Journal of Applied Biosciences 96:9102 – 9108

ISSN 1997–5902

Breeding of the land crab *Cardiosoma armatum* (Herklots 1851) in enclosure in Benin.

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Original submitted in on 30th September 2015. Published online at www.m.elewa.org on 31st December 2015 http://dx.doi.org/10.4314/jab.v96i1.7

ABSTRACT

Objective: Tests of breeding of 70 juveniles (35♂ and 35♀) and 5 berried females of *Cardiosoma armatum* (Herklots 1851) were carried out in captivity for 42 days. The aim of the present experiment was to investigate the growth performance of the land crab, the ability to domesticate (water and soil quality) traits.

Methodology and results: The experimental rearing system consisted of a series of seven rectangular pens installed in a temporary building. All experimental pens were supplied with mud and drinking tap water. The experimental pens represented three sexual treatments (two replicates each) including the control of growth in bearing on sex. The crabs were fed on palm nuts (*Elaeis guineensis*), banana leaves (*Musa sp*), Seashore paspalum (*Paspalum vaginatum*) and a pelleted feed. The results show a non-significant difference between enclosure for temperature, pH of the soil and water. The average values recorded in pens were: 31.11 ± 0.28 ° C (temperature), 77.57 ± 0.59% (air humidity), 6.55 ± 0.13 (soil pH), 6.61 ± 0.11 (pH of water basins), 0‰ (Salinity), favouring a survival rate of 94.28%. In monosex rearing, the group 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 ($p < 0.05$).

Conclusion and application of results: This species has good growth performance and can be recommended for the Benin aquaculture. These results showed the optimal conditions required for breeding of *Cardiosoma armatum* in pens.

Keywords: growth, *Cardiosoma armatum*, Benin

INTRODUCTION

The forecast of the human diet is also in the domestication and enhancement of other animal aquatic resources (Fiogbé, 2002). 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 authors believe that the demand for animal products is expected to increase in West Africa (Delgado *et al*. 2001). In Benin, the contribution of the fisheries sector to GDP remains marginal 0.1% (INSAE, 2008) .The statistics of the last ten years shows a drastic decline in fish catches and Benin imports averaged nearly 45,000 tons of marine fish annually (Hinvi *et al*. 2013). There is a potential of 130,000 ha watershed, containing a series of lagoons, lakes, rivers, marshes and swamps (FAO 2008). 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 (Hinvi *et al*. 2013). The current study was initiated in this framework of crustaceans, to evaluate the ability to domesticate and the growth performance of the land crab *Cardiosoma armatum* bred in captivity, in order to come up with some references on animal husbandry of this species. The crabs of the genus Cardiosoma are distributed within several kilometres away from the coast (Gilchrist, 1998). They were defined by Burggren and McMahon (1988) as crabs that show significant behavioural, morphological, physiological and / or biochemical adaptations permitting extended activities out of water. *Cardiosoma* are omnivorous crabs. They could feed on leaves, fruits and grasses collected near the vicinity of their burrows. These crabs will also feed on insects, worms and are sometimes cannibalistic. However, preferred food items of *Cardiosoma* are leaves of red and white mangroves, which were the dominant vegetation around its usual habitat (Hill, 2001).

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% (Sinsin *et al.* 2004).

The experimental layout comprised of seven pens (E1-E7) installed in a temporary building. The E1 to E4 were the same in dimensions: L = 1.73 m, l = 0.93 m and h = 0.65 m. E5 to E7 measured 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 (Fig. 1).

