

Breeding of the Land Crab *Cardiosoma armatum* (Herklots 1851) in Captivity in Benin

Edéa OG^{1,3}, Gbangboché AB^{1,3*}, Hinvi LC² and Azando EV^{1,4}

¹Laboratory of Animal Improvement and Biotechnology, Institute of Applied Biomedical Sciences, Faculty of Agricultural Sciences, University of Abomey-Calavi, Benin

²Laboratory of Hydrobiology and Aquaculture, Faculty of Agricultural Sciences, University of Abomey-Calavi, Benin

³University of Agriculture of Ketou, Po Box 43 Ketou, Benin

⁴University of Parakou, University Centre of Djougou, National High School of Agricultural Sciences and Technics, Republic of Benin

Abstract

Tests of breeding of 70 juveniles (35♂ and 35♀) and 5 berried females of *Cardiosoma armatum* were carried out in captivity for 42 days. The crabs were fed on palm nuts (*Elaeis guineensis*), banana leaves (*Musa sp.*), (*Paspalum vaginatum*) and a granulated supplement. The results show a non-significant difference between enclosure for temperature, pH of the soil and water, favoring a survival rate of 94.28%. In monosex rearing, the lot of males presented an average daily gain (ADG) higher than that of females: 0.13 ± 0.08 g vs. 0.09 ± 0.04 g ($p < 0.05$). In mixed farming, average daily gain (ADG) of males is significantly lower than that of females: 0.10 ± 0.05 g vs. 0.12 ± 0.08 g ($p < 0.05$). Furthermore, the males in monosex farming presented an average daily gain above ($p < 0.05$) that of males in mixed farming. There is no significant difference between males in mixed farming and females in monosex culture ($p < 0.05$). The carapace of males is wider than that of females: 5.2 ± 0.39 cm vs. 5.1 ± 0.34 cm during the test ($p < 0.05$). This species has good growth performance and can be recommended for the Benin aquaculture.

Keywords: Benin; *Cardiosoma armatum*; Crab; Growth; Weight

Introduction

The runaway human population forecasts that the future of the human diet is also in the domestication and enhancement of other animal aquatic resources [1]. Moreover, the global distribution of aquaculture production between regions and countries at different levels of economic development remains unbalanced and could worsen the problem of food availability in Africa. This is why some authors believe that the demand for animal products is expected to increase in West Africa [2] to bridge the gap. In Benin, the contribution of the fisheries sector to GDP remains marginal 0.1%. The statistics of the last ten years show a drastic decline in fish catches and Benin imports averaged nearly 45,000 tons of marine fish annually [3]. With a potential of 130,000 ha watershed, containing a series of lagoons, lakes, rivers, marshes and swamps [4], and with a view to reducing poverty, a new direction is given to Aquaculture in Benin, to inventory new species of crustaceans candidates for aquaculture, including crabs [3]. The current study was initiated in the framework of a set of activities on crustaceans, to evaluate both the ability to domestication and the growth performance of *Cardiosoma armatum* (land crab) bred in captivity, in order to deliver some references on animal husbandry of this species.

Materials and Methods

Environment of studies, experimental system and animals breeding

The experiment was conducted in the experimental farm of the Faculty of Agricultural Sciences at the University of Abomey-Calavi, located between 6° 20' and 6° 43' North latitude and 2° 12' and 2° 30' East longitude. The climate on the site is equatorial with an alternation of two rainy seasons and two dry seasons. The average rainfall is 1200 mm per year, the average daily temperature of 25°C to 29°C and a relative dampness between 69% and 97% [5].

The experimental device consists of seven pens (E1-E7) installed in a makeshift building fitted out for the occasion. The E1 to E4 are identical in dimensions: L=1.73 m, l=0.93 m and h=0.65 m. E5 to E7 measure respectively: L=2.37 m and 1.48 m; l=1.25 m and 0.65 m; h=0.65 m and 0.40 m. Each mesh cover fitted enclosure is subdivided

into three compartments each with 4 holes drilled for the passage of water. The central compartment contains black clay soil, while the other two, smaller located on either side of the first is of water tanks (Figure 1). Crabs are divided into 7 lots: L1 (10♀); L2 (10♀); L3 (10♂); L4 (10♂); L5 (10♂ and 10♀); L6 (5♂ and 5♀) and L7 (5♀), the latter being intended for batch female reproductive grained monitoring the acquisition. All crabs were identified by some white paint mark and followed for 6 weeks.

A band of 75 crabs (35♂ and 40♀) purchased from a Conservative-collector was followed for 42 days. To restore the natural habitat for crabs, forage is transplanted in each pen (*Paspalum vaginatum*) as a food, with added banana leaves (*Musa sp.*), palm nuts (*Elaeis guineensis*) and a pelleted feed (Table 1).

