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Effect of salinity on survival and growth of blue crab, *Callinectes amnicola* from Lagos Lagoon, Nigeria

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Abstract: *The effect of salinity on the survival and growth of Callinectes amnicola (De Rocheburne) from the Lagos Lagoon, Nigeria was monitored in the laboratory for 22 weeks. The crabs were euryhaline and tolerated a salinity range of 5 to 25‰ and had 90% survival at 15 and 20‰. The highest gain in weight (173.0%) and carapace width (56.1%) was obtained at salinity of 15‰. The highest specific growth rate (1.98) was obtained at 15‰, while the lowest specific growth rate (-0.28) was recorded at 35‰. The condition factor of the crabs showed a fairly consistent pattern at the different salinity levels with values ranging from 5.7 to 7.3. Complete moulting was obtained at salinity of 15‰ in the 12th week of the experiment. The crab with carapace width of 6.8cm increased to 8.1cm (19.1%) after moulting.*

Key words: *Salinity tolerance, Survival, Growth, Callinectes amnicola, Lagos Lagoon*
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Introduction

The Lagos Lagoon with a surface area of nearly 207 km^2 is the largest lagoon in West Africa (FAO Report, 1969). The lagoon is habitat for a variety of fauna including plankton (Nwankwo and Akinsoji, 1992), nekton (Fagade and Olaniyan, 1973, 1974; Adetayo and Kusemiju, 1994) and benthos (Yoloye and Adegoke, 1977, Ajao and Fagade, 1990 and Ogunwenmo and Kusemiju, 2004) The blue crab, *Callinectes amnicola* (De Rocheburne) occurs commonly in the lagoons and coastal waters of West Africa and it is a popular food item with the riverine and coastal populace. Fagade and Olaniyan (1974) reported its occurrence in the Lagos Lagoon at salinity up to 24.7‰ while Kusemiju (1981) reported its occurrence in the adjacent Lekki Lagoon with salinity of less than 2‰.

The distribution and existence of crabs depends on specific environmental parameters such as salinity, pH, temperature and dissolved oxygen (Diaz and Conde, 1989; Lee and Winckin, 1995; Carmona-Suarez and Conde, 1996; Guillory *et al.*, 1996). While hatching and larval development occurs successfully under a relatively narrow range of salinity and water temperatures (Lee and Winckin, 1995), juvenile or adult crabs can tolerate a wide range of salinities and temperatures. Various studies have suggested salinity as an ecological indicator in the Lagos Lagoon (Olaniyan, 1969; Fagade and Olaniyan, 1974; Ogunwenmo and Kusemiju, 2004). Salinity ranged between 0.05 and 28.7‰ in the lagoon (Fagade and Olaniyan, 1974).

The water temperature on the other hand ranged between 27 and 30°C and there was only a slight variation of 1- 3°C between the dry and rainy season water temperatures (Ogunwenmo and Kusemiju, 2004).

In the Lagos Lagoon, the constant harvest pressure on *C. amnicola* and the loss of submerged aquatic vegetation habitat which young crabs require for shelter and food during their development had led to decline in the crab fishery (Solarin and Kusemiju, 2003). Efforts may now be geared towards the aquacultural potentials for blue crab production in the lagoon.

This paper evaluates the salinity tolerance and effects of salinity on the growth of *C. amnicola* from the Lagos Lagoon, a tropical estuarine system. Results obtained will help determine the best salinity for the culture and which parts of the lagoon will give suitable environmental conditions.

Materials and Methods

A total of 80 live crabs were used for the experiment. Ten specimens of live crabs collected from the Lagos Lagoon were placed in each of the eight 30 litres bowls having different salinity regimes. The crabs ranged in size from 6.7 to 8.2 cm carapace width and had weight of 11.5 to 23.4 g. The crabs were acclimatized in lagoon water for 72 hr. Holding bowls used were made of coloured plastic to reduce the effect of direct sunlight. Each bowl contained ten litres of water of varying salinity.

Freshwater was obtained from a borehole. The various salinity levels were obtained by dilution of brackish water collected from the Lagos Lagoon and adjacent marine environment. The salinity of the various bowls was determined using a refractometer (BIOMARINE Aqua Fauna Model) after serial dilution of water to 5, 10, 15, 20, 25, 30 and 35‰. Water

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temperature, dissolved oxygen and pH were monitored in each of the experimental bowls using Rosemount Analytical Solu Bridge Model RB6-349A-KFX37. Continuous aeration was provided in each bowl by an air pump through rubber tubing fitted with air stones.

