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The Age and Growth of *Callinectes amicola* (De Rochebrune, 1883) from Okpoka Creek, Niger Delta, Nigeria.

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Abstract: The Age and growth of *Callinectes amicola* from Okpoka Creek in the Niger Delta area of Nigeria was studied for a period of one year (January – December 2007).The size classes 30–39.9mm and 40–49.9mm constituted the highest with 31.0% and 31.5% respectively. Very small size class below 10mm was completely absent and largest size group (70–79.9mm) were very few (0.2%). The results of the modal length-at-age revealed that all the sexes of *Callinectes* belonged to the age groups 1 to 3 years. Four year classes with modal classes ranging from 6.7 – 68.3mm for males; 5.0–78.3mm for female and 5.8–75.8mm for combined sex. The annual carapace length increment was highest in year class 1+ and declined with time for both sexes and combined. The absolute increment was: male (17.5mm for 1–2y, 14.1 mm for 2–3y and 20.53mm annual mean); female (18.3 for 1–2y, 10.8 for 2–3y and 24.43 annual mean) and combined (18.3mm for 1–2y, 12.5mm for 2–3y and 24.43mm annual mean). Relative increment was male (47.7% for 1–2y, 26.0% for 2–3y and 36.85% annual mean); female (37.2% for 1–2y, 16.0% for 2–3y and 26.60% annual mean) and combined (40.7% for 1–2y, 19.7% for 2–3y and 30.20% annual mean). Instantaneous rate of increase was male (0.390 for 1-2y, 0.231 for 2–3y and 0.311 annual mean); female (0.316 for 1-2y, 0.148 for 2–3y and 0.232 annual mean) and combined (0.341 for 1–2y, 0.180 for 2–3y and 0.261 annual mean). Powell–Wetherall plot was L_∞ (61.80mm), K (0.995 y^{-1}) and Z/K (1.694). The length at age data was L_∞ (61.80mm), *K* (2.10 y^{-1}), t_o (1.220), ϕ (3.90) and *Rn(*0.122) ELEFAN 1 scans routine was L_∞ (61.80), *R (2.10),* ϕ (3.90) and *Rn (0.121).* The non-seasoned version of the Von Bertalanffy Growth Function (VBGF) was L_∞ (87.305mm), K (0.636 y^{-1}), t_o (0.889) and ϕ (3.685). The longevity or maximum age (Tmax) was 4.7 years. The overall growth parameters obtained were: L_∞ = 61.80, K= 1.244y^{-1}, t_o = 1.0545, Z/K = 1.694, R = 0.995, ϕ =3.825 and Rn =0.121.

Key words: *C. amnicola*, age, growth Okpoka Creek and Nigeria

INTRODUCTION

The blue crab, *C. amnicola* is a popular food item in the diet of coastal communities in West Africa. It is caught in the creeks, lagoons and adjacent inshore marine waters. It supports a major artesanal fishery in coastal communities in Nigeria. Recreational fishers often seek this interesting animal. Many physiologists have also used the blue crab as an experimental animal because of its ready availability, economic value, hardiness and complex life cycle (Miller and Houde, 1999; Smallegange and Jaap Van Der Meer, 2003). It also plays a crucial role in the estuarine food webs, providing food for many species (Laughlin, 1979; Hines *et al.,* 1987, Orth and Van Montfrans, 1990; Thomas *et al.,* 1990; Heck and Coen, 1995). It is one of the most abundant estuarine macro invertebrates and supports valuable commercial and recreational fisheries along the Atlantic and Gulf coasts (Guillory and Perret, 1998).

