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Reproductive parameters of female edible crab *Cardisoma armatum* Herklots, 1851 (Brachyura: Gecarcinidae) from Kribi mangroves, Cameroon

Paramètres de reproduction du crabe comestible femelle Cardisoma armatum Herklots, 1851 (Brachyura : Gecarcinidae) des mangroves de Kribi, Cameroun

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ABSTRACT
In order to contribute in the knowledge of reproductive aspects of female *Cardisoma armatum* Herklots, 1951 sampling was carried out once every two months from March 2019 to March 2020 in mangroves around Kribi municipality. In all, 51 females were isolated, sexed, measured and dissected. Maturity stages of ovaries were identified and described visually using their macroscopic aspects (color and volume). According to occurrence of females in different ovarian stages, maturation and spawning peaks occurred in September and November respectively. Regarding to Gonado-Somatic Index (GSI), ovarian maturation occurred from May 2019 to March 2020 with a peak of maturation observed between July and August. The Hepato-Somatic Index (HSI) variation showed a high peak between May and June meaning an intense storage of lipid reserves in hepatopancreas. The condition factor value remained below 1, which means that *C. armatum* females don't show good wellbeing. The negative allometry between carapace width and body weight relationships suggesting the width growth is faster than weight gain. Fecundity estimates ranged from 1080 to 5436 oocytes (mean 2399.71 oocytes). The oocytes diameter varied from 0.42 to 1.27 mm with a mean of eggs 0.75±0.25 mm. Absolute fecundity is proportional to the body weight and carapace width of the individual, while the oocyte diameter is inversely proportional to the body weight and carapace width. These data recorded in a natural ecosystem are determinant for crab farming in order to maintain long-term food security and conservation of this species.
Keywords: Fecundity, Gonado-Somatic Index, Hepato-Somatic Index, Oocyte diameter, Ovarian maturation

RESUME
Pour la connaissance des paramètres de reproduction des femelles *Cardisoma armatum* Herklots 1951, des prospections ont été réalisées une fois tous les deux mois de mars 2019 à mars 2020 dans les mangroves de la ville de Kribi. Au total, 51 femelles ont été isolées, sexées, mesurées et disséquées. Les stades de maturité des ovaires ont été identifiés visuellement et décrits à l'aide de paramètres macroscopiques. Les pics de maturation et de ponte se sont produits respectivement en septembre et en novembre. L'indice gonado-somatique révèle que la maturation ovarienne semble s'être produite de mai 2019 à mars 2020 avec un pic de maturation entre juillet et août. La variation de l'indice hépato-somatique a montré un pic élevé entre mai et juin signifiant un stockage intense des réserves lipidiques dans l'hépatopancréas. La valeur du facteur de condition est restée inférieure à 1, ce qui signifie que les femelles de *C. armatum* ne présentent pas d'embonpoint. L'allométrie négative observée entre la largeur de la carapace et le poids corporel suggère que la croissance en largeur est plus rapide que le gain en poids. Les estimations de fécondité allaient de 1080 à 5436 ovocytes (moyenne de 2399,71 ovocytes). Le diamètre ovocytaire variait de 0,42 à 1,27 mm avec une moyenne des œufs de 0,75 ± 0,25 mm. La fécondité absolue est proportionnelle au poids corporel et à la largeur de la carapace de l'individu, tandis que le diamètre ovocytaire est inversement proportionnel au poids corporel et à la largeur de la carapace. Ces données pour un écosystème naturel sont déterminantes pour l'élevage du crabe afin de maintenir la sécurité alimentaire à long terme et la conservation de cette espèce.
Mot clés : Fécondité, Indice Gonado-Somatique, Indice Hépato-Somatique, diamètre des ovocytes, maturation ovarienne

1. Introduction

The fishing sector is part of the development programs chosen by the Cameroonian government to boost growth and jobs to maintain long-term food security and balance (DSCE 2009). For achieve this objective, several programs in promotion and intensification of aquaculture were carried out particularly crab farming. This is because the rise of consumption of edible mangrove crabs without renewal will favor the decline of their availability or even disappearance in their natural environment. That is the case of *C. armatum* crabs recorded in Cameroonian mangroves, where they are threatened species because of an intense harvesting for consumption (Ngo-Massou et al. 2016). Nonetheless, this species is known to have good growth performance and can be recommended for the aquaculture (Edea et al. 2015). However, knowledge of this species remains only widespread in coastal areas where riparian communities make it one of the main sources of dietary protein (Fagbuaro et al. 2013, Gassanou et al. 2018). This species is sought and appreciated for its flesh quality and nutritional value rich in minerals and low in fat (Elegbede & Fashina-Bombata 2013). *C. armatum* is the one African crab of the fourth species of *Cardisoma* genus known. The exploitation of this land species is still done traditionally and therefore less expensive and accessible for local people as fish (Amakoe 2011).

