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The Fishery and Bionomics of the Swimming Crab, *Callinectes amnicola* (DeRocheburne, 1883) from a Tropical Lagoon and its Adjacent Creek, Southwest, Nigeria

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Abstract: The fishery and the bionomics of the swimming crab *Callinectes amnicola* from Lagos lagoon and its adjacent creek, south-west Nigeria was investigated from October 2003 to March 2004. The results indicate that the lift net was highly selective for the crab. The wire basket trap was more tedious to operate because of the fencing and gear fixing techniques that are needed for proper installation. The longevity of the wire trap was 3 to 3½ months. The Catch Per Unit Effort (CPUE) (number of crabs per traps) ranged between 2.5 and 15 crabs for lift nets; between 5.6 and 17 crabs for wire basket traps. *C. amnicola* were more abundant at depth 1.5 and 2.0 m in the lagoon. The maximum size of crab from the lagoon catch and creek was 16.6 cm with a weight of 348.5 g. The crab exhibited positive allometric growth. The condition factor was higher in males than females and increased in crab size. The fecundity ranged between 1,148 and 736,266 eggs, the average number of eggs per females was 141,290. Male: Female ratio was 1:0.39. A larger proportion of stomachs from the samples contained food (80.8%) with very few (19.2%) with empty stomach. The major food items were molluscs and crustaceans, apart from fishes and algal filaments which formed only between 0.4 and 4.0% of the food of *C. amnicola* from the lagoon and the creek. There was no variation in the feeding habits in relation to size.

Key words: Fishery, bionomics, basket trap, longevity, feeding habits, fecundity

INTRODUCTION

The swimming crab, *Callinectes amnicola* is an important food item in coastal waters of West Africa. It belongs to the phylum arthropoda, order decapoda and family portunidae. There are nine species of crabs found in the brackish water ecological zone of the Niger Delta in Nigeria (Abby-Kalio, 1982; Hart and Chindah, 1998). Three are edible namely, the land crabs-*Cardiosoma armatum*, the big fisted swimming crab, *Callinectes amnicola* and *Callinectes latimanus* (Abby-Kalio, 1982).

Before now, crab fishery was under exploited. In some parts of the country the harvesting is confined to teenagers and women but recently the crab fishery knows no sex. The crab fishery is done using basket trap, wire trap and majorly circular lift net locally known as Garawa. *Callinectes amnicola* is abundant all year round especially in shallow shaded sub-tidal waters where it is caught in large quantities (Chindah *et al*., 2000). It constitutes a major source of protein in the diet of the coastal states of Nigeria.

Despite its importance in the lagoon and as a source of protein, little is known on its fishery and biology in the south-western Nigeria. Previous reports on the species in the Nigerian waters were by Fagade (1969) on its occurrence, Abby-Kalio (1982) on its edibility, Mba (1980) on its chemical concentration, Lawal-Are and Kusemiju (2000) on its size composition, growth pattern and feeding habits and Lawal-Are (2003) on aspects of its biology from three lagoons in the South-western Nigeria. Solarin (1998) on the crab fishery in Lagos lagoon where it was reported the lift net was highly selective for the crab. Furthermore, baited gears performed better than unbaited ones. Additionally Solarin (1998) on the soak time of the lift net where it was said to influence the number of crabs. There is a dearth literature on the use of wire basket trap for crab fishing in Nigeria.

This research investigates the fishery of the portunid swimming crab, *Callinectes amnicola* and its bionomics in the natural environment in the Lagos lagoon and an adjacent creek, Nigeria.