Age and growth studies of aquatic organisms are very important in fishery management (Gerkins, 1978). Age and growth are particularly important for describing the status of a fish population and for predicting the potential yield of the fishery. It is essential for the estimation of growth rate, age at maturity, longevity and spawning (Food and Agriculture Organization, 1981). It also facilitates the assessment of production, stock size, recruitment to adult stock and mortalities (Lowe-McConnel, 1987). Hence, understanding the growth parameters is important for many ecological processes, which are often size dependant. Often an organism is considered a predator or a prey based upon its growth history (Miller and Smith, 2003). Also, an accurate growth model is fundamental to stock assessment (Smith, 1997) as growth usually translates recruitment into fishery production (Miller and Smith, 2003; Sharov *et al.*, 2003)

The growth performance index or phi-prime ϕ is a measure of growth performance of species (Munro and Pauly, 1983; Moreau *et al*; 1986 and Rabour *et al*., 1998). The growth performance index ϕ is determined by the magnitude of the growth constant or stress factor 'K' (Pauly, 1980) and the asymptotic length (L_∞) (Rabour,

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et al., 1998). The growth potential of a species may also be determined by the genetic make up, fishing regime and diet type (Ssentongo and Welcomme, 1985).

The relationship between a measure of length and age of individuals is described by a growth curve (Santos, 1978). The determination of such a curve is of fundamental importance for the analysis of the population structure of species. The parameters derived from the growth curve can provide information concerning the maximum size and age reached by the organisms as well as the growth rate and the reproductive period (Valenti *et al.,* 1987). The growth curves also facilitates to understanding of some species life cycle patterns.

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 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).

Complete studies on brachyuran growth are scarce. Few notable ones are: Phinney (1977) for the snow crab (*Chlonocoetes bairdi*); Olmi and Bishop (1983) for blue crab (*Callinectes sapidus*); Prasa *et al.* (1989) for three Portunid crab species; D'Incao *et al.*, (1993) for *Chasmagnathus granulate,* Cracco and Fontoura (1996) for *Crytograpus angulatus,* Sukumaran and Neclakantan (1997) for *Portunus sanguinolentus* and *Portunus pelagicus,* Villasunil *et al.* (1997) for *Callinectes sapidus*, Flores and Negrerios-Fransozo (1998) for shore crab (*Pachygrapsus transverses*, Branco *et al.* (2002) for *Portunus Spinimanus*, Lee and Hsu (2003) for *Portunus sanguinolentus,* Atar and Secer (2003) for *Callinectes sapidus* and Silva Castiglioni *et al.* (2004) for fiddler crab (*Uca rapax*). Information on age and growth of *Callinectes amicola* from Okpoka Creek in the Niger Delta area of Nigeria will compliment existing data the effective management of the species in the 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 and 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 kilometers 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 2.20 m 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 8m 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.