The crabs were fed with white meat of chicken parts at 5% of their body weight. The mortality of crabs in each bowl was recorded. Change of water in each bowl was carried out every 48 hr or when necessary. The weight gained was monitored fortnightly. The experiment lasted 22 weeks and was replicated.

$$^{1}SGR = \frac{\text{Loge final body weight} - \text{Loge carapace width}}{\text{Time in days}} \times 100$$

$$^{2}K = \frac{\text{Total body wt. (g)}}{\text{Carapace width}^3} \times 100$$

Results and Discussion

The records of the survival and growth performance of the blue crabs at different salinity levels over the 22 week test period are presented in Table 1.

Survival: The crabs tolerated a salinity range of 5 to 25‰. The tolerance rate of the crabs was monitored after abrupt transfer to varied salinities from acclimatization tanks. The percentage survival curve was recorded at 15 and 20‰ salinities and 50% survival at 5 and 25‰. 25% survival rate was observed at 0‰, while 10% survival rate was recorded when salinity was 30‰ and 5% survival rate occurred in 35‰ salinity. The medium was hypertonic to the crab. However, 75% survival rate was recorded when salinity was 10‰. The percentage of survival decreased gradually at 35‰, and from Week 2, no specimens survived. At 0‰, none of the crabs survived by Week 10. At 10‰, survival rate dropped to 95% between Weeks 1 and 2, however, between Weeks 3 and 10 there was 90% survival. At 5, 20 and 30‰ salinities survival rate were 40, 50 and 15% respectively from Weeks 7 to 10.

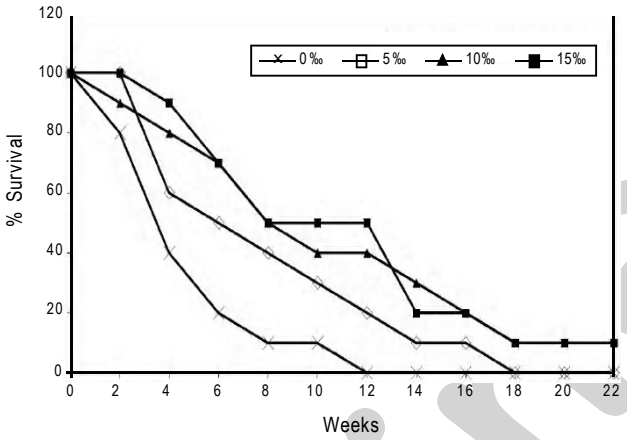

Fig. 1a: Survival curves of *C. amnicola* in varied salinity concentrations (0 - 15‰) in 22 weeks

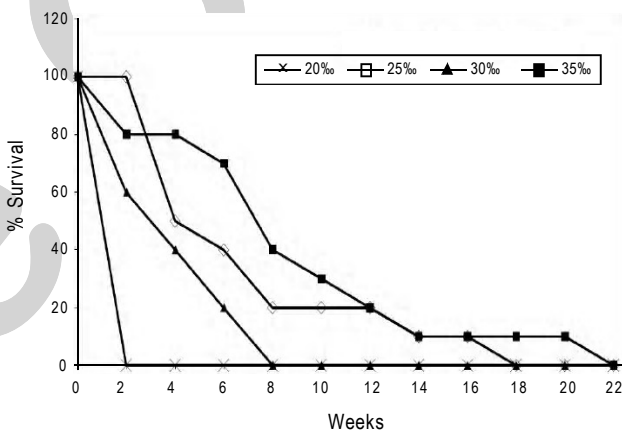

Fig. 1b: Survival curves of *C. amnicola* in varied salinity concentrations (20-35‰) in 22 weeks

Table - 1: Mean growth performance of *C. amnicola* at different salinity levels in 22 weeks

Parameters	Salinity ($^{o}/_{oo}$) concentration							
	0	5	10	15	20	25	30	35
Initial body weight (g) (28.9-48.2)	31.3	28.9	29.6	48.2	41.1	42.1	39.7	40.8
Final body weight (g) (35.4-132.4)	37.2	55.2	55.7	132.4	95.3	89.5	46.3	35.4
Weight gain per crab (g)	5.9	26.3	46.1	83.9	54.2	47.4	6.6	-5.4
Weight gain (%)	18.8	91.0	116.4	173.0	131.9	112.6	16.6	-13.2
Initial carapace width (cm) (6.7-8.2)	6.9	6.7	7.5	8.2	8.0	8.1	7.2	7.6
Final carapace width (cm) (7.5-12.8)	8.4	9.2	10.7	12.8	11.9	11.0	8.6	7.5
Gain in width (cm)	1.5	2.5	3.2	4.6	3.9	2.9	1.4	-0.1
Width gain (%)	21.7	37.3	42.7	56.1	48.8	35.8	19.4	-1.3
Specific Growth Rate (%/day)[1]	0.34	1.28	1.52	1.98	1.66	1.49	0.30	-0.28
Condition factor (K)[2]	6.3	7.1	7.0	6.3	5.7	6.7	7.3	-