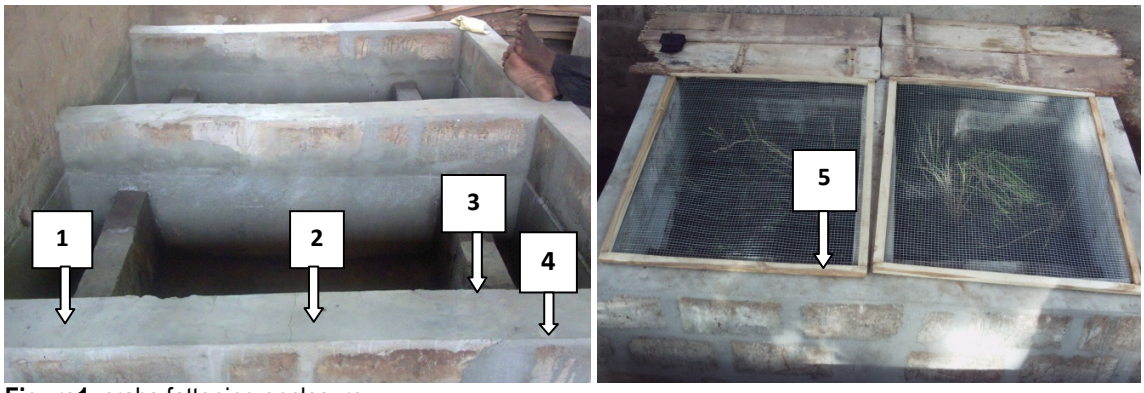

Figure1: crabs fattening enclosure

Legend: (1; 4) water containers; (2) substrate compartment (black clay soil); (3): bulkhead (breakthrough of 04 holes); (5) roasting lid

Crabs were divided into 7 groups: L1 (10♀); L2 (10♀); L3 (10♂); L4 (10♂); L5 (10♂ and 10♀); L6 (5♂ and 5♀) and L7 (5♀). The females of L7 were grained and used in reproduction study. 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 (Tab. 1).

Table 1: Incorporation rate of ingredients in granulated supplement

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

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 contained 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).

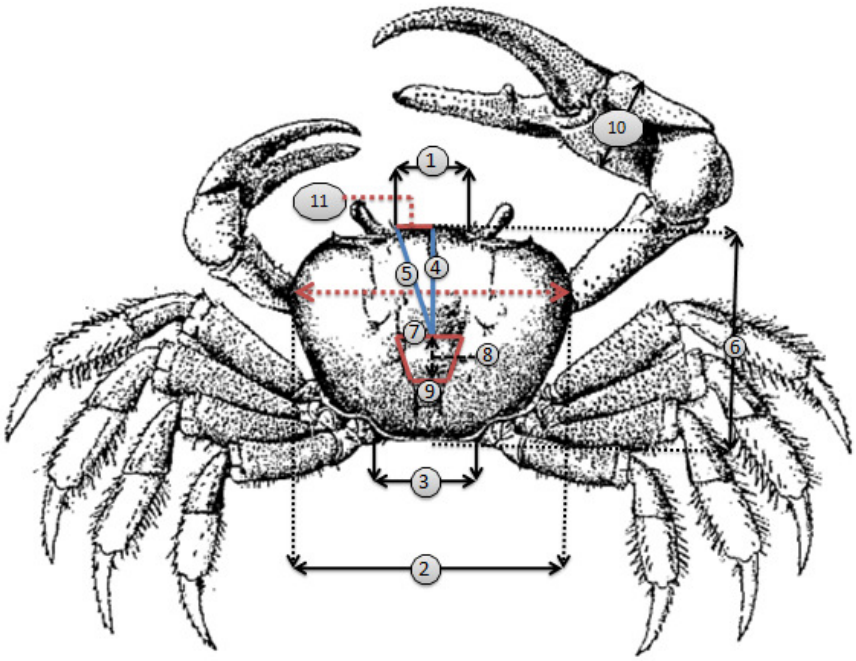

Figure 2: Growth parameters measured on *Cardiosoma armatum*
Source: Capart, 1951; Hinvi *et al.*, 2013
Legend : (1) Lio : inter orbital width; (2) Lc : shell width; (3) Lip : inter pleopods width ; (4) EF=e : distance between the middle of the large base of the trapezium and métagastrique middle of 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 ; tgα = k/e

The tools used are the electronic scale (range, 500 g), the calliper (accuracy 0.05 mm), the thermo-hygrometer, the salt meter and the ground pH meter. In total 1960 (i.e. 70x7x4) morphometric parameters were collected and 6 groups 1480 (i.e. 74x5x4) data collected on abiotic parameters.

The survival rate was calculated by the ratio (number of living / total workforce) x 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

SI = Total weight x 100 eggs / female grainy mass.

Statistical analysis: The procedure of the generalized linear model (Proc GLM) of SAS (System Statistical Analysis, 9.2, 2008) 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, group, sex. The model is as follows:

Yijkl = μ + Ti + Sj + V k + eijkl

With

Yijkl: 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;

Ti: fixed effect of groups (1, 2, 3, 4, 5, 6);

SJ: fixed effect of the frequency of measurements (1, 2, 3 and 4).