Trials in crab farming are slow to emerge in Cameroon. This delay appears to be attributed to the lack of scientific data on growth parameters, feeding and reproductive parameters of potentially aquaculture crab species in their natural environment. In addition, like for fish farming, more than 90% of fish farmers are artisanal operators with no real technicality, hence the need to have of farmed species that are easy to manage (Lazard & Levêque 2009). For that, the use of native species or naturalized constitutes in this context a comparative advantage over cash exotic, especially for the supply of broodstock and fry (Tiogue et al. 2010). However, mastering this information in our biotope is a necessary prerequisite for the knowledge and breeding of these species for conservation. Growth parameters through size-weight relationships and the condition factor provide information on the living conditions and wellbeing of aquatic species, their growth and survival (Fulton 1902, Elegbede et al. 2018). While reproductive parameters such as gonad maturity stages, Gonado-Somatic Index and fecundity are used to describe the reproductive cycle and to determine the spawning period as well as a stock's reproductive potential and survival (Tiogue et al. 2008). Primarily, the reproductive cycle for species with commercial value or ecological potential has been commonly studied in crustaceans (Castiglioni et al. 2010). For that, several aspects of their biology has been mentioned through assessment of fecundity and oocyte diameter distributions (Kodama et al. 2004); maturity stages of gonadal development (Shinozaki-Mendes et al. 2012) and several relationships between fecundity and body size (Pereira et al. 2009) and clutch volume and carapace width (Darnell et al. 2010). About the gonadal development, maturity stages can be assessed by assigning crabs macroscopic characters that can be distinguished visually (Sharifian et al. 2017). For aquaculture issue, the reproductive cycle of species must be firstly studied in the natural environment before their domestication in an artificial environment and to optimize production (Tiogue et al. 2008). For that reason, this study was undertaken to improve the information of the reproductive cycle of *C. armatum* female in their natural ecosystem for an adequate comprehension in order to promote the domestication of this species.

2. Materials and methods

2.1. *Site description*

The survey was carried out in the Kribi city around the back mangroves of Nziou (2°58’35”-2°58’44”N and 9°54’59”-9°55’07”E) (Fig.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 marked by high and stable temperatures of about 28.7 °C (Ngo-Massou et al. 2018). Heavy annual rainfalls reach 3,000 mm and the tidal regime reaches 1.5 m in the spring tide (Giresse et al. 1996). The flora remains poor with *Rhizophora racemosa* GF Meyer being largely the dominant species (Ngo-Massou et al. 2016).

2.2. *Data collection*

Survey was carried out from March (2019) to March (2020) to reduce the sampling pressure impact on the crab population. Specimens were collected during the daytime under low tide condition in several bucket traps baited buried in the ground distributed near to the *Cardisoma* holes. Collected specimens were stored for one hour in a deep freezer and then they were thawed at room temperature and washed for removing the mud to the external skeleton. Only females and Ovigerous crabs were identified by looking at the abdomen shape as illustrated in Fig. 2.