MATERIALS AND METHODS

Description of Study Sites

The Lagos lagoon (Fig. 1) is part of a series of coastal lagoons found along the West African coast. It is situated in the rainforest belt of Nigeria which experiences a well marked alternation of wet

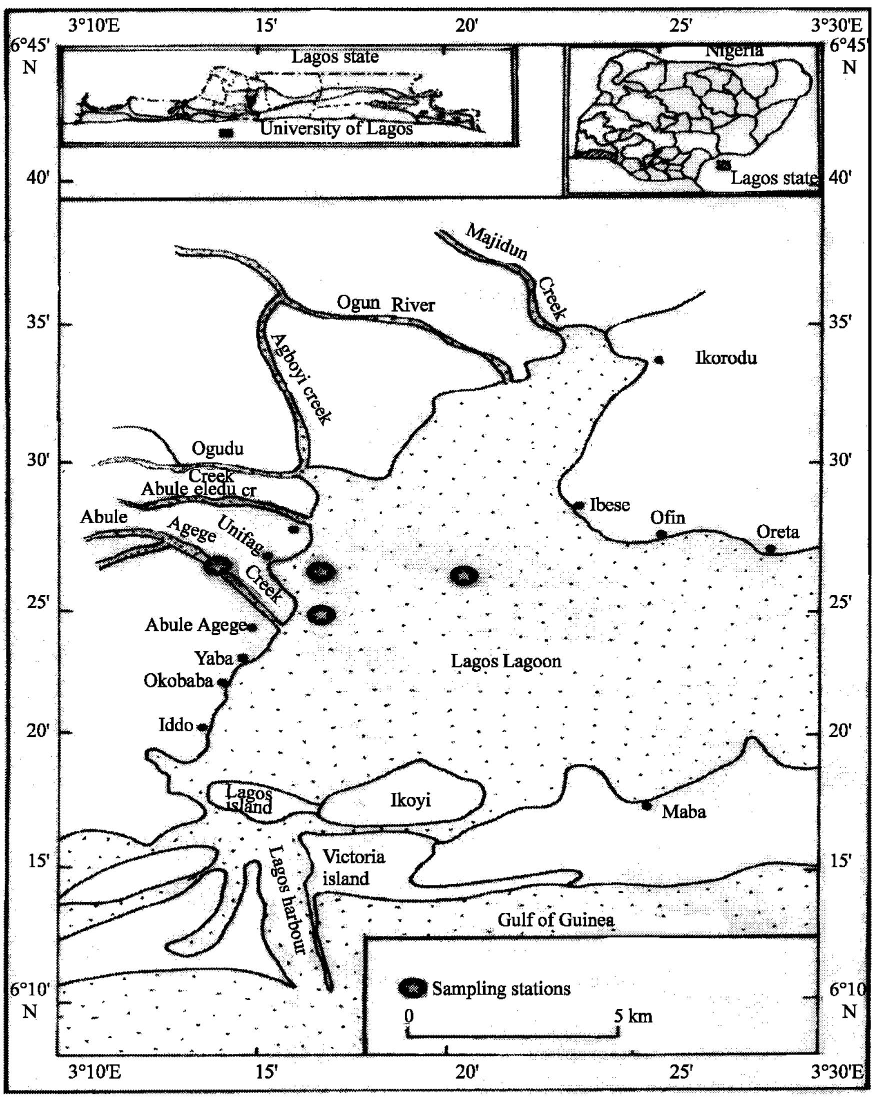

Fig. 1: Map of Lagos lagoon showing adjoining Abule agege creek

(May-October) and dry (November-April) seasons (Nwankwo, 1991). Two peaks of rainfall linked with excessive floods are generally associated with this area, a major peak in June and a lesser peak in September. The lagoon is brackish as a result of the influence of tidal sea water incursion and freshwater discharge from adjoining creeks and rivers. The major adjoining creek of importance in this study is the Abule-Agege creek (Fig. 1). Emmanuel (2004) had previously described the area of study that fall within the University of Lagos Campus. The riparian vegetation was characterized by *Paspalum vaginatum*, *Acrostichum aureum*, *Phoenix reclineta*, *Rhizophora racemosa*, *Avicenia nitida*, *Drapanocarpus lunatus* and *Cyperus articulatus*.