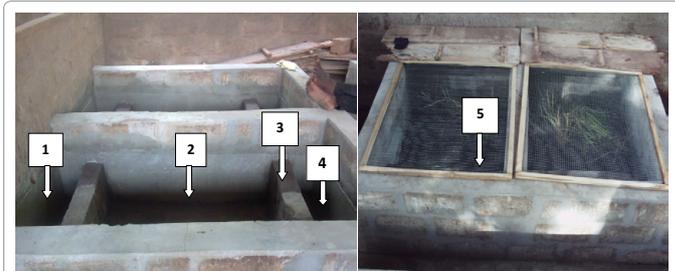


Figure 1: Crabs fattening enclosure.

(1; 4) Water containers; (2) Substrate compartment (black clay soil); (3): Bulkhead (breakthrough of 04 holes); (5) Roasting lid.

***Corresponding author:** Gbangboché AB, Laboratory of Animal Improvement and Biotechnology, Institute of Applied Biomedical Sciences, Faculty of Agricultural Sciences, University of Abomey-Calavi, Benin, Tel: (00229) 96 11 47 27; E-mail: gbangboche_ab@gmail.com

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Ingredients	Incorporation rate (%)
Cornmeal	43.15
Fishmeal	21.57
Wheatflour	10.29
Oyster shell	21.57
Concentrate (CMV)	2.92

Table 1: Incorporation rate of ingredients in granulated supplement.

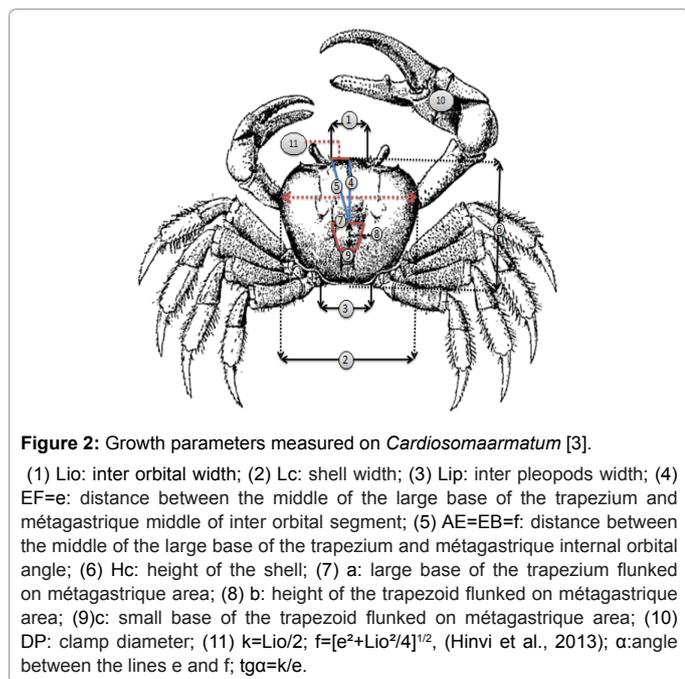


Figure 2: Growth parameters measured on *Cardiosoma armatum* [3].

(1) Lio: inter orbital width; (2) Lc: shell width; (3) Lip: inter pleopods width; (4) EF=e: distance between the middle of the large base of the trapezium and métagastrique middle of inter orbital segment; (5) AE=EB=f: distance between the middle of the large base of the trapezium and métagastrique internal orbital angle; (6) Hc: height of the shell; (7) a: large base of the trapezium flunked on métagastrique area; (8) b: height of the trapezoid flunked on métagastrique area; (9) c: small base of the trapezoid flunked on métagastrique area; (10) DP: clamp diameter; (11) $k=Lio/2$; $f=[e^2+Lio^2/4]^{1/2}$, (Hinvi et al., 2013); α : angle between the lines e and f; $tg\alpha=k/e$.

Data collection

The measurements were performed at intervals of 14 days from the date of acquisition, i.e., 4 sessions ($42/14+1=4$). The collected data contain abiotic parameters (temperature and humidity in enclosures, pH and salinity of the water basins, soil pH), and morphometric parameters (inter orbital width, carapace width, height shell diameter and clamps (Figure 2). The tools used are the electronic scale (range, 500 g), the caliper (accuracy 0.05 mm), the thermo-hygrometer, the salt meter and pH meter ground. In total 1960 (i.e., $70 \times 7 \times 4$) morphometric parameters data are collected and 6 lots 1480 (i.e., $74 \times 5 \times 4$) data collected on abiotic parameters. The survival rate was calculated by the ratio (number of living/total workforce) \times 100. The average daily gain (ADG) expressed in g was calculated and corresponds to weight gain/number of days. The gonadosomatic index (GSI) was calculated for berried females; It corresponds to: $GSI = \text{Total weight} \times 100 \text{ eggs} / \text{female grainy mass}$.