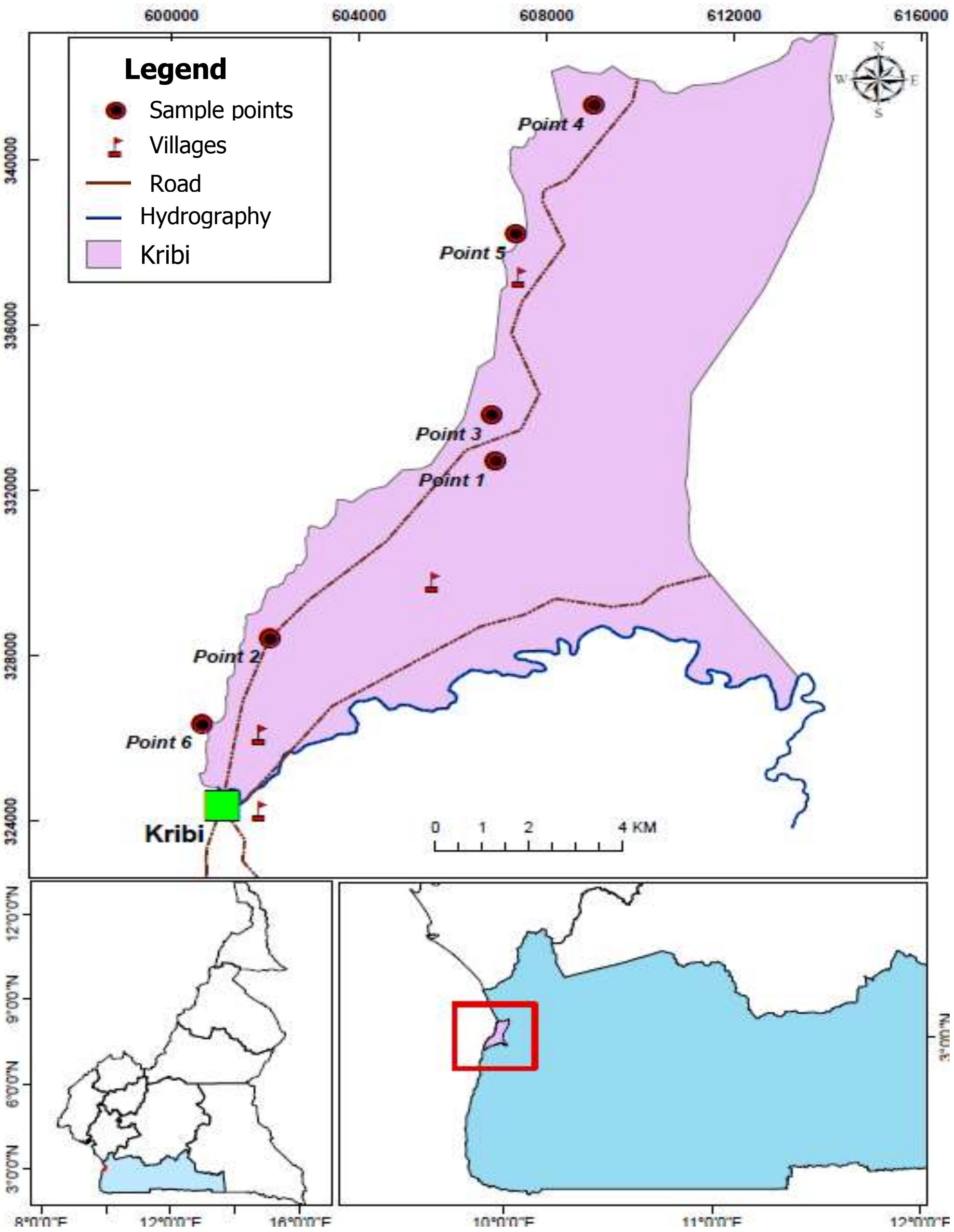

Figure 1: Localization of different sampling points

For all females identified, carapace width (CW) and carapace length (CL) were measured using caliper (0.01 mm accuracy) and body weight (BW) was measured using digital scales to the nearest 0.01g. Then, they were dissected by removing the exosquelette to assess maturity stages of ovaries using visual examination of the consistence, volume and coloration according to the scales proposed by Lawal-Are (2010). Ovaries and hepatopancreas of the mature females were weighed by a digital scale with accuracy of 0.01g in order to determine the Gonado-Somatic Index (GSI) and Hepato-Somatic Index (HSI). Then, 1g of ovary was isolated from each in order to select 40 oocytes. The oocyte diameter (OD) was measured on selected oocytes using an ocular micrometer under compound microscope.

Figure 2: (A) represents different carapace shape and color of *C. armatum* and (B) the ventral view of one mature and two ovigerous females

2.3. *Ethical approval*

Crabs were handled in respect with the Cameroon National Ethical Committee (Reg. num. FWA-IRD 00001954) in accordance with the internationally accepted principle guidelines of the European Union on Animal Care (CEE Council 86/609).

2.4. *Data analysis*

The population structure was analyzed with the descriptive statistics approach. The mean carapace size was compared using the Student t-test. The condition factor was calculated in relationship to size using the equation as follows:

$$K=100\ BW / CW^3$$

Where K= condition factor (g/mm^3); BW= body weight (g); CW= carapace width (mm)

Determination model of the relationship between the carapace widths with body weight using the Ricker (1975) equation:

$$BW= a\ CW^{b}$$

Where: BW = body weight (g); CW = carapace width (mm); a,b = Constant

The square of the coefficient (r^2) was determined to identify the degree of association of the two variables (a and b). Growth pattern related to value of allometry coefficient (b) was defined. Then, b value was comparing with the theoretical value 3. If b=3, isometry growth; b>3, positive allometric growth; b<3, negative allometric (Yilmaz et al. 2012). The significance of b was tested using *Student's* test at 5%.

The Gonado-Somatic Index (GSI) expresses gonad weight as a proportion of total weight and widely used to evaluate reproduction timing. Hepato-Somatic Index (HSI) is defined as the ratio of liver weight to total body weight and used as a measure of the energy reserves of an animal. GSI and HIS were calculated following equations of Giese (1966) and Clarke (1977) respectively:

$$GSI = (OW / BW) \times 100$$

$$HSI = (HW / BW - OW) \times 100$$

Where OW=Ovary weight (g), BW= body weight (g), HW= hepatopancreas weight (g).

Fecundity was estimated using Absolute (AF) and Relative fecundity (RF). AF represents the total number of mature oocytes in the ovaries before laying. It will be obtained using the following formula:

$$AF= No \times OW$$

No = number of oocytes in 1g of ovary, OW = ovary weight (g)

RF was calculated according to the following formula:

$$RF = No / BW$$

No = number of oocytes in 1g of ovary, BW = Body weight (g)

The relationships between morphological and reproductive parameters were estimated through a correlation coefficient.