Field Procedures

The crabs were collected weekly using the circular lift net (Garawa) (Fig. 2) and wire basket trap from Lagos lagoon and one of its adjacent creeks, Abule-agege creek respectively between October 2003 and March 2004. It is a circular structure made of a thin metal sheet (bridles) 5.0 cm high and the diameter of the circle of the bridle is 45 cm. Strong nylon cords were woven in a net-like fashion from the centre to the edge. A twine about 1½ m long is attached to the centre and the other free end of the twine was tied to a floater which served as a markers on the water surface to show the position of the gear. The trap was baited at the centre with remains of the chicken. The trap was operated from a canoe usually manned by two persons, one rowing while the other throws the trap into the water. The crabs were not entrapped, most of them were feasting on the bait, remain on the trap until they were removed into the boat. On the operation of the wire basket trap, the fence was made from reeds, *Paspalum sp* and sticks in connection with the trap that was constructed with chicken wire gauze (31 mm mesh size).The trap had one non-return valve with 10 cm diameter opening. The length of the trap was 45 and 40 cm diameter. The wire was sowed together to form a dome shape (Fig. 3). The traps were placed in the hole created on the fence and were tightened by placing *Paspalum sp* and reeds on the sides to block any available holes. The catches were removed by loosing one of the sides rope half way.

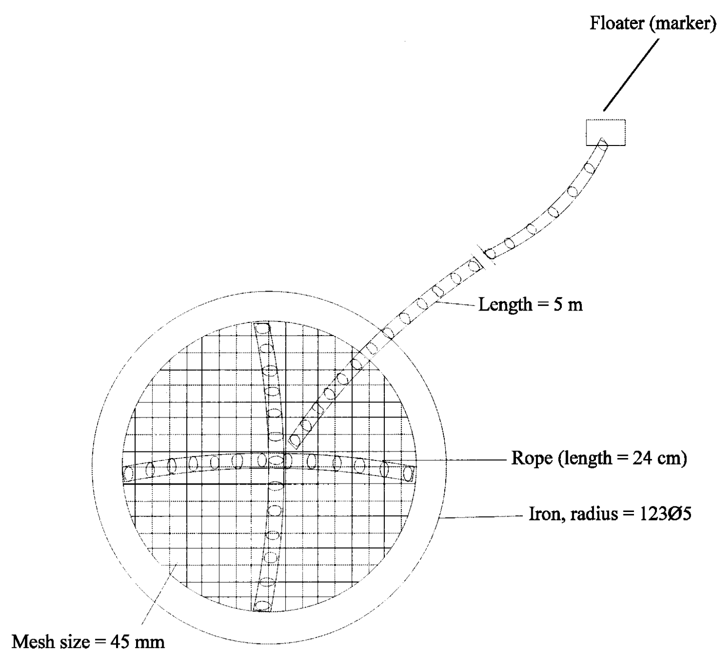

Fig. 2: Circular lift net (Garawa)

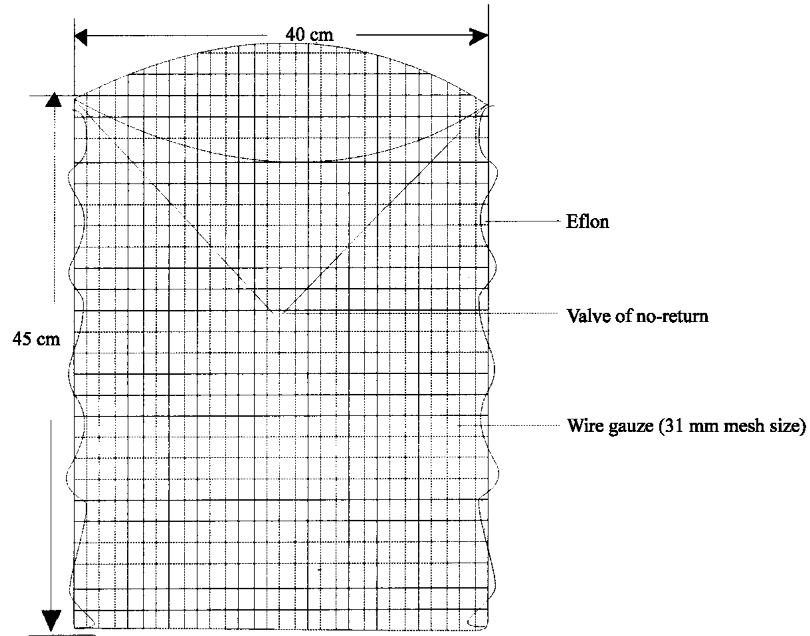

Fig. 3: The wire basket trap

The crab pots were set up at various bottom depths for the study of crab distribution in Lagos lagoon in October (1st trip) and March (2nd trip). The soak time of the trap was also examined. The catches of other fisher folks around the study areas were also examined to complement the CPUE while some fisher folks were interviewed on their fishing duration. The wire basket trap longevity was examined.