Statistical analysis

The procedure of the generalized linear model (Proc GLM) of SAS was first applied to morphometric parameters for the analysis of variance. The mean values were compared by t-test. The fixed effect considered is the frequency of measurement, lot, sex. The model is as follows:

$$Y_{ijkl} = \mu + T_i + S_j + V_k + e_{ijkl}$$

With Y_{ijkl} : average daily gain, inter orbital width of carapace, inter pleopods width, shell height, left clamp diameter, the diameter of the

right claw crab, the subdivided, frequency of measurement and j sex k

μ : The value of the overall average;

T_i : Fixed effect of lot (1, 2, 3, 4, 5, 6);

S_j : Fixed effect of the frequency of measurements (1, 2, 3 and 4)

V_k : Fixed effect of sex (male and female)

e_{ijkl} : Random residual effect.

The average abiotic parameters (temperature, air dampness, moisture in the enclosure, the pH of the soil and water, the salinity of the pond water) was calculated (*mean proc*) and compared by the t test.

Results and Discussion

Abiotic parameters and survival of crabs

The average values recorded in pens (Tables 2 and 3) were: $31.11 \pm 0.28^\circ\text{C}$ (temperature), $77.57 \pm 0.59\%$ (air humidity), 6.55 ± 0.13 (soil pH), 6.61 ± 0.11 (pH of water basins), 0% (salinity). These parameters remained constant and did not change significantly in a pen to each other outside the moisture which remained homogeneous in the L5 and L7, and significantly higher than the other ($p < 0.05$). The average temperature recorded during the test period is in the range [$25, 2^\circ\text{C}$ and 33.1°C] reported by [6,7] to the surface of the water in the lake Nokoué.

Morphometric parameters

The evolution of the morphometric parameters is reported in Table 3, by sex, by lot and frequency measurement.

The effect on the frequency of measurements did not significantly influence these parameters, the result of the absence of molt. Molting is an essential and decisive phase in the growth in weight and especially crab size. According to Chartois et al. [8] and Miserey [9], the increase in size is achieved by successive molts during which the animal rejects its shell and all internal parts calcified.

The effect of gender reveals a significant difference ($p < 0.05$) for the width of the shell and the diameter of the left clamp, showing the superiority of the male to the female. Compared to the ADG, males batch L1 and L2, showed values identical to those of the females of the lot L5 and L6, and higher ($p < 0.05$) than males of the same batch. Addo et al. [10] reported values of 0.28 ± 0.03 (males bred in monosex), 0.18 ± 0.04 (females bred in monosex) and 0.15 ± 0.01 g (both sexes combined) largely higher than those in this study (Table 3). These differences could be attributed to farm equipment, used food, food distribution methods, and environmental conditions.

Reproduction, survival of adults and larvae

The 5♀ lot L7 is all grainy for purchase by the presence of eggs in the space between the chest and abdomen by Cuesta and Anger [11]. The appearance of the eggs would be preceded by molting, before setting experimentation. The body mass of these pregnant females (MCP g) varied between 135 and 165 for an average of $151.0 \text{ g} \pm 12.64 \text{ g}$. The release of the eggs takes place between 2-3 weeks after the experiment formatting. The empty weight (MV, g) after release of eggs varies between 113.2 and 136.0, which corresponds to an average $125.8 \text{ g} \pm 9.70 \text{ g}$ (MV). The gonadal somatic indices (GSI), varied between 15.57 and 17.57 with an average (%) of 16.58 ± 0.90 . The population of the larvae (about 250) obtained decreased to total extinction in a 96 hour interval. The salinity of the water in the tank to 0% could probably be one of the causes. Indeed Cuesta and Anger [11] on the study of

LOTS	Parameters				
	pH soil	pH water	Salinity (‰)	Dampness (%)	Temperature(°C)
Lot1 (n=10♀)	6.51 ± 0.09	6.68 ± 0.08	0	75.1 ± 0.32	31.49 ± 0.03
Lot2 (n=10♀)	6.4 ± 0.13	6.58 ± 0.12	0	76.8 ± 0.63	31.31 ± 0.07
Lot3 (n=10♂)	6.54 ± 0.11	6.53 ± 0.17	0	77.9 ± 0.32	31.02 ± 0.06
Lot4 (n=10♂)	6.61 ± 0.12	6.58 ± 0.09	0	76.9 ± 0.32	31.29 ± 0.06
Lot5 (n=10♂ et 10♀)	6.6 ± 0.09	6.62 ± 0.06	0	78.9 ± 0.32	30.82 ± 0.06
Lot6 (n=5♂ et 5♀)	6.64 ± 0.05	6.66 ± 0.07	0	79.8 ± 0.42	30.72 ± 0.04
Lot7 (n=5♀)	6.55 ± 0.32	6.62 ± 0.18	0	77.59 ± 1.8	31.12 ± 1.64
Means ± standard deviation	6.55 ± 0.13	6.61 ± 0.11	0	77.57 ± 0.59	31.11 ± 0.28

Table 2: Abiotic parameters.