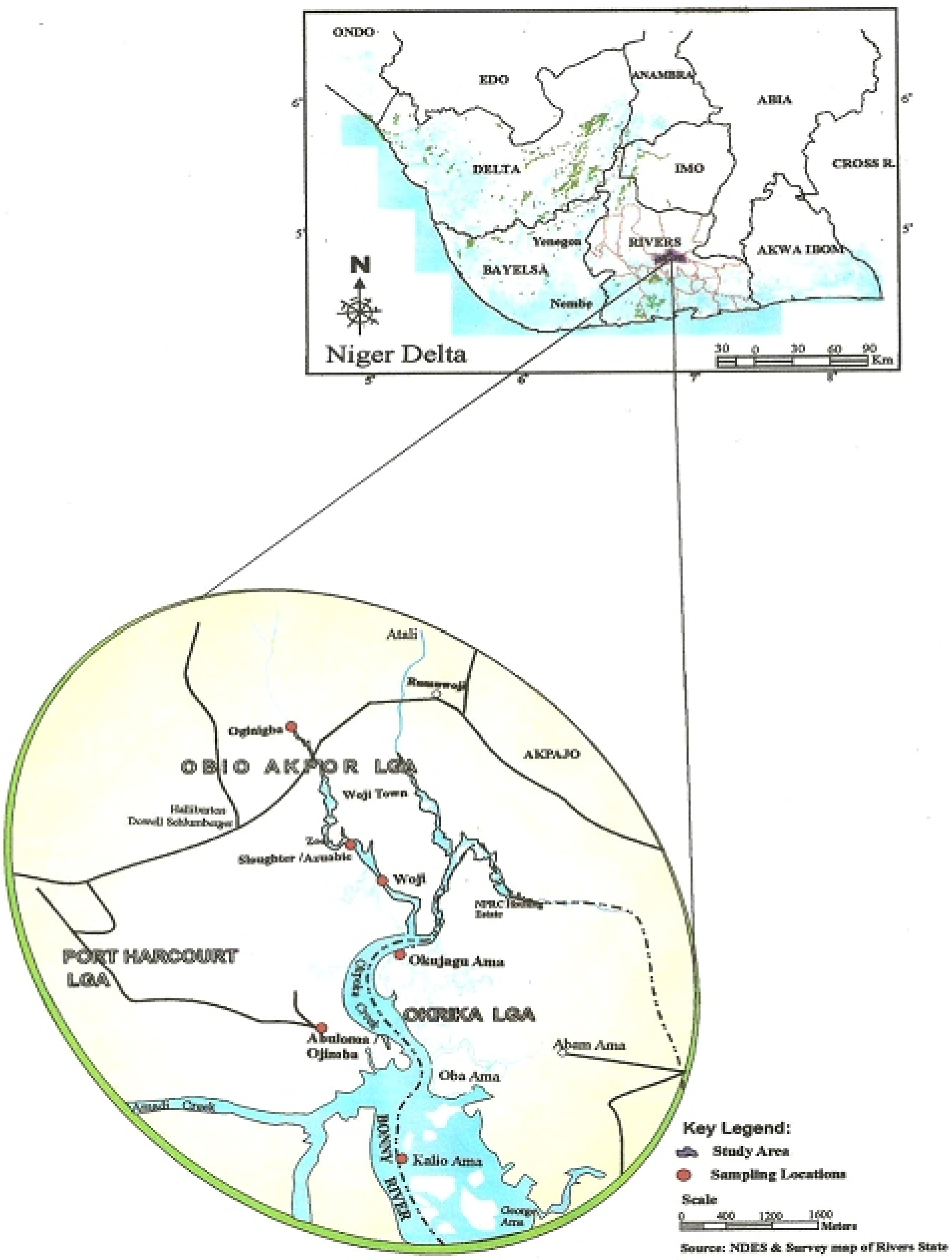

Fig. 1: Map of niger delta showing rivers state and the study area

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 twelve (12) calendar months (January to December, 2007) using the square lift net trap 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 4.9m^2. The mesh sizes of the bag-like net were 1.2cm to 2.0cm 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 6m 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 and 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 0.5mm precision vernier caliper to the nearest millimeter (mm) while weight measurement was done using a 0.001g precision Adam (PGW series) weighing balance to the nearest grams (g).

The age structure of the crab samples collected and measured during the study period was estimated based on the modified Peterson method, known as the "Integrated Method" (Pauly, 1983; Sparre, 1987). This was achieved by analyzing the polymodal length-frequency distribution plots obtained from the crab sample data grouped into 10mm class intervals. The data for each sex was pooled together into one length-frequency plot per year. The cumulative length-frequency histogram was redrawn repeatedly for six times on the assumption that growth patterns repeat themselves from year to year.

A single smooth curve interconnecting the majority of the peaks of sequentially arranged length-frequency data was drawn first rising rapidly and then decreasing smoothly according to growth curves of fishes. The growth curve was fitted by eye to interconnect the plots of the length-frequency distributions arranged in time series. The meeting points of the curve with the length axis gave the mean length of the species and the relative age of the crab read from time axis (Pauly, 1983).

The application of this method according to Pauly (1983) is based on the following assumptions.

- The succeeding modal lengths represent the next growth points and reflect the average growth of the stock.
- Length growth is at first rapid and then decreases smoothly and is best approximated by a long continuous curve for the whole population.

Similarly, that the single smooth curve is assumed to represent the average growth of the crabs of a given stock as the growth pattern repeats it self from year to year. The single growth curve was fitted by eye. Each discrete mode in the distribution was presumed to be a year class.

