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The Composition, Ranking and Diversity of *Callinectes amnicola* (De Rochebrune, 1883) Food from Okpoka Creek, Niger Delta, Nigeria

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Abstract: The composition, ranking and diversity of *Callinectes amnicola* food from Okpoka creek was studied for a period of two years (January 2006-December 2007). The total of nine hundred and thirty (930) stomachs examined, five hundred and sixty representing (60.2%) had food items while three hundred and seventy (39.8%) were empty. The highest percentage empty stomachs (80.0%) were recorded in August 2007 while the lowest (16.7%) was observed in March 2006. The food items observed in the stomachs were Crustacea, Pisces, Mollusca, Annelids, plant materials, sand grains and unidentified masses. Crustacea consisted of shrimp parts and crab appendages. Pisces consisted of fish flesh, fish scales and fish bones/spines. Mollusca consisted of bivalve shells; bivalve tissues and gastropod shells while the plant materials were made up of higher plant parts and algae cells. The ranking of the individual food items in the gastric stomachs of *C. amnicola* in a descending order of magnitude using the three analytical methods showed that, the frequency of occurrence method showed that, bivalve shells scored (14.4%); closely followed by shrimp parts (13.4%) gastropod shells (12.6%), fish bones/spines (11.9%), fish scales (10.6%) and crab appendages (10.1%). Annelids (1.6%) occurred the least. The numerical method showed that, shrimp parts and bivalve shells were the highest by number with 13.2% each; closely followed by fish bones/spines (12.6%), algae cells (11.0%) and gastropod shells (10.2%). Others were fish scales (8.7%), crab appendages (7.7%), sand grains (6.6%) and fish flesh (4.7%). Annelids were the least in occurrence with 1.3%. Bivalve shells (14.6%) scored the highest point, closely followed by shrimp parts (14.%) and then fish bones/spines (13.9%). The lowest point was scored by annelids (1.9%). (7.7%), sand grains (6.6%) and fish flesh (4.7%). The result shows a high diversity in food intake. The diversity indexes (H and J) estimated, revealed high diversity (H = 1.0186) in food intake with relative diversity or evenness (J = 0.9144) approaching one (1).

Key words: *Callinectes amnicola*, food, composition, ranking, diversity, Okpoka creek and Nigeria

INTRODUCTION

Callinectes amnicola is a famous crab belonging to the family Poruntidae. It is one of the most important economic swimming crabs present in the brackish wetland and lagoons in Nigeria (Abbey-Kalio, 1982; Solarin, 1988). *C. amnicola* inhabits muddy bottoms in mangrove areas and River mouths (Defelice *et al.*, 2001). The species is generally cherished source of protein and minerals in human diet and animal feeds (Chindah *et al.*, 2000; Emmanuel, 2008) and the most important food organism caught in the coastal (inshore) fishery and lagoons in west Africa (Lawal-Are *et al.*, 2000).

Food is important in the life of an organism. The basic body functions: Growth, development and reproduction depend on food. The successful culture of any fish species requires proper understanding of the various food habits or the ecological niche for the production of different species (Stickney, 1979). A good knowledge of food and feeding habits of fishes is inevitable in aquaculture.

Ranking contributes to the composition of species in a community. Information on the ranking of *C. amnicola* food items facilitates the formulation of its feed for its culture. Diversity index is a mathematical measure of species diversity in a community. Diversity indices provide more information about community composition than simply species richness (i.e., the number of species present); they also take the relative abundances of different species into account. Diversity indices provide important information about yarity and commonness of species in a community. The ability to quantify diversity in this way is an important tool for biologists trying to understand community structure.

The Okpoka creek is one of the most numerous creeks in Niger Delta. The Niger Delta estuarine waters cover an area of about 680km^2. The Bonny/ New Calabar river systems formed about 39% of the total area (Scott, 1966). The Niger Delta area is the richest part of Nigeria in terms of natural resources with large deposits of petroleum products (oil and gas); (Moffat and Linden, 1995; Braide *et al.*, 2006). Similarly, the vast coastal

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features which include forest swamps, mangrove, marsh, beach ridges, rivers, streams and creeks serve as natural habitats for various species of flora and fauna (Alalibo, 1988; Jamabo, 2008).

