are, A. O., 2010. Reproductive biology of the blue crab, *Callinectes amnicola* (De Rochebrune) in the Lagos Lagoon, Nigeria. *Turkish Journal of Fish and Aquatic Sciences* 10: 1-7.

[24] Aydın M, Karadurmus U, Erbay M. 2012. Length-weight Relationships and Reproduction Characteristics of *Liocarcinus navigator* (Herbst, 1794), *Ege Journal of Fisheries Aquatic Science* 29 (4): 193-197.

[25] Ricker WE. 1975. Computation and interpretation of biological statistics of fish populations. *Journal of the Fisheries Research Board of Canada* 191: 203-233.

[26] Yilmaz, S., Yazıcıog˘lu, O., Erbas_aran, M., Esen, S., Zengin, M., Polat, N., 2012. Lengthweight relationship and relative condition factor of white bream, Bliccabjoerkna (L., 1758), from Lake Ladik, Turkey. J. Black Sea/Medit. *Environment* 18: 380-387.

[27] Dagnelie P. 1973. Théorie et MéthodesStatistiques: Applications Agronomiques Presses Agronomiques de Gembloux: Belgique, 1.

[28] Elegbede IO, Lawal-Are AO. 2013. Comparative study of condition factor, stomach analysis and some aspects of reproductive biology of two land crabs: *Cardisoma armatum* (Herklots, 1851) and *Cardisoma guanhumi* (Latreille, 1825) from a mangrove swamp ecosystem, Lagos, Nigeria. *Journal of Marine Science Research and Development* 4 (1): 1-4.

[29] Goussanou A, Bonou AG, Chikou A, Gandonou P, Mensah GA, Youssao AKI. 2017. Morphological, structural characteristics and growth relationship of crabs *Callinectes amnicola* and *Cardisoma armatum* in the Nokoué lake Porto-Novo lagoon in South Benin. *Journal of Applied Biosciences* 118: 11803-11816.

[30] Fulton TW. 1902. The rate of growth of fishes. 20th Annual Report of the Fishery Board of Scotland 1902 (3): 326-446.

[31] King M. 1995. Fisheries biology, assessment and management. Cambridge, Massachusetts: Fishing News Books, Blackwell. ISBN: 0852382235.

[32] Arimoro FO, Idoro B. 2007. Ecological studies and biology of *Callinectes amnicola* (Family: Portunidae) in the Lower Reaches of Warri River, Delta State, Nigeria. *World Journal of Zoology* 2 (2): 57-66.

[33] Pinheiro MAA, Fiscarelli AG. 2009. Length-weight relationship and condition factor of the mangrove crab *Ucides cordatus* (Linnaeus, 1763) (Crustacea, Brachyura, Ucididae). *Brazilian Archives of Biology and Technology* 52: 397-406.

[34] Franco-López J, Sánchez CB, Escorcia HB, Abarca LGA, FerreiraTC, Vázquez-López H. 2010. Biological and ecological aspects regarding *Cynoscionnothus* Holbrook, 1855 (Perciforms: Sciaenidae). *Research Journal of Fisheries and Hydrobiology* 5: 66-75.

[35] Elegbede IO, Lawal-Are AO, Titilade PR. 2018. Size and growth of *Cardisoma armatum* and *Cardisoma guanhumi* as an ecological parameters for mangrove ecosystem. *Journal of American Science* 14 (7): 90-105.

[36] Nazek J, Younes G, Sukhn C, El-Dakdouki MH. 2018. Length-weight relationships and relative condition factor of fish inhabiting the marine area of the Eastern Mediterranean city, Tripoli-Lebanon. *Egyptian Journal of Aquatic Reseach* 44: 299–305.

[37] Turner LM, Hallas JP, Morris S. 2011. Population Structure of the Christmas Island Blue Crab, *Discoplax hirtipes* (Decapoda: Brachyura: Gecarcinidae) on Christmas Island, Indian Ocean. *Journal of Crustacean Biology* 31 (3): 450–457.

[38] Sparre P. 1992. Introduction to tropical fish stock assessment. Part I Manual. *FAO Fisheries Technical Paper* 306/1. Rev 1. Rome, p 376.

[39] Moura NFO, Coelho PA, 2004. Maturida de sexual fisiológica em *Goniopsis cruentata* (Latreille) (Crustacea, Brachyura, Grapsidae) no Estuário do Paripe, Pernambuco, Brazil. *Revista Brasileira de Zoologia* 21: 1011-1015.

[40] Ali RAS, Elawad AN, Khalifa MM, El-Mor M. 2016. Length–weight relationship and condition factor of Liza ramada from Eastern coast of Libya. *International Journal of Fish and Aquatic Research* 2: 1-9.

[41] Aráujo MSLC, Negromonte AO, Barreto AV, Castiglioni DS. 2012. Sexual maturity of the swimming crab *Callinectesdanae* (Crustacea: Portunidae) at the Santa Cruz Channel, a tropical coastal environment. *Journal of the Marine Biological Association UK* 92: 287-293.

[42] Hartnoll RG, Clark PF. 2006. A mass recruitment event in the land crab *Gecarcinus ruricola* (Linnaeus, 1758) (Brachyura: Grapsoidea: Gecarcinidae), and a description of the megalop. *Zoological Journal of the Linnean Society*146: 149-164.

[43] Atar HH, Secer S. 2003. Width/length weight relationships of the blue crab (*Callinectes sapidus*, Rathbun, 1986) population living in Beymeleklagoon lake. *Turkish Journal of Veterinary and Animal Sciences* 27: 443-447.

[44] Goussanou A, Bonou AG, Chikou A, Mensah GA, Karim IYA. 2018. Sizes at first sexual maturity and capture and demographic parameters of crabs *Callinectes amnicola* and *Cardisoma armatum* in the complex Nokoué Lake Porto-Novo lagoon in South Benin. *International Journal of Fisheries and Aquatic Studies* 6 (1): 195-201.

[45] Zouari, SB. 2010. Contribution à l'étude écobiologique et biochimique du crabe *Carcinus aestuarii* dans la région Nord de Sfax. Mémoireprésenté pour l'obtention du diplôme de mastère en biodiversitéetressourcesaquatiques, Faculté des Sciences de Sfax, Université de Sfax, p 104.

[46] Fondo EN, Kimani EN, Odongo DO 2010. The status of mangrove mud crab fishery in Kenya, East Africa. *International Journal of Fisheries and Aquaculture* 2 (3): 79-86.

[47] Johnson DD, Gray CA, Macbeth WG. 2010. Reproductive biology of *Portunuspelagicus*in a south-east Australian estuary. *Journal of Crustacean Biology* 30 (2): 200-205.

[48] Soundarapandian P, Varadharajan D, Anand T. 2013. Male reproductive system of blue swimming crab, *Portunus pelagicus* (Linnaeus, 1758). *Journal of Cytololy and Histology* 5: 206.

[49] Kunsook C, Gajaseni N, Paphavasit N. 2014. A stock assessment of the blue swimming crab *Portunus pelagicus* (Linnaeus, 1758) for sustainable management in Kung Krabaen Bay, Gulf of Thailand. *Tropical Life Sciences Research* 25 (1): 41-59.