The points at which the growth curve cuts the length axis on the sequentially arranged time scale, gives the length-at-age. The values obtained from the length–at–age data were used to estimate the growth rates as proposed by Everhart *et al.* (1975).

The absolute, relative and instantaneous growth rates of *Calinectes amnicola* from the Okpoka creek were evaluated based on the following relationships:

Absolute growth is the rate of increment in size over a given year (i.e., L_2-L_1), (1)

Where, L_2 and L_1 are two succeeding lengths separated by time interval (1y). Relative rate of increase is the increment between two age groups divided by the length at a younger age (expressed as a percentage).

$$\text{i.e., } \frac{(L_2 - L_2)}{L_1} \times 100 \qquad (2)$$

while the instantaneous rate of growth is the difference between natural logarithms (Wn) of weight or length (Ln) for consecutive groups (Ricker, 1975)

$$\text{i.e., } g = LnL_2 - LnL_1 \qquad (3)$$

L_1 and L_2 are the succeeding lengths separated at one year interval.

The unobserved Lmax reached by the crab of a given stock was estimated by adopting the theory of extreme values proposed by Gummel (1954). This theory assumes that lengths are continuous; and that samples from which the extreme lengths are drawn have a constant distribution with fixed parameters and that the extreme lengths are taken from independent samples. $Lmax_2$ is the maximum length of the crab species calculated based on the formula by Taylor (1962)

$$Lmax = L_\infty\ 0.95 \qquad (4)$$

The annual growth parameters (L_∞, K and t_o) of the crab were determined using the Von-Bertalanffy's (1938) growth function (VBGF). The growth parameters were estimated from the equation;

$$L_t = L_\infty\ (1 - e^{-k}(t - t_o) \qquad (5)$$

Where: L_t is the predicted length at age t,
L_∞ =asymptotic length i.e. the length the crab will attain at a very old age.
K =Von Bertalanffy growth coefficient defined as the rate at which the asymptotic is approached.
t = the age of the crab
t_o = the theoretical age when the crab size is zero.

L_t was estimated using Pauly's integrated length frequency distribution plot as the points where the growth line of the distribution plot cut the histogram along the time axis.

The modified Powell-Wetheral plot routine formulated by Wetheral (1986), following up on the work of Powell (1979) and incorporated as a routine in FiSAT, software package (Gayanilo *et al.,* 1995) was used to determine the asymptotic length (L_∞) and ratio of the coefficients of total mortality (Z) and growth coefficient (Z/K). In this routine, t_o was replaced by the co-ordinates of a point described by a starting sample (SS) and starting length (SL). The K values were obtained by an automatic routine in ELEFAN known as Scan of K- values. The best K value was indicated by the highest value of Rn (Goodness of fit index).

The principle involved in evaluation of growth parameters through the Powell-Wetherall plot is explained as follows:

Loo and K values were obtained from the Ford-Walford plot (Pauly, 1983) of L_t+ 1 (length separated by one year interval against L_t and fitting the line by least squares linear regression equation:

$$L_t + 1 = a + bL_t \tag{6}$$

$$L_\infty = \frac{a}{1-b} \tag{7}$$

Where: a = (L_t + 1) axis intercept
b = slope of regression line
(i.e., L_t +1/L_t)

$$Z/K = \frac{(1+b)}{(1-b)} \tag{8}$$

L_∞ was also the value of L_t at the point of intercept of the regression line with 45° line at which point $L_t = L_t + 1$.

The asymptotic lengths were obtained from three sources:

- L_∞ a, defined the asymptotic lengths obtained from the Powell-Wetherall plot as incorporated in FiSAT.
- L_∞ b, refers to asymptotic length assessed through the length- at –age routine in FiSAT.
- The final L_∞ was evaluated using the ELEFAN 1 routine with the growth curves superimposed on the length-frequency plot. The best pair of growth parameters (L_∞ and K) were obtained using the automatic search routine in ELEFAN 1. The best pair of growth parameters was obtained through the provided goodness of fit indices.