Laboratory Procedures

In the laboratory, the carapace width and the carapace length were measured, the weight of each crab was also measured using a Sartorius weighing balance.

The condition factor (K) of the crab was determined using the formula:

$$K = 100W/L^b \text{ (Bannister, 1976)}$$

Where:

W = Weight of the crab in gram
L = Carapace length in centimeter
b = Regression coefficient

For food analysis, the cardiac stomach of each specimen was dissected out and the contents examined under a binocular microscope. The food analysis was by the numerical and occurrence methods (Kwei, 1978; Hyslop, 1980). For fecundity determination, 21 ripe crabs were obtained from market women, examined and analyzed using gravimetric method (Kelly *et al.*, 1996).

Statistical Analysis

Statistical evaluations were carried out with SPSS (1999) window version 10.0. An ANOVA and Least Significant Difference (LSD) were used to compare variation in catches at different depth at 0.05 probability level.

RESULTS

Fishery of the Crab

The number of crabs caught in a day by a canoe varied with the length of fishing. The counted landings varied from just under one hundred to a little over six hundred from the fishermen in the study areas. The fishing duration ranged from 3 to 5 h for lift net. Most crab caught in this study was under 30 min while there was no crab left in the trap after 1 h soak time.

Most crab caught in the creek were juveniles and the durability of the trap (wire) was short (3-3 ½ months). The traps were set overnight (18:00-06:00 h) each sampling day.

Catch and Effort

The monthly CPUE was based on catch per trip per the number of traps used. The highest average catch per unit effort was in March (15 crabs per 40 traps) and the least was in November (2.5 crabs per 40 traps) for lift net while the highest CPUE for wire basket trap was in March (17 crabs per 5 traps) and the least was in November (5.6 crabs per 5 traps).

Depth Distribution of Crab in Lagos Lagoon

The distribution of *C. amnicola* by depth was shown in Table 1. Statistical analysis using ANOVA showed that there was significant difference in the number of crabs caught from depth of 1-3.5 m. Further analysis using Least Significant Difference (LSD) at p = 0.05 revealed that no significant difference was observed in catch at the depths of 1.0, 3.0 and 3.5 m since no crab was caught at these depths.

However, the number of crabs caught at the depth of 1.5 and 2.0 m were significantly different from that of 1.0, 3.0 and 3.5 m. Significant difference was also observed in the number of crab caught at the depth of 1.5 and 2.0 m.

Growth Pattern

Length-Frequency Distribution

A total number of 188 crabs were examined for growth. The carapace length ranged from 2.8 to 16.6 cm and the width ranged between 5.6 and 30.0 cm (Table 2). The weight of all the specimens ranged between 3.20 and 348.5 g. One age group was recorded in the species during the study.

Length-Weight Relationship

The log carapace length/log weight relationship values for male, female and combined sexes are show in Fig. 4-6:

$$\text{Male: Log wt} = -1.495 + 3.2737 \text{ log carapace length}$$
$$(n = 135, r = 0.9873)$$

Table 1: Occurrence of *C. amnicola* by depth in Lagos lagoon

Bottom depth (cm)	1st Trip No. of crabs	1st Trip %	2nd Trip No. of crabs	2nd Trip %
1.0^a	0	0.00	0	0.00
1.5^b	4	16.70	5	22.70
2.0^c	18	75.00	16	72.70
3.0^a	0	0.00	0	0.00
3.5^a	0	0.00	0	0.00
Total	24	100.00	22	100.00

Depths with the same superscript letter in a column are not significantly different in the number of crab caught at LSD (p = 0.05)

Female: Log wt. = -1.192 + 2.9888 log carapace length
(n = 53, r = 0.9446)
Combined sexes: Log wt. = -1.3421 + 3.1784 log carapace length
(n = 188, r = 0.9756)

The value of b for male and combined sexes were more than 3 but for females was less than 3, the species generally exhibited positive allometric growth whereas the females exhibited negative allometric growth in isolation.