3. Results

3.1. *Ovarian maturation*

In all, 51 females were collected. Macroscopic analyses of females showed four ovarian maturity stages (1 to 4) according to the macroscopic characters and color changes (Fig. 3). Stages 1 and 2 represent 23.53 % of females and belonging to immature females (Fig. 4). Mature females comprised females in stage 3 (39.22%) and stage 4 (31.37%).

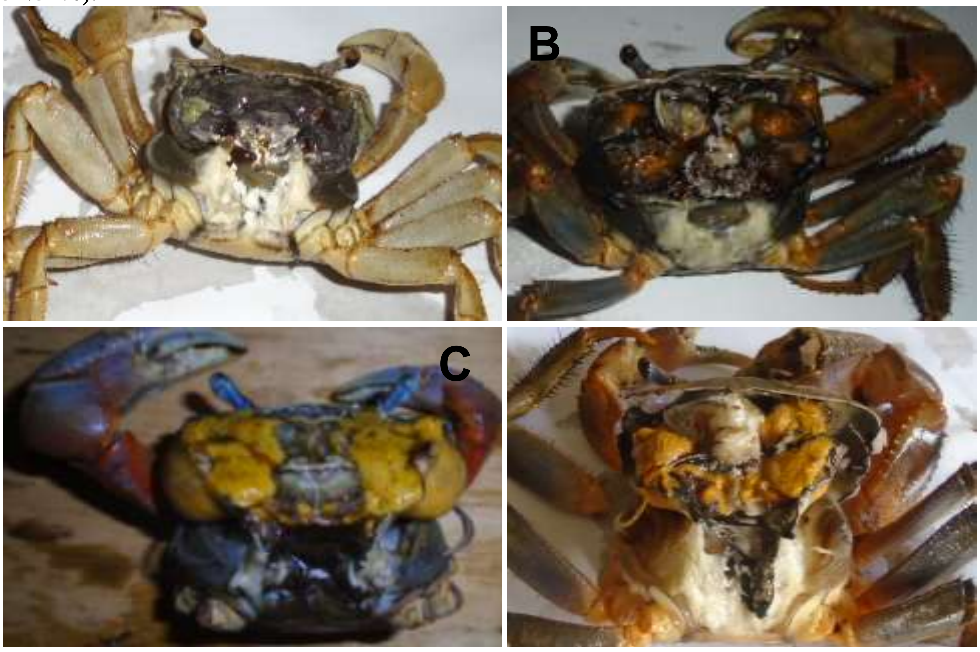

Figure 3: Stages of ovarian development identified macroscopically. (A)=Stage I, (B) = Stage II, (C) = Stage III and (D)= stage IV.

Independently to the ovary stages, ovigerous females represent 5.88% of individuals. Based on the occurrence of females in different ovarian stages, immature females were dominant between March to September 2019 and reaching the peak in May 2019. Females in stage 3 were encountered during all the sampling and reaching the peak in September 2019 and declined progressively until March 2020. Females in stage 4 and ovigerous females were identified from July 2019 to March 2020 peaked in November (2019) which correspond to maturation and spawning periods. Hence, the reproduction of *C. armatum* seems occurred during most of the sampling period with the peak of maturation in September (2019) and for spawning a peak occurred in November (2019).

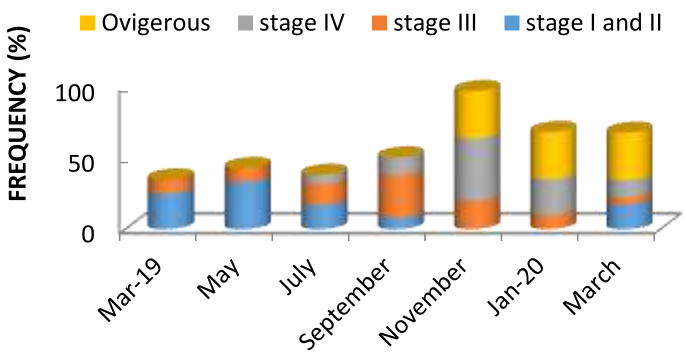

Figure 4: Frequency of maturation stages

3.2. *Condition factor (K)*

The condition factor (K) of all females ranged from 0.21 to 0.88 g/mm^3 (mean 0.56±0.15 g/mm^3) (Fig.5). K of immature varied from 0.21 to 0.64 g/mm^3 (0.47±0.13 g/mm^3). K of females in stage 3 varied from 0.38 to 0.76 (0.53±0.10 g/mm^3) and 0.32 to 0.88 (0.67±0.15 g/mm^3) for stage 4. The one-way ANOVA test showed that K was significantly higher (*p*<0.001) during high rainy season (0.56±0.17 g/mm^3) compared to low dry season (0.55±0.13 g/mm^3), and also strongly significantly different (*p*<0.001) among the months