Table - 2: ANOVA table comparing specific growth rate in weight of *C. amnicola* at different salinity levels

Source of variation	df	SS	MS	F_{cal}
Between groups	1	1084.10	1084.10	14.39
Within groups	14	1054.54	75.32	
Total	15	2138.64		

F_{tab}, $F^{05,1,14} = 4.60$

The high rate of survival of C. *amnicola* at various salinity levels showed a wide range of salinity tolerance by the species. This confirmed previous reports that blue crabs are euryhaline and have a wide tolerance of salinity variation and can utilize all salinity regimes of an estuary with various life cycle stages occupying specific regimes (Rogers *et al.,* 1990; Wilber, 1994; Lee and Winckin, 1995; Guillory *et al.,* 1996; Epifanio and Garvine, 2000; Angaman *et al.,* 2004).

Despite the high salinity tolerance, however, the highest survival, highest growth, highest condition factor and complete moulting for *C. amnicola* were obtained at 15‰ salinity level. This meant that this species was most tolerant of the medium brackish water condition in the Lagos Lagoon and could be subjected to culture in the lagoon.

The Lagos Lagoon, a tropical estuary has salinity gradients ranging from less than 1.0 to 24.9‰ (Fagade and Olaniyan, 1974; Ezenwa and Kusemiju, 1981). Salinity is the most variable ecological factor in the lagoon with daily and seasonal variations. It would appear that crabs are able to utilize the varying salinities in the lagoon for the development of various stages of their life history from larval development to adults. Apart from osmoregulation, different stages of the life cycle of the blue crab would definitely move to more suitable areas of the lagoon taking full advantage of the salinity gradients.

Growth: The percentage gain or loss in body weight and carapace width of *C. amnicola* in different salinity regimes are presented in Table 1. There were varying increases in mean body weight of the crabs between 0 and 30‰ salinities. The highest gain in weight of 173.0% was obtained at the 15‰ salinity. A weight loss of 13.2% was recorded at 35‰. However, progressive gains of between 16.6 and 131.9% body weights were recorded at other salinity levels. The initial mean carapace width of the crab ranged from 6.7 to 8.2 cm. The highest gain of 56.1% carapace width was recorded at 15‰. There was a 1.3% loss in carapace width of the crab at 35‰.

Specific growth rate (% / day) of *C. amnicola* was also examined (Table 1). The highest specific growth rate (1.98) was obtained at a salinity of 15‰ while the lowest specific growth rate (-0.28) was obtained at 35‰. Very low specific growth rates were also obtained at 0‰ (0.34) and 30‰ (0.30).

Analysis of variance was employed to evaluate differences in specific growth rate at the various salinity levels. The results presented in Table 2 showed that differences in the specific growth rates at different salinities were highly significant at $p < 0.05$.

The condition factor (Table 1) showed a fairly consistent pattern at the different salinity levels with values ranging from 5.7 to 7.3 (0-30‰). Crabs exposed to 35‰ however had condition factor of 8.4.

Moulting: Moulting of crab was observed during the salinity experiment. One female crab moulted completely (shed its old shell) in salinity concentration of 15‰ in the 12th week of the experiment. The crab with carapace width of 6.8 cm increased to 8.1 cm (19.1%) after moulting.

Physico-chemical parameters: During the course of this study, water temperature, dissolved oxygen content and pH values were uniform in all the experimental bowls. Water temperature varied from 25.9 to 28.6°C (mean 26.7°C), dissolved oxygen 4.4-6.8 mg l^{-1} (mean 5.3 mg l^{-1}) and pH 6.8-7.9. Temperature and other environmental factors were uniform in all the experimental bowls.

Generally, temperature gradient in the Lagos Lagoon is less variable with only a difference of 1-3°C between the dry and rainy seasons (Fagade and Olaniyan, 1974; Kusemiju, 1981).

C. amnicola from the Lagos Lagoon had the highest survival, best growth performance and complete moult at salinity of 15%. The crab can be subjected to culture in a large area of the lagoon where the 15% salinity regime predominates.

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