Despite the ecological and economic importance of swimming crab species, *Callinectes amnicola* to the human society of the coastal regions in Nigeria particularly, Okpoka creek in the Niger Delta area, information about its food and feeding habits are few. Notable among the few are Lawal-Are (1998), Chindah *et al.* (2000), Lawal-Are and Kusemiju (2000), Lawal-Are (2003) and Emmanuel (2008). Chindah *et al.* (2000), Warner (1977), Paul (1981), Lawal-Are (1998), Lawal-Are and Kusemiju (2000), Lawal-Are (2003) and Emmanuel (2008). Therefore, the composition, ranking and diversity of *Callinectes amicola* food from Okpoka Creek, in the Niger Delta area of Nigeria is necessary for the management of its fishery.

MATERIALS AND METHODS

Study Area: The study was carried out in Okpoka creek, which is one of the several adjoining creeks off the Upper Bonny River estuary in the Niger Delta (Fig. 1). The Bonny River Estuary lies on the Southeastern edge of the Niger Delta, between longitudes 6°58′ and 7°14″ East and latitudes 4°19″ and 4°34′ North. It has an estimated area of 206 km^2 and extends 7 km offshore to a depth of about 7.5 m (Irving, 1962, Scott, 1966; Alalibo, 1988). The Bonny River is a major shipping route for crude oil and other cargoes, and leads to the Port Harcourt quays, Federal Ocean Terminal, Onne, and Port Harcourt Refinery company terminal jetty, Okirika. Specifically, the Okpoka creek lies between Longitudes 7°03′ and 7°05′ East and Latitudes 4°06′ and 4°24′ and it is about 6 km long.

Characteristically, the area is a typical estuarine tidal water zone with little fresh water input but with extensive mangrove swamps, inter-tidal mud flats, and influenced by semi-diurnal tidal regime. In the Bonny River estuary, the salinity fluctuates with the season and tide regime is influenced by the Atlantic Ocean (Dangana, 1985). Tidal range in the area is about 0.8m at neap tides and 2.20m during spring tides (NEDECO, 1961).

It is strategically located southwestern flanks of Port Harcourt and Okirika of Rivers State. The creek is bounded by thick mangrove forest dominated by *Rhizophora species* interspersed by White mangrove (*Avecinia* sp.) and Nypa palm. Along the shores of the creek are located the Port Harcourt Trans- Amadi Industrial layout, several establishments, markets, the main Port Harcourt Zoological garden and several communities. The communities are Oginigba, Woji New layout, Azuabie, Okujagu- Ama, Ojimba- Ama, Abuloma, Okuru- Ama, Oba-Ama and Kalio- Ama.

Artisanal fishers mainly exploit the fisheries. The fishers use wooden/dug-out canoes ranging in size from 3 to 8 m long. The canoes are either paddled or powered by small outboard engines, and manned by an average of two men. From these boats, the fishers operate their cast nets, hook and lines, gillnets, crab pots, etc.

Sampling stations: Six sampling stations were established along a spatial grid of the Okpoka creek covering a distance of about six kilometers. The sampling stations were established based on ecological settings, vegetation and human activities in the area. The sampling station is about one kilometer apart from each other.

Station 1: Located upstream of the Port Harcourt main abattoir at Oginigba waterfront with living houses on the left flank of the shoreline. Vegetation is sparse with mainly red mangrove (*Rhizophora* sp.,) white mangrove, *Avicenia* sp. and Nypa palm (*Nypa fructicans*).

Station 2: Situated at Azuabie / Port Harcourt main abattoir waterfront. It is located downstream of Station 1. The bank fringing the Azuabie/abattoir is bare with no visible plants except toilet houses, residential houses, animal pens, boats and badges, while at the opposite side there are few mangrove and Nypa palm. Human activities here include slaughtering of animals, marketing, fishing and boat building. It is located downstream of Station 1 and it is main collection point of abattoir wastes and other human and market wastes.

Station 3: It is downstream from the Port Harcourt abattoir at the Woji sand-Crete. It is about one kilometer away from Station 2. The major activities here included sand mining and loading.

Station 4: This station is located at Okujagu-Ama area. There are no industrial activities here. Mainly fishers occupy the area. Nypa palm dominates the marginal vegetation while the opposite side is thickly populated with red mangrove forest. *Rhizophora racemosa* and *Rhizophora mangle*. The main activity is fishing, boat ferrying and occasional sand moving.

Station 5: Is situated at Ojimba cum Abuloma waterfronts. There are no commercial activities apart from ferryboats operations. The shoreline fringes have mainly Nypa palm. The area is shallow and at low tide, the greater part of the bottom mud flat is exposed.