Table 2: The Carapace Length-Frequency distribution of *C. amnicola* from Lagos Lagoon and Abule-Agege Creek

Carapace length	No. of crabs	Frequency (%)
2.0-4.9	60	3.90
5.0-7.9	34	18.08
8.0-10.9	69	36.70
11.0-13.9	56	29.78
14.0-16.9	20	10.63
Total	188	100.00

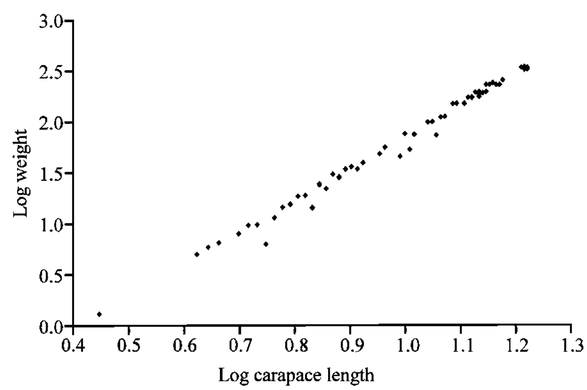

Fig. 4: Log length/log weight relationships in *C. amnicola* (male) from Lagos Lagoon and Abule-Agege Creek

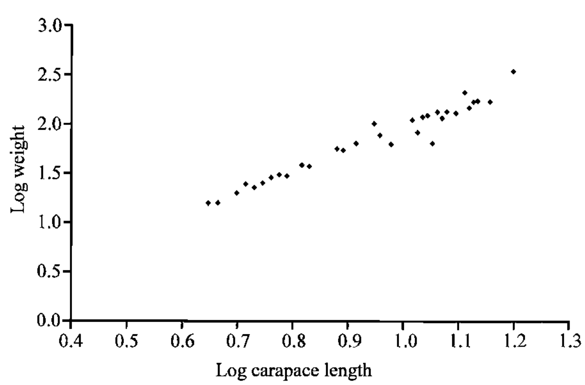

Fig. 5: Log length/log weight relationship in *C. amnicola* (female) from Lagos Lagoon and Abule-Agege Creek

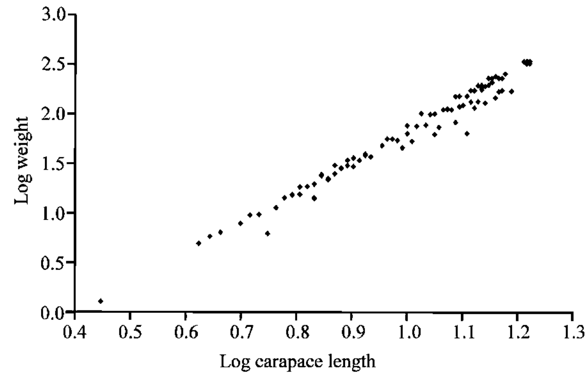

Fig. 6: Log length/log weight relationship in *C. amnicola* (combined) from Lagos Lagoon and Abule-Agege Creek

Condition Factor

There was marked variation in the condition factor between sexes. The highest condition factor (7.75) was observed in males with carapace length range from 16.0-17.9 cm. In the females, the highest condition factor (7.62) was observed in specimens whose carapace length varied from 16.0-17.9 cm. The condition factor for males ranged from 5.06 to 7.75 with a mean of 6.67. The females condition factor ranged from 5.42 to 6.67 with a mean of 6.28. The combined sexes condition factors ranged from 5.06 to 7.75 with a mean of 6.38.