VK: fixed effect of sex (male and female)

eijkl: 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 test t.

RESULTS AND DISCUSSION

Abiotic parameters and survival of crabs: The average values recorded in pens (Tab. 2 and 3) were: 31.11 ± 0.28 ° C (temperature), 77.57 ± 0.59% (dampness), 6.55 ± 0.13 (soil pH), 6.61 ± 0.11 (pH of water basins), 0‰ (salinity). There is no significant difference ($p < 0.05$) for these parameters (apart from dampness) between enclosures. The dampness is homogenous in the L5 and L7 but there is a significant difference ($p < 0.05$) between another's (L1, L2, L3, L4, L6). The average temperature recorded during the test period was in the range [25.2 ° C and 33.1 ° C] reported by (Adounvo *et al*. 2003; Lalèyè *et al*. 2003a) at the surface of the water in the lake Nokoué.

Table 2: Abiotic parameters of soil and water in crab's enclosures

GROUPS	PARAMETERS				
	pH soil	pH water	Salinity (0/00)	Dampness (%)	Temperature(°C)
Group1 (n=10♀)	6.51±0.09	6.68±0.08	0	75.1±0.32	31.49±0.03
Group2 (n=10♀)	6.4±0.13	6.58±0.12	0	76.8±0.63	31.31±0.07
Group3 (n=10♂)	6.54±0.11	6.53±0.17	0	77.9±0.32	31.02±0.06
Group4 (n=10♂)	6.61±0.12	6.58±0,09	0	76.9±0.32	31.29±0.06
Group5 (n= 10♂ and10♀)	6.6±0.09	6.62±0.06	0	78.9±0.32	30.82±0.06
Group6 (n= 5♂ and 5♀)	6.64±0.05	6.66±0,07	0	79.8±0.42	30.72±0.04
Group7 (n=5♀)	6.55±0.32	6.62±0.18	0	77.59±1.8	31.12±1.64
Mean ± S.E	6.55±0.13	6.61±0.11	0	77.57±0.59	31.11±0.28

Table 3: Morphometric, reproduction and survival parameters of crabs

GROUPS	**PARAMETERS**												
	Morphometric								**Reproduction and survival**				
	Lio (cm)	Lc (cm)	Lip (cm)	Hc (cm)	DPG (cm)	DPD (cm)	Weight(g)	ADG (g)	MCP (g)	MCV (g)	IGS (%)	Larvae survival (%)	Adults' survival (%)
Group1 (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
Group2 (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
Group3 (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
Group4 (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
Group5 (n= 10♂ and 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
Group6 (n= 5♂ and 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
Group7 (n=5♀)	-	-	-	-	-	-	-	-	151.0±12.64	125.8±9.70	16.58 ±0.90	0	90
Mean±S.E	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 : centimetre ; 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%.

Morphometric parameters: The evolution of the morphometric parameters is reported in Table 3, by sex, by group and frequency measurement. The effect on the frequency of measurements did not significantly influence ($p < 0.05$) these parameters, the result of the absence of molt. Molting is an essential and is a decisive phase in the growth, in weight and especially in crab size. According to Chartois *et al*. (1994) and Miserey (2005), the increase in size is achieved by successive molts during which the animal rejects its shell and all calcified internal parts. 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 group L5 and L6, and higher ($p < 0.05$) than males of the same batch. Addo *et al*. (2006) 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 (Tab. 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♀ group L7 is all grainy for purchase due to the presence of eggs in the space between the chest and abdomen by Cuesta and Anger (2005). 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 g ± 12.64 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 g ± 9.70 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 value (0%0) of the water in the tank could probably induce the all larvae death. Indeed Cuesta and Anger (2005) on the study of larval survival of *Cardiosoma armatum* revealed that 15%o salinity tends to cause high mortality and a significant delay in growth, while Salinity of 25%o 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 favourable to their survival. Furthermore, the presence of black clay soil and availability of water in the net pens allowed crabs to express their natural behaviour of digging burrows and burying the hot hours of the day. These observations are consistent with those of Hill (2001) that the survival and growth of land crabs are dependent on the substrate and water. Their burrows protect against environmental stresses.

CONCLUSION

The results of different tests show that intensive production of *Cardiosoma armatum* can be done in enclosures in an intertropical environment. 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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