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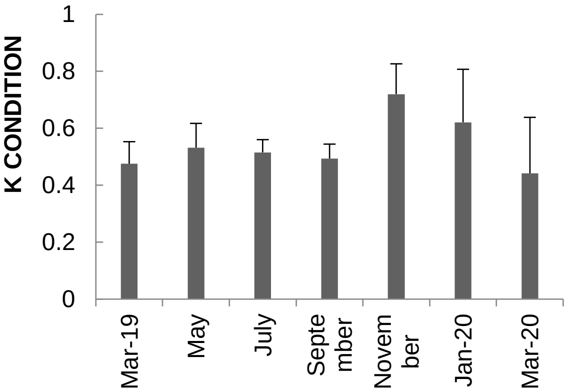

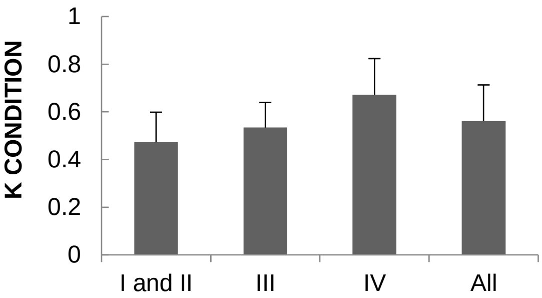

Figure 5: K condition factor frequency; a=per months, b=per stages

3.3
. *Relationships between morphological parameters*

Table 1 summarizes some averages of growth parameter. Carapace width (CW) of all females varied from 53 to 91 mm with a mean of 69.50 ± 9.40 mm. The minimum length of carapace (CL) was 26 mm and the maximum was 80 mm with a mean of 59.24 ± 10.07 mm. Body weight (BW) ranged from 84.8 to 400g with a mean of 191.34 ± 78.27g.

Table 1: Growth parameters mean. n=number of individual; CW = carapace width; CL= carapace length; BW = body weight

	Maturity stages				All
	I and II	III	IV	Ovigerous	
n	12	20	16	3	51
CW (mm)	64.43±10.93	68.15±7.96	78.00±6.99	63.33±13.69	69.50±9.40
CL (mm)	51.64±6.68	58.05±11.10	66.43±4.79	60.33±7.71	59.24±10.07
BW (g)	117.31±26.07	169.29± 45.26	273.85±61.49	218.53±31.74	191.34±78.27

The mature females (CW=72.07±56.47, CL=60.24±5.94, BW=201.57±53.37) are significantly ($p<0.01$) wide, taller and heavier than immature (CW=64.43±10.93, CL=51.64±6.68, BW=117.00±26.07). Ovigerous females (BW=218.53±31.74) are significantly ($p<0.05$) heavier than non-ovigerous (BW=201.57±53.37). The correlation coefficients (r) ranged from 0.7 to 0.9 ($p<0.05$) indicating that a high positive and significant correlations were evident between CW-BW of all female groups. Also, the coefficient of determination R^2 values varied between 0.539 and 0.836. The CW-BW analysis on Table 2 showed that the allometry coefficient (b) of CW-BW relationship remained below 3 (b<3; $p<0.05$) for all stages which means a significant negative allometry (Fig. 6).