Sex Ratio

A total of 188 specimens were sexed of which 135 were males and 53 were females giving a sex ratio of 1 male to 0.39 females (Table 3). The males were significantly more numerous than the females and the sex ratio was statistically different from the expected 1:1 ratio. During the month of December however, the females predominated over the males with the sex ration 1:1.4. For January and March all the samples collected were males.

Fecundity

The carapace length of the specimens whose fecundity was determined ranged from 10 to 13 cm, while the weight ranged between 97.7 and 154.7 g. The number of eggs in each mature ovary ranged from 1,148 eggs in a crab of carapace length 12.2 cm and weight 70.5-736, 266 eggs in a crab of carapace length 12.5 cm and weight 154.7 g. A mean fecundity of 141,290 eggs per female was obtained. The relationships between fecundity carapace length and fecundity/crab weight (Table 4).

The regression equation obtained for this species was:

$$\text{Log fecundity} = -1.4567 + 6.2677 \text{ log carapace length}$$
$$(n = 21, r = 0.0046)$$
$$\text{Log fecundity} = -0.246 + 5.1928 \text{ log weight}$$
$$(n = 21, r = 0.0023).$$

Food and Feeding Habits

A total of 188 specimens ranging in carapace length between 2.8 and 16.6 cm were examined for the food studies of this species.

Table 3: Monthly variation of sex ratio in *C. amnicola*

Months	Male	Female	Sex ratio Male	Sex ratio Female
October 2003	54	24	1	0.40
November 2003	25	11	1	0.40
December 2003	13	18	1	1.40
January 2004	14	-	-	-
February 2004	14	-	-	-
March 2004	15	-	-	-
Total	135	53	1	0.39

- : Means not recorded

Table 4: The Relationships between fecundity/carapace length and fecundity/crab weight

Carapace length (cm)	Log CL	Total weight (g)	Log WT	Fecundity	Log fecundity
10.0	1.00	97.70	1.990	312,944	5.50
10.2	1.00	101.60	2.010	224,491	5.35
10.4	1.01	58.30	1.770	187,823	5.27
10.6	1.02	42.80	1.630	24,904	4.40
11.0	1.04	111.50	2.058	26,387	4.42
11.2	1.05	131.80	2.120	3,831	3.58
11.4	1.06	122.30	2.090	126,521	5.10
11.6	1.06	101.60	2.010	78,744	4.90
11.6	1.06	81.36	1.910	179,338	5.25
11.6	1.06	148.40	2.170	13,330	4.12
11.6	1.06	133.50	2.130	9,237	3.97
12.2	1.09	95.23	1.980	7,397	3.87
12.2	1.09	145.50	2.160	43,207	4.64
12.2	1.09	70.50	1.840	1,148	3.06
12.6	1.10	154.70	2.190	736,266	5.87
12.6	1.10	115.50	2.060	44,787	4.65
12.6	1.10	122.10	2.090	394,531	5.60
12.6	1.10	137.00	2.140	36,697	4.56
12.8	1.11	146.20	2.160	10,909	4.04
12.8	1.11	71.02	1.850	219,109	5.34
13.0	1.11	84.70	1.920	285,480	5.46

CL = Carapace Length; WT = Weight

Frequency of Empty Stomach

36(19.2%) out of 188 specimens had empty stomachs. The empty stomachs were however recorded only during six months of the year: October (27.8%); November (8.3%); December (8.3%); January (27.8%); February (13.9%); March (13.9%). The percentage of empty stomachs varies from month to month.

Summary of Food Items

Molluscs were the most important food items accounting for 69.1% by number and 29.6% by occurrence. Amongst the molluscs, gastropods shells and bivalve shells constituted the most important food items. Gastropods shells accounted for 45.7 and 17.3% of the food by numerical and occurrence methods. The corresponding figures for bivalves' shells were 23.4 and 12.33%, respectively (Table 5, 6).