LOTS	Parameters													
	Morphometric								Reproduction and survival					
	Lio (cm)	Lc (cm)	Lip (cm)	Hc (cm)	DPG (cm)	DPD (cm)	Poids (g)	ADG (g)	MCP (g)	MCV (g)	IGS (%)	Larvae survival (%)	Adults survival (%)	
Lot1 (n=10♀)	1.23 ± 0.09	4.81 ± 0.21	1.64 ± 0.05	3.93 ± 0.18	1.31 ± 0.40	1.24 ± 0.43	59.85 ± 1.73	0.09 ± 0.04 ^b	-	-	-	0	90	
Lot2 (n=10♀)	1.27 ± 0.05	5.16 ± 0.29	1.73 ± 0.13	4.24 ± 0.26	1.44 ± 0.46	1.54 ± 0.47	72.18 ± 1.66		-	-	-	0	90	
Lot3 (n=10♂)	1.37 ± 0.21	5.02 ± 0.44	1.71 ± 0.14	4.13 ± 0.32	1.82 ± 0.57	1.38 ± 0.49	72.09 ± 1.41	0.13 ± 0.08 ^a	-	-	-	0	100	
Lot4 (n=10♂)	1.28 ± 0.23	5.18 ± 0.42	1.67 ± 0.15	4.2 ± 0.44	1.75 ± 0.57	1.42 ± 0.40	75.64 ± 3.47		-	-	-	0	100	
Lot5 (n=10♂ et 10♀)	1.26 ± 0.18	5.22 ± 0.40	1.75 ± 0.15	4.27 ± 0.33	1.42 ± 0.56	1.56 ± 0.59	76.62 ± 2.58	♂0.10 ± 0.05 ^b ♀0.12 ± 0.08 ^a	-	-	-	0	100	
Lot6 (n=5♂ et 5♀)	1.23 ± 0.08	5.13 ± 0.26	1.70 ± 0.09	4.22 ± 0.23	1.66 ± 0.61	1.52 ± 0.51	74.05 ± 1.34		-	-	-	0	90	
Lot7 (n=5♀)	-	-	-	-	-	-	-	-	151.0 ± 12.64	125.8 ± 9.70	16.58 ± 0.90	0	90	
Means ± standard deviation	1.3 ± 0.16	♂5.2 ± 0.39 ^a ♀5.1 ± 0.34 ^b	1.7 ± 0.13	4.2 ± 0.32	♂1.7 ± 0.55 ^a ♀1.4 ± 0.43 ^b	1.5 ± 0.50	71.74 ± 2.03	0.11 ± 0.05	151.0 ± 12.64	125.8 ± 9.70	16.58 ± 0.90	0	94.28	

Cm: Centimeter; Lio: Inter Orbital Width; Lc: Shell Width; Lip: Inter Pleopods Width; Hc: Height of the Shell; DPG: Left Clamp Diameter; DPD: Right Clamp Diameter. ADG: Average Daily Gain. Values of the same parameter having different letters (a; b) are different at a threshold of 5%.

Table 3: Morphometric, reproduction and survival parameters of crabs.

larval survival of *Cardiosoma armatum*, revealed that 15‰ salinity tends to cause high mortality and a significant delay in growth in most of the stadiums while Salinity 25‰ promotes maximize survival. Besides the health status of animals from being unknown, breeding conditions could also contribute to the loss of larvae. Crab survival rate obtained at the end of the test is 94.28%. This therefore indicates that the temperature conditions in addition to food, hygiene and health in the period were favorable to their survival. Furthermore, the presence of black clay soil and availability of water in the net pens allowed crabs to express their natural behavior of digging burrows and burying the hot hours of the day. These observations are consistent with those of Hill [12] that the survival and growth of land crabs are dependent on the substrate and water dandruff. Their burrows protect against environmental stresses (extreme freshness, high temperatures).

Conclusion

The results of different tests show that livestock *Cardiosoma armatum* can be done in enclosures intertropical environment. The growth of individuals during the experiment is much more weight, as the duration of the experiment is relatively short. The rearing system (monosex, mixed) and sex are factors influencing the growth of crabs. Indeed, in farming monosex male individuals showed an average daily gain (ADG) higher than females while the opposite occurs in mixed farming. Furthermore, the males showed significantly greater carapace width than females. Better growth performance could be achieved by extending the feeding time of the crabs through the creation of dark

conditions in the pens for their protection from the light of day. In addition, a longer term experiment could also be used to study changes in morphometric parameters crabs and reproduction in the species. Furthermore, an increase in salinity of the pond water containing larvae obtained during the experiment could help maintain larvae alive.

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