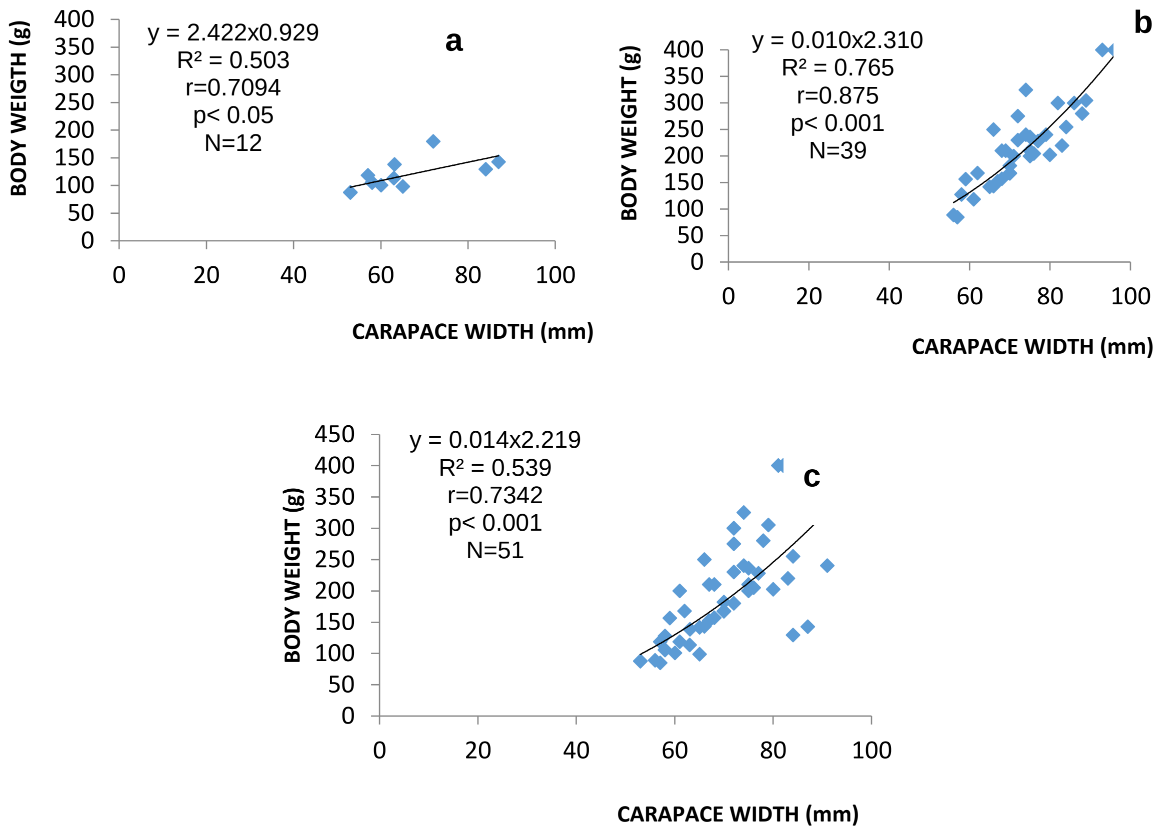

Figure 6: Carapace width and body weight relationship, a=immature, b=matures and c= combined

Table 2: Relative growth of body weight (BW) according the carapace width (CW).

Stages	a	b	R^2	r	n	$BW=a\ CW^b$	tcal	tth	Growth characteristics
Immatures	2.422	0.929	0.5032	0.7094***	12	$BW= 2.422\ CW^{0.929}$	71.03	1.812	
Matures	0.010	2.311	0.7653	0.8748***	39	$BW= 0.010\ CW^{2.311}$	1.07	1.697	Negative allometry
Combined	0.014	2.219	0.539	0.7342***	51	$BW= 0.014\ CW^{2.219}$	0.25	1.676	

a, estimated parameters of relationship; b, allometry coefficient; R^2, coefficient of determination; r, correlation coefficient; ***, higher significant correlation; n, number of individuals; $BW= aCW^b$, growth equation; t_{cal}, student test calculated; t_{th}, student test standard value; $t_{cal} > t_{th}$ means b value significantly different from 3.

3.4. *Gonado-somatic index (GSI) and Hepato-somatic index (HSI)*

Gonado-somatic index (GSI) ranged from 1.60 to 10.89 with the mean value 5.74±2.56 (Table 3). The highest of GSI mean value bimonthly (8.26±2.24) was found in July and the lowest in March 2020 (2.59 ± 0.98) (Fig. 7). The one-way ANOVA test showed that the GSI and HSI were not significantly different (p>0.05) among the months. Based on the variations of GSI mean values, ovarian maturation of *C. armatum* female occurred from May 2019 to March 2020 with five phases of sexual cycle: a pre-maturation phase from May to July 2019; a rapid maturation phase marked by a very rapid increase in the GSI between July to September 2019; a spawning phase marked by the slow decline of the GSI values (November 2019 to January 2020); a post-egg-laying and sexual rest phase extending from January to March 2020 marked by the fast decline of the GSI values.

Table 3: Gonado-somatic index (GSI) and Hepato-Somatic Index (HSI) variation

Stages	n	Ovaries weight (g)	Hepatopancreas weight (g)	GSI (%)			HSI (%)		
				Mean±SD	Min	Max	Mean±SD	Min	Max
III	20	11.36 ±3.90	3.27±4.28	6.77±2.16	3.76	10.64	1.96±2.42	0.24	7.87
IV	16	10.78±3.83	2.39±2.98	4.45±2.46	1.6	10.89	0.88±1.12	0.2	3.83
III+IV	36	11.10±3.86	2.88±3.76	5.74±2.56	1.6	10.89	1.48±2.01	0.2	7.87

These observations were close of those obtained in ovarian maturation aforementioned. The evolution trend of HSI shows opposite progression to that of GSI. The Hepato-somatic index (HSI) was observed lowest in July 2019 (0.38±0.12), whereas a high peak of hepatopancreas development was observed in May 2019 (5.55±0.66). The Spearman correlation showed a strongly positive significant correlation between GSI and HSI (r=0.72; p<0.001).