The second most important food items were crustaceans which accounted for 26.4 and 19.1% of all the food items by numerical and occurrence methods respectively. Amongst the crustaceans, shrimp appendages, juveniles crab appendages were the most important while Copepods formed a complementary diet. The third most important food items were the Pisces which constituted 4.0 and 11.6% of all the food taken by numerical and occurrence methods respectively. Amongst the Pisces, fish scales, fish vertebrae were the most important while fish spines, fish eye and otoliths formed a complementary diet. Algal filament and chicken baits appeared to be less important as food items for they constituted only 0.4 and 0% total food consumed.

Table 5: Major food organisms in the stomachs of *C. amnicola*

	Numerical method		Occurrence method	
Food organisms	No.	%	No.	%
Molluscs	8060	69.1	82	29.6
Crustacea	3083	26.4	53	19.1
Pisces	466	4.0	32	11.6
Algal filament	48	0.4	3	1.1
Chicken baits	-		31	11.2
Sand grains	-		39	14.1
Unidentified food items	-		49	17.0

- : Means not recorded

Table 6: Summary of the stomach contents of *C. amnicola* from Lagos lagoon and Abule Agege creek

	Numerical method		Occurrence method	
Food organisms	No.	%	No.	%
Molluscs				
Gastropod shells	5333	45.700	48	17.3
Bivalve shells	2727	23.400	34	12.33
Crustacean				
Juvenile crab appendages	2012	17.300	41	14.8
Shrimp appendages	995	8.500	10	3.6
Copepod	76	0.700	2	0.7
Pisces				
Fish scales	251	2.200	10	3.6
Fish vertebrae	116	0.800	10	3.6
Fish spine	94	0.800	7	2.5
Fish eye	1	0.008	4	1.4
Fish otolith	1	0.008	1	0.4
Algal filaments	48	0.400	3	1.1
Chicken baits	-	-	31	11.2
Sand grain	-	-	29	10.5
Unidentified items	-	-	47	17.0

Table 7: Summary of stomach content of small crabs\(2.8-10.0 cm) size

	Numerical method		Occurrence method	
Food organisms	No.	%	No.	%
Molluscs				
Gastropod shells	2368	43.40	22	22.2
Bivalve shells	1192	21.60	19	19.2
Crustaceans				
Juvenile crab appendages	1380	25.30	19	19.2
Shrimp appendages	470	8.60	7	7.1
Pisces				
Fish vertebrae	59	1.10	5	5.1
Fish eye	-			
Fish otolith	1	0.02	1	1.0
Chicken baits	-		2	2.0
Sand grain	-		12	12.1
Unidentified items	-		12	12.1

Feeding in Relation to Size

The specimens were divided into two size categories in order to facilitate comparison of food habit in relation to size. All the major food items were represented in the two size groups. In the small size (2.8-10.0 cm carapace length), molluscs contributed the most important food items accounting for 65.0 and 41.4% of the food items by the numerical and occurrence respectively. In the large size group (10.2-16.6 cm carapace length), mollusc were the most important food item accounting for 72.7 and 23.0% by numerical and occurrence, respectively (Table 7, 8).

Table 8: Summary of stomach contents of Large Crabs (10.2-16.6 cm) size

	Numerical method		Occurrence method	
Food organisms	No.	%	No.	%
Molluscs				
Gastropod shells	2965	47.8	26	14.6
Bivalve shells	1545	24.9	15	8.4
Crustacea				
Juvenile crab appendages	632	10.2	22	12.4
Shrimp appendages	525	8.5	3	1.7
Copepod	76	1.2	2	1.1
Pisces				
Fish scales	251	4.1	10	5.6
Fish spine	94	1.5	7	0.9
Fish vertebrae	57	0.9	5	2.8
Fish eye	4	0.1	4	2.2
Algal filaments	48	0.8	3	1.7
Chicken baits	-	-	29	16.2
Sand grains	-	-	17	9.6
Unidentified items	-	-	35	19.7

DISCUSSION

The lift net was highly selective for the crab. It was observed that baited trap performed better than unbaited, this agreed with what Solarin (1998) observed in the same kind of trap in Lagos lagoon. The trap is easy to operate, but care must be taken in handling the catch to avoid being bitten by the crab. The soak time of the trap influenced the number of crabs caught. The crabs probably left the traps after feasting on the chicken baits. This agreed again with Solarin (1998) who reported that, with shorter intervals of soak time, the CPUE increased and with longer intervals, the CPUE decreased due to saturation. This was not the case of wire basket trap, the longer the soak time the higher the number of crab caught and this was aided by the dead fish in the trap.