Station 6: Is located in front of Kalio-ama directly between Okpoka and Amadi creeks. The human activities here include jetty operations, oil and non-oil industrial activities, boat traffic and fishing. Vegetation is few dominated by red mangrove interspersed with white mangrove *Avicenia africana*.

Sample collection: The crabs for study were collected fortnightly for twenty four (24) calendar months (January, 2006 to December, 2007) using the square lift net trap

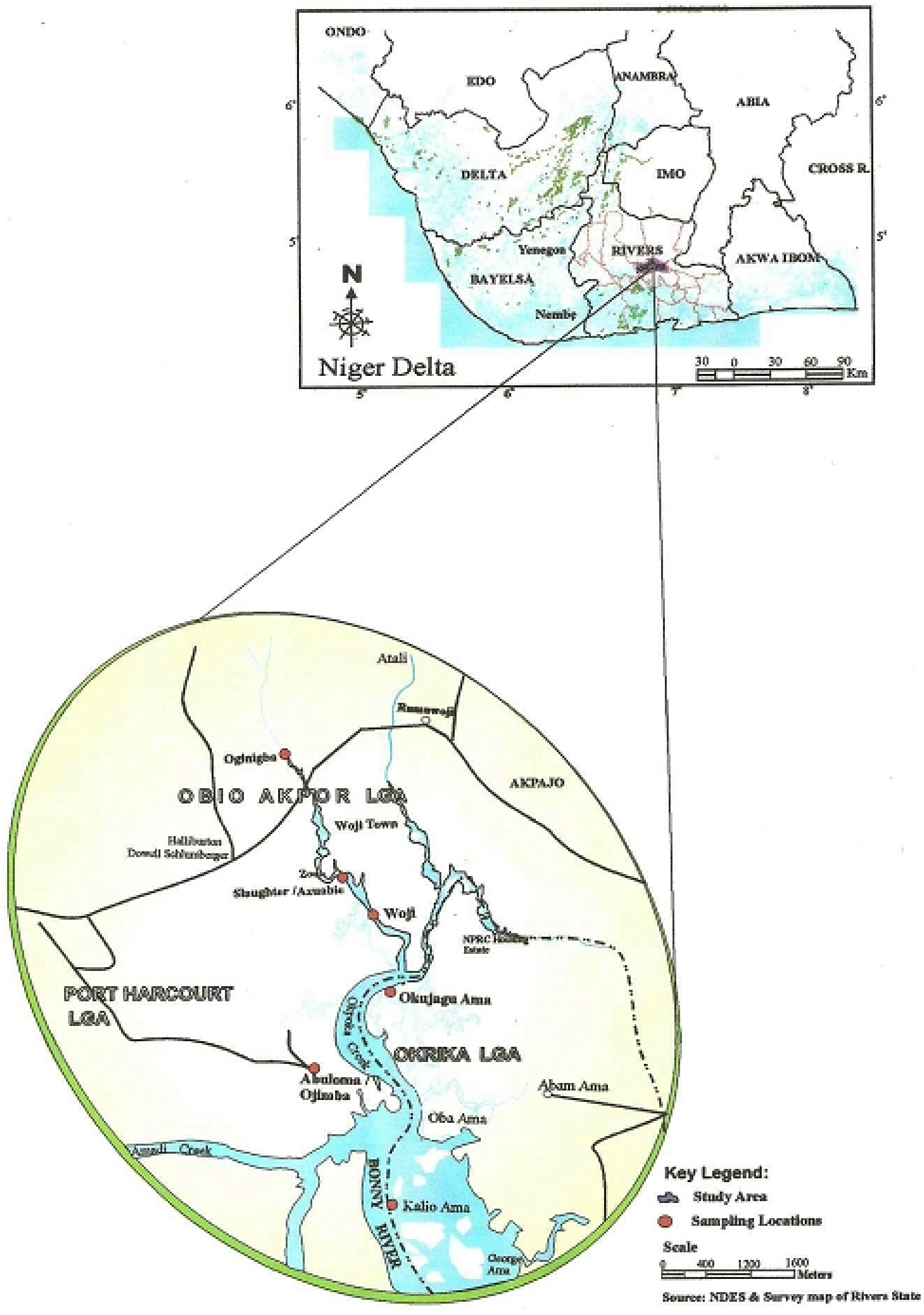

Fig 1: Map of Niger Delta showing Rivers State and the study area

at each of the sampling stations along the Okpoka creek. The lift net trap has a square structure made of wooden stick of about 4cm thick and an area of 4.9 m^2. The mesh sizes of the bag-like net were 1.2 to 2.0 cm multifilament nylon. The length of the bag is 40 to 60 cm. Strong nylon cords were woven in a net-like fashion from the centre to the middle of each of the four edges. A twine of about 6 m long was attached to the centre and the other free end of the twine was tied to a floater, which served as a marker on the water surface to show the position of the gear.