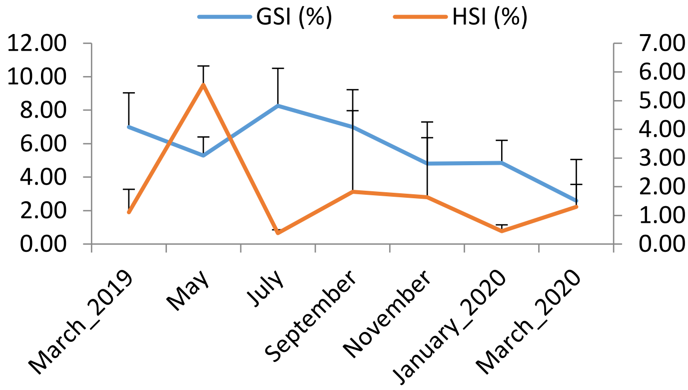

Figure 7: Gonado-Somatic Index (GSI) and Hepato-Somatic Index (HSI) bimonthly mean values

3.5. ***Fecundity***

Among 100 and 360 oocytes were counted with a mean of 228±68 oocytes in 1 g of mature female ovary (Fig. 8). The absolute fecundity (AF) ranged from 1080 to 5436 (mean 2399.71±1218.62) while the relative fecundity (RF) varied from to 0.42 to 2.13 (mean 1.15±0.45).

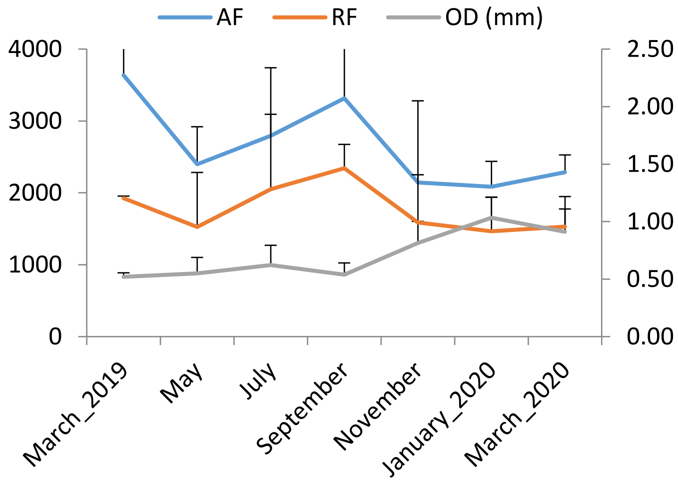

Figure 8: Bimonthly variation of fecundity patterns

The oocytes diameter (OD) varied from 0.42 to 1.27 mm with mean 0.75±0.25 mm (Table 4). Females size (68.15±7.96 mm) and body weight (169.30 ± 45.26 g) in stage III laid 2367±994.42 eggs with mean oocyte diameter of 0.76±0.27 mm, while females size (75.00±6.99 mm) and body weight (273.85±61.49 g) in stage IV laid 2679±1242.67 eggs with mean oocyte diameter of 0.74±0.23 mm.

Table 4: Fecundity patterns and oocyte diameter according to maturation stages

Stages	n	Number of oocytes	AF		RF		OD	
			Mean ± SD	Min-Max	Mean ± SD	Min-Max	Mean±SD	Min-Max
III	20	234± 62	2665.72±1185.64	1260-5184	1.35± 0.42	0.54-2.13	0.75±0.26	0.43-1.27
IV	16	230±77	2367.175±994.42	1080-5436	0.89± 0.34	0.42-1.58	0.71±0.29	0.42-1.14
III+IV	36	232±69	2399.71±1218.62	1080-5436	1.15± 0.45	0.42-2.13	0.75±0.25	0.42-1.27

With regard to these results, the absolute fecundity is proportional to the body weight and carapace width of the individual, while the oocyte diameter is inversely proportional to the body weight and carapace width. Moreover, correlations between some morphological and reproductive variables were showed in the Table 5. Absolute fecundity was significantly and positively correlated with the carapace width, body weight, Gonado-somatic index, Hepato-Somatic Index, gonads weight and oocytes diameter ($0.60 < r < 0.90$; $p<0.001$). Body weight, carapace width, carapace length, Gonado-somatic index, ovaries weight and oocyte diameter were also significantly and positively correlated ($0.70 < r < 0.96$; $p<0.001$). The lowest significant correlation ($r=0.3$; $p<0.05$) was observed between carapace width and oocyte diameter while the highest significant ($r=0.94$; $p<0.001$) was observed between the Gonado-somatic index and ovaries weight. The positive and significant correlations between these several variables suggest that the evolution of these variables is proportional.