The wire basket-trap was more tedious to operate because of the fence and the fixing of the gear. The trap had preference for juvenile crabs, since they were set in the creek which serves as the nursery ground for the species. Emmanuel (2004) has previously observed that most crabs caught in the creek were juveniles. With regards to longevity, the trap lasted for 3 months between October 2003 and late January 2004, while it stays for a shorter time in the dry season (Early February and Middle of March 2004). This may be as a result of salinity fluctuation in the creek and salt content of the water which resulted in high level of oxidation and eventual deterioration.

The CPUE was high in March due to availability of food in the environment. More crabs were associated with wire basket trap due to the operational duration though; they were mostly juveniles with low economic values.

This study revealed that *C. amnicola* was more abundant at depths of 1.5 and 2.0 m. This showed that the marker should be adjusted to these depths for maximum catch. The reason for none availability of crab at depths of 1.0, 3.0 and 3.5 m is not known. Since studies in this area are scanty, no comparis on could be made.

The maximum size of *C. amnicola* recorded from Lagos lagoon during this study was 16.6 cm with weight of 348.5 g. The size of *C. amnicola* from Lagos lagoon was therefore slightly similar to what was recorded from Badagry and Lekki lagoons as reported by Lawal-Are (2003) where it measured 2.2 to 16.4, 3.5 to 16.1 and 3.5 to 16.8 cm for Badagry, Lekki and Lagos lagoons respectively.

The value of the regression coefficient (b) extrapolated from the log carapace length/log weight relationship indicated that if the crabs specific gravity remains constant, the crab grows positively allometric. This was contrary to what reported for Badagry, Lagos and Lekki lagoons for the same species (Lawal-Are, 2003).

The condition factor was higher in the males than in females and the condition factor was lower in the smaller crabs. The results conforms with Warner (1977) who reported that in true crabs, the males were generally larger than the females but disagreed with Lawal-Are and Kusemiju (2000) that of the view that condition factors for *C. amnicola* females were more greater than that for males. The lower condition factor reported for females may be due to weights loss from spawning.

There was no definite linear relationship obtained between the fecundity-weight and carapace length. The value of correlation coefficient (r) obtained showed positive correlation among fecundity, carapace length and weight. There was, however, no significant difference in correlation between fecundity and weight (r = 0.0023) and fecundity and carapace length (r = 0.0046). In this study, specimens of the same carapace length or weight had variable fecundity. The sex ratio of *C. amnicola* from Lagos lagoon and its adjacent creek was 1:0.39 (male/female), the male being significantly more numerous than the females. This probably points to fecundity as variable irrespective of the weight or carapace length of *C. amnicola*. The high number of eggs observed revealed that there is a high recruitment level in *C. amnicola* if were hatched and released into the water.

The fullness of the gut of this species suggests that its environment contained abundant food organisms. This supported what was reported by Hart and Chindah (1998) that there were abundant foods in the Eagle Island environment for organisms that dwell there. The number and variety of food items found in the gut of the individual crab showed that the species (*C. amnicola*) is more of a predator than a scavenger. This agreed with Chindah *et al*. (2000) on the same species but negates the observation of Blundon and Kennedy (1982) who reported *Callinectes sapidus* as mostly a scavenger. It is possible that this species may be scavenging as an alternative source of food as a result of low availability of food but when food is abundant, it represents an infinitesimal food source as was observed by Wear and Haddon (1987) and Chindah *et al*. (2000).

There were no distinct changes in the food habits relative to size. This disagreed with what was reported by Lawal-Are and Kusemiju (2000) and Chindah *et al*. (2000) where they reported changes in the food items in relation to size differences.

It was observed that the chicken bait used to fish the crab was not eaten by crab but the crab only feasting on them as a result of the smell.

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