The lift net trap was baited at the centre with animal offal and fish. The trap was operated from a hand-paddled canoe manned by two persons; one rowing while the other sets and hulls the trap into and from the water. The crabs were caught trapped and most of them were observed feasting on the bait until they were hulled into the boat. Sampling lasted for 4 hours on every sampling day and samples were collected between low ebbing and low flooding tide periods. The catches were taken to the laboratory in a cooler and stored in a deep freezer for further analysis.

Crabs were identified to species level carried out using photo cards and available identification keys (Fischer, 1978; Williams, 1974; Schneider, 1990). Therefore each crab was sorted into species, sex and the required metric measurements were taken.

The carapace width and length were measured with a 0.5 mm precision vernier caliper to the nearest millimeter (mm) while weight measurement was done using a 0.001 g precision Adam (PGW series) weighing balance to the nearest grams (g).

The significance of each category of food organisms in the diet of *C. amnicola* was determined by pooling the various food items for all the stomachs examined using numerical, occurrence and points methods respectively.

The general food items recorded for the different methods (numerical, occurrence and point) were pooled for all the stomachs examined during the sampling and relative proportions were plotted to indicate the significance of each category of food organisms in the diet of *C. amnicola.*

The Shannon- Weaver diversity index was used to determine the food preference. The Shannnon – Weaver index has the expression:

$$H = -\sum_{n}^{K} Pi Log Pi \quad \text{(Holgate, 1981)} \qquad (1)$$

Where:

H = Shannon- Weaver index
K = Number of categories (groups)
Pi = Proportion of observations found in each category.

The relative diversity (J), which indicates the evenness of the composition of food items, was estimated with the equation.

$$J = \frac{H}{H \max} \quad \text{(Pielou, 1969)} \qquad (2)$$

Where:

Hmax = LogK
J = Pielou's index of evenness

RESULTS

Results of the gastric stomach contents analysis using the frequency of occurrence, numerical and point methods are given in Table 1 and the monthly sample size and percentage food/empty stomachs examined are given in Table 2.

The total of nine hundred and thirty (930) stomachs examined, five hundred and sixty representing (60.2%) had food items while three hundred and seventy (39.8%) were empty. The highest percentage empty stomachs (80.0%) were recorded in August 2007 while the lowest (16.7%) was observed in March 2006. The food items observed in the stomachs were Crustacea, Pisces, Mollusca, Annelids, plant materials, sand grains and unidentified masses. Crustacea consisted of shrimp parts and crab appendages. Pisces consisted of fish flesh, fish scales and fish bones/spines. Mollusca consisted of bivalve shells; bivalve tissues and gastropod shells while the plant materials were made up of higher plant parts and algae cells.

The results of the ranking of the individual food items in the gastric stomachs of *C. amnicola* in a descending order of magnitude using the three analytical methods are presented in Table 3. The frequency of occurrence method showed that, bivalve shells scored (14.4%). This was closely followed by shrimp parts (13.4%) gastropod shells (12.6%), fish bones/spines (11.9%), fish scales (10.6%) and crab appendages (10.1%). Annelids (1.6%) occurred the least. The numerical method showed that, shrimp parts and bivalve shells were the highest by number with 13.2% each. They were closely followed by fish bones/spines (12.6%), algae cells (11.0%) and gastropod shells (10.2%). Others were fish scales (8.7%), crab appendages (7.7%), sand grains (6.6%) and fish flesh (4.7%). Annelids were the least in occurrence with 1.3%. Bivalve shells (14.6%) scored the highest point, closely followed by shrimp parts (14.%) and then fish bones/spines (13.9%). The lowest point was scored by annelids (1.9%). (7.7%), sand grains (6.6%) and fish flesh (4.7%).

The monthly index of diversity of food assessment is presented in Table 4. The result shows a high diversity in food intake. The diversity indexes (H and J) estimated, revealed high diversity (H = 1.0186) in food intake with relative diversity or evenness (J = 0.9144) approaching one (1).