L_∞ could also be estimated with the formula:

$$L_\infty = L_{max} \times 0.95$$

(Pauly and Martusobruso, 1980) Where; L_{max} = the length of the longest fish in the sample. K was calculated as:

$$K = Log_e\ b$$

t_o was estimated by ploting

$$L_n (L_\infty - L_t)/ L_\infty = a + bt \tag{10}$$

Where;
a = L_n (L_∞ - L_t/L_∞) axis intercept
b = slope of regression line.

The intercept of the straight line on t – axis gave t_o.

Another parameter introduced in ELEFAN 1 is the Winter Point (WP). This is an optional parameter that designates time of the year (expressed as fraction of a year) when growth is slowest.

Winter point (WP), which has the formula:

$$WP = t_s + 0.5 \tag{11}$$

Where, t_s is the age at the beginning of growth oscillation, i.e. the time of year when growth is slowest (Pauly, 1987).

ELEFAN 1 identifies the peaks in the length-frequency samples and searches for the best combination of growth parameters (L_∞, K, C, WP) using a goodness-of-fit index (Rn) (Pauly, 1987).

From the final estimates of L_∞ and K, the growth performance index (ϕ) of *C. amnicola* was calculated with the formula:

$$\phi = Log_{10}K + 2Log_{10} L_\infty \tag{12}$$

(Pauly and Munro, 1984) as incorporated into the scan of k-value routine.

Where;
K = growth coefficient of Von Bertalanffy growth formula:
L_∞ is the asymptotic carapace length.

Tmax was calculated according to Pauly (1983)

$$T\max = 3/K \tag{13}$$

Where:
Tmax = maximum age of the crab
K = growth coefficient of the Von Bertalanffy Growth Formula (VBGF)

RESULTS

The monthly carapace length-frequency data used for the estimation of growth parameters in *C. amnicola* are given in Table 1. The size classes 30-39.9 mm and 40-49.9 mm constituted the highest with 31.0% and 31.5% respectively. Very small size class below 10mm was completely absent and largest size group (70-79.9mm) were very few (0.2%).

The relative ages, modal carapace length- at- age and annual increment of the different sexes of *Callinectes amnicola* obtained are presented in Table 2. The results of the modal length-at-age revealed that all the sexes of *Callinectes* belonged to the age groups 1 to 3 years. Four year classes with modal classes ranging from

Table 1: Monthly Carapace Length Distribution of *Callinectes amnicola* in Okpoka Creek

Size Class (mm)	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total	%
	Freq.	Freq.	Freq.	Freq.	Freq.	Freq.	Freq.	Freq.	Freq.	Freq.	Freq.	Freq.		
0 – 9.99	0	0	0	0	0	0	0	0	0	0	0	0	00	0
10 – 19.99	27	22	25	20	18	12	13	13	11	21	21	28	231	3.1
20 – 29.99	183	123	157	88	161	74	84	43	48	107	113	132	1313	17.7
30 – 39.99	188	175	260	189	240	174	182	187	201	149	186	166	2297	31.0
40 – 49.99	194	176	184	195	218	174	172	184	173	198	250	221	2339	31.5
50 – 59.99	75	79	84	74	69	64	76	70	65	75	88	94	913	12.3
60 – 69.99	32	26	32	19	16	17	15	25	27	30	36	38	313	4.2
70 – 79.99	3	1	2	0	0	0	0	0	0	1	2	4	00	0.2
Total	788	602	744	585	722	512	542	522	525	581	696	683	231	

Table 2: Carapace Length-at-age and annual increment of the different sexes of *Callinectes amnicola*.