Table 5: Correlation matrix between some morphological and reproductive variables

Variables	AF	RF	OD	GSI	HSI	CW	CL	BW	OW
AF	1	0.76***	0.44**	0.83***	0.64***	0.52***	0.59***	0.62***	0.88***
RF		1	0.54***	0.74***	0.77***	0.18	0.37**	0.33*	0.72***
OD			1	0.57***	0.69***	0.32*	0.45**	0.68***	0.58***
GSI				1	0.70***	0.25	0.28	0.35*	0.94***
HSI					1	0.26	0.42**	0.65**	0.62***
CW						1	0.78***	0.81***	0.55**
CL							1	0.82***	0.46**
BW								1	0.64***
OW									1

Discussion

In the current study, four ovarian maturity stages of *C. armatum* females were identified according to the volume of ovary expansion in the body and color changes. This finding is in accordance with Botelho et al. (2001) and Ikhwanuddin et al. (2012) which classified the ovarian maturation of female of others crabs into four stages. Also, concerning the variation of ovary color, El-Sherif et al. (2012) reported that the color changes in the ovary during the maturation of crustaceans were due to the synthesis of carotenoid pigments. The peaks of maturation and for spawning occurred in September and November (2019) respectively which are the rainiest period in Kribi area. Accordingly, our findings corroborate with those reported by Delfosse (1999) and Sharifian et al. (2017) about breeding of *C. armatum* and *Sodhiana iranica* crabs respectively which occurred once a year in the rainy season. Likewise, other contributing abiotic and biotic factors may be associated with the maturation and breeding activity of crabs in subtropical areas such as temperature, salinity, oxygen, and photoperiod (Costa & Negreiros-Fransozo 2003), population's evolutionary histories and food availability which has a direct effect on egg (Litulo 2005).

The condition factor was significantly higher during high rainy season compared to low dry season, and showed variation among our sampling months. Pinheiro & Fiscarelli (2009) reported similar findings about variations of condition factor based in seasons and gonadal maturation in mangrove crab *Ucides cordatus*. Throughout the entire sampling period, K was below 1 meaning that *C. armatum* is not wellbeing despite being in his natural environment. This situation is probably due to the lack of food caused by the anthropogenic degradation of mangrove vegetation in the study area and intensive harvesting of this species. Similarly low values of K were reported in Mexico for *C. crassum* (0.59) due to a high human pressures which representing a high mortality rate (Vázquez-López & Ramírez-Pérez 2015). In contrast, the highest K values were reported for *C. armatum* (28.60) and *C. guanhumi* (30.75) in Nigeria indicating favorable environmental conditions such as habitat and food availability (Olalekan & Lawal-Are 2013). In accordance with Fulton (1902), the condition factor is used to determine the condition of the habitat and overall wellbeing of crab. Like in fishes, monitoring of condition coefficient may also be indicative of food abundance, adaptation to environment and gonadal development (King 1995).

The mature females are significantly ($p<0.01$) wide, taller and heavier than immature and ovigerous females are significantly ($p<0.05$) heavier than non-ovigerous. It was previously reported that ovigerous females are usually heavier than non-ovigerous in many species of crabs (Araújo et al. 2012). The values the coefficient of determination R^2 obtained indicate a good quality of the prediction of a linear regression. In accordance with Nazek et al. (2018), these values suggest that the extrapolation in future catches can be done in that geographical spot for this size range. The negative and significant allometry of CW-BW relationships suggesting that weight evolution is less important than that in size in *C. armatum* females. Similar findings were recorded by Elegbede et al. (2018) of the same species in Nigeria. Additionally, negative allometric trends were also reported in females of several other crab species: *Callinectes amnicola* (Onyekachi & Bernard 2014), *Rhithropanopeus harrisii* (Hegele-Drywa et al. 2014) and *Ocypode macrorera* (Dubey et al. 2014). This is scientifically attributed to the slow rate of growth of female crabs and the great amount of energy invested in the reproductive process at the expenses of growth by females (Turner et al. 2011). In contrary, observations of higher b value of *C. armatum* were linked to the higher population and standing stock biomass and condition indices (Atar & Secer 2003). 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 (Hartnoll & Clark 2006). 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 (Sparre 1992, Suman et al. 2018).

Based on the variations of GSI mean values, *C. armatum* showed a rising trend during spawning period from July to September, with a drop between November to January suggested that this crab is a seasonal breeder. In accordance with Litulo (2004) who reported breeding restricted to certain months in subtropical areas for some crabs. In contrast, Mouton & Felder (1995) reported the reproduction in tropical areas occur year round because environmental favorable conditions. The peak of HSI observed in May seems due to intense increase of lipid reserve storage in the hepatopancreas for vitellogenesis. The same findings were reported to *Carcinus aestuarii* crab and lean fishes which accumulate lipids in the liver before passing into the gonads (Zouria 2010). Fecundity studies in *C. armatum* have been particularly poorly documented, but several studies investigating on several others crabs also confirmed that fecundity was strongly and positively related to carapace width and highly variable among locations, months, and years (Arimoro & Idoro 2007, Crowley et al. 2019).

For the optimum management of crab farming, the knowledge of ecology, growth and reproductive season are priority data. In this study we found that the wellbeing of this crab depends on availability of foods and stability of environment. The rate of fecundity is strongly and positively related to carapace width and some abiotic factors. However, histological studies of ovary will be necessary later in order to characterize ovarian cycle using microscopic observations of cells.

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