DISCUSSION

The high percentage of stomachs with food (60.2%) observed in this study indicates abundance of food organisms in the environment for the crabs. This assertion was corroborated by the findings of Hart and Chindah (1998) who reported that there were abundant foods in the Eagle Island environment for organisms that dwell there. Similar observations were also made by Chindah *et al.* (2000) in New Calabar River and Emmanuel (2008) in Lagos Lagoon. The high incidence of empty stomachs (50-60%) and (58.3-80.0%) during the rainy months could be due to paucity of food organisms in the environment

Table 1: Percentage composition of various food items of *Callinectes amnicola* by the Numerical (NO), frequency of occurrence (FO) and point (PT) methods.

FOOD ITEMS	Numerical (N) %	Frequency of Occurrence FO) %	Point (PT) %
Crustacea:			
Shrimp parts	13.2	13.4	14.2
Crab appendages	7.7	10.1	8.4
	20.9	**23.5**	**22.6**
Pisces:			
Fish flesh	4.7	4.8	4.4
Fish scales	8.7	10.6	9.3
Fish bones/spines	12.6	11.9	13.9
	26.0	**27.3**	**27.6**
Mollusca:			
Bivalve shells	13.2	14.4	14.6
Bivalve tissues	3.1	4.3	3.6
Gastropod shells	10.2	12.6	10.9
	26.5	**31.3**	**29.1**
ANNELIDS	**1.3**	**1.6**	**1.9**
Plant materials:			
Algae	11.0	4.4	7.2
Higher plant parts	3.4	4.6	3.0
	14.4	**8.4**	**10.2**
Sand Grains	**6.6**	2.6	**4.9**
Unidentified Mass	**4.3**	**4.9**	**4.3**

Table 2: Monthly total number of gastric stomachs examined and relative percentage of food and empty stomachs of *Callinects amnicola*.

Month/Year	Total Examined	Food stomachsEmpty stomachs			
		No	%	No	%
Jan. 06	36	24	66.7	12	33.3
Feb. 06	40	27	67.5	13	32.5
March 06	48	40	83.3	8	16.7
April 06	20	15	75.0	5	25.0
May 06	30	16	53.3	14	46.7
June 06	25	20	80.0	5	20.0
July 06	40	16	40.0	24	60.0
Aug. 06	38	18	47.4	20	52.6
Sept. 06	40	20	50.0	20	50.0
Oct. 06	25	20	80.0	5	20.0
Nov. 06	30	21	70.0	9	30.0
Dec. 06	48	28	58.3	20	41.7
Jan. 07	45	34	75.6	11	24.4
Feb. 07	40	32	80.0	8	20.0
March 07	46	28	16.9	18	39.1
April 07	45	32	71.1	13	28.9
May 07	40	28	70.0	12	30.0
June 07	46	13	28.3	33	71.7
July 07	8	20	41.7	28	58.3
Aug. 07	40	8	20.0	32	80.0
Sept. 07	44	24	54.5	20	45.5
Oct. 07	46	30	65.2	16	34.8
Nov. 07	40	28	70.0	12	30.0
Dec. 07	30	18	60.0	12	40.0
Total 36	930	560	60.2	370	39.8

Table 3: Ranking of food items by the frequency of occurrence (FO), numerical (NO) and point (PT) methods in the food of *Callinects amnicola* January 2006 – December 2007

S/N	Food species	% FO	Food species	%NO	Food species	% PT
1	Bivalve shells	14.4	Shrimp parts	13.2	Bivalve shells	14.6
2	Shrimp parts	13.4	Bivalve shells	13.2	Shrimp parts	14.2
3	Gastropod shells	12.6	Fish bones/spines	12.6	Fish bones/spines	13.9
4	Fish bones/spines	11.9	Algae	11.0	Gastropod shells	109
5	Fish scales	10.6	Gastropod shells	10.2	Fish scales	9.3
6	Crab appendages	10.1	Fish scales	8.7	Crab appendages	8.4
7	Unidentified mass	4.9	Crab appendages	7.7	Algae	7.2
8	Fish flesh	4.8	Sand grains	6.6	Sand grains	4.9
9	Algae	4.4	Fish flesh	4.7	Fish flesh	4.4
10	Bivalve tissues	4.3	Unidentified mass	4.3	Unidentified mass	4.3
11	Higher plant parts	4.0	Higher plant parts	3.4	Bivalve tissues	3.6
12	Sand grains	2.6	Bivalve tissues	3.1	Higher plant parts	3.0
13	Annelids	1.6	Annelids (UNID)	1.3	Annelids	1.9

Table 4: Summary of monthly diversity of food items in *Callinects amnicola* from Okpoka Creek.