Sex	Age (Y)	Modal length (mm)	Annual increment (mm)	L_{T+1}
Male	0+	6.7	6.7	36.7
	1+	36.7	30.0	54.2
	2+	54.2	17.5	68.3
	3+	68.3	14.1	-
Female	0+	5.0	5.0	49.2
	1+	49.2	44.2	67.5
	2+	67.5	18.3	78.3
	3+	78.3	10.8	-
Combined sexes	0+	5.8	5.8	45.0
	1+	45.0	42.5	63.3
	2+	63.3	18.3	75.8
	3+	75.8	12.5	-

Table 3: Absolute, Relative and Instantaneous rates of increase in Carapace Lengthat-age of the different sexes of *Callinectes amnicola* from Okpoka Creek, Upper Bonny River, Niger Delta, Nigeria

Characteristics	Sex	Year Class		Annual Mean
		1-2	2-3	
Absolute increment (mm)	M	17.5	14.1	20.53
	F	18.3	10.8	24.43
	CS	18.3	12.5	24.43
Relative increment (%)	M	47.7	26.0	36.85
	F	37.2	16.0	26.60
	CS	40.7	19.7	30.20
Instantaneous rate of increase	M	0.390	0.231	0.311
	F	0.316	0.148	0.232
	CS	0.341	0.180	0.261

N/B: M = Male; F = Female; CS = Combined Sex

6.7–68.3mm for males; 5.0–78.3 mm for female and 5.8–75.8mm for combined sex. The annual carapace length increment was highest in year class 1+ and declined with time for both sexes and combined.

The results of the absolute, relative increments and the instantaneous rates of increase are presented in Table 3. The absolute increment was: male (17.5 mm for 1-2 y, 14.1 mm for 2-3 y and 20.53 mm annual mean); female (18.3 for 1-2 y, 10.8 for 2-3 y and 24.43 annual mean) and combined (18.3mm for 1-2 y, 12.5 mm for 2-3 y and 24.43 mm annual mean). Relative increment was male (47.7% for 1-2 y, 26.0% for 2-3 y and 36.85% annual mean); female (37.2% for 1-2 y, 16.0% for 2-3 y and 26.60% annual mean) and combined (40.7% for 1-2 y, 19.7% for 2-3y and 30.20% annual mean). Instantaneous rate of increase was male (0.390 for 1-2y, 0.231 for 2-3y and 0.311 annual mean); female (0.316 for 1-2 y, 0.148 for 2-3 y and 0.232 annual mean) and combined (0.341 for 1-2 y, 0.180 for 2-3 y and 0.261 annual mean).

The results of the estimated growth parameters L_∞, K, t_o and ϕ' based on the FISAT software are shown in Table 4. Results result from the FISAT software; a modified Powell-Wetherall plot was L_∞ (61.80mm), K (0.995 y^{-1}) and Z/K (1.694). The length – at age data was L_∞ (61.80mm), K (2.10 y^{-1}), t_o (1.220), ϕ (3.90) and Rn(0.122) ELEFAN 1 scans routine was L_∞ (61.80), R (2.10), ϕ (3.90) and Rn (0.121). The non-seasoned version of the Von Bertalanffy Growth Function (VBGF) was L_∞ (87.305mm), K (0.636 y^{-1}), t_o (0.889) and ϕ (3.685). The longevity or maximum age (Tmax) was 4.7 years. The overall growth parameters obtained were: L_∞=61.80, K= 1.244y^{-1}, t_o = 1.0545, Z/K = 1.694, R=0.995, ϕ =3.825 and Rn =0.121.

DISCUSSION

The variation in size of crabs used for this study icompared favourably with other previous studies. Variation in sizes may be indicative of high fishing mortality at the Okpoka creek. This is explained in Tagatz (1968), Murphy and Kruse, (1995) and Guillory (1997). They reported that directed fishing mortalities from illegal harvest of blue crabs and indirect fishing mortality have important management implications because many juveniles approaching maturel size are impacted and probably results in reduced catch of larger size crabs. Secondly, the lower proportion of adult *C. amnicola* in the crab population suggests a drastic adjustment, probably of a density-dependent compensatory nature, in the size of the crab cohort, during the early life history stages.

Cannibalism has been identified as a feature in aquatic organisms that leads to density-dependent overcompensation (Rosas *et al*., 1994). *Callinectes amnicola* is said to be cannibalistic and this