Month	H	Hmax	J
Jan.	1.0277	1.1139	0.9226
Feb.	1.0001	1.1139	0.8985
March	0.9907	1.1139	0.8892
April	1.0180	1.1139	0.9139
May	0.9959	1.1139	0.8941
June	1.0256	1.1139	0.9207
July	1.0494	1.1139	0.9424
Aug.	1.0441	1.1139	0.9373
Sept.	1.0155	1.1139	0.9116
Oct.	1.0260	1.1139	0.9211
Nov.	1.0060	1.1139	0.9031
Dec.	1.0247	1.1139	0.9199
Mean	1.0186	1.1139	0.9144

H = Shannon-Weaver index, H_{max} = LogK, J = Pielou index of evenness

due to seasonal variability of the water quality, and the use of passive gear for sampling as noted by Allison (2006).

It may also be related to spawning and breeding activities as was reported by Coasta and Negreiros-Fransozo (1998) in their study on the reproductive cycle of *callinectes danae* in the Ubatuba region, Brazil. Other probable causes of empty stomach may include intermittent feeding or high rate of digestion. Joyce *et al.* (2002) observed that quick digestion can complicate dietary analysis as the prey organisms can become quickly eroded making identification difficult. This could lead to the reduction in the proportion of such organisms that can be identified as well as the stomachs fullness.

The present results on the food of the swimming crab, *calinectes amnicola,* revealed that the crab is an opportunistic benthic predator as the stomach content showed mainly the presence of Crustacea (shrimp parts and crab appendages), Pisces (fish flesh, fish scales, fish bones/spines), and mollusca (Bivalve shells, bivalve tissues, and gastropod shells). Other food items frequently observed are plant materials composed of algae and plant parts were observed in relatively high number. Minor food items observed include, annelids, sand grains and unidentified materials.

This finding compared favourably with the results of Lawal-Are (1998), on *C. amnnicola* in the Badagry Lagoon Nigeria; Lawal-Are and Kusemiju (2000) on *Callinectes amnicola* in the Badagry lagoon. Chindah *et al.* (2000) on *Callinectes amnicola* of the New Calabar River, Nigeria; Lawal-Are (2003) on *Callinectes amnicola* in the Badagry and Lekki Lagoons and Emmanuel (2008) on the same species from Lagos Lagoon and its adjacent Creek, South-West Nigeria. The carnivorous way of feeding was also seen to be associated with an herbivorous habit in some as the juvenile crabs fed more on plant materials.

This suggestion agreed with Lawal-Are (2003) on the same species. Similarly, the number and variety of food organisms found in the gastric stomach of the individual crab indicated that the species (*Callinectes amnicola*) is more of a predator than a scavenger. This observation is in agreement with Chindah *et al.* (2000) and Emmanuel (2008) on the same species but negates the observation of Blundon and Kennedy (1982) who reported *Callinectes sapidus* as mostly a scavenger. Juvenile and adult blue crabs have been characterized as opportunistic benthic omnivores, detritovores, cannibals and scavengers, with food habits determined by local abundance and availability of prey (Darnell, 1961; Laughlin, 1982; Guillory *et al*., 1996).

Laughlin (1982) however concluded that it is difficult to place blue crabs in one trophic level and starvation is less likely in species with opportunistic feeding habits than in species with specialized feeding habits. Changes in fish diet with locations have been reported (Arendt *et al*., 2001; Joyce *et al*., 2002). When the present study results, are compared with the results of earlier workers on the same species, a minor shift in food items requirement was observed, which could be attributed to differences in habitats, relative abundance of prey organisms and individual species food habits as reported by Hseuh *et al*.(1992), Rosas *et al.* (1994), Reigada and Negreiros-Frasozo (2004) and Chande and Mgaya (2004). Furthermore, Laughlin (1982) demonstrated that the feeding habits of *C. sapidus* change with age and with the distribution of its prey. While Blundon and Kennedy (1982) also noted that changes in diet are influenced by morphological changes of feeding related structures such as Chelae and mouthparts, during growth.

Sand particles were also observed in the stomachs, which were not considered as food, but probably picked up along with the main food items from the bottom. This is in agreement with reports of Nikolsky (1963), Alfred-Ockiya and George (1998), Allison (2006) and Chindah *et al.* (2000).

The Shannon Weaver Index indicates a high diversity of food intake. The high values of the Relative Diversity Index (J = 0.9144) reflected the relative abundance of each food item in the stomach of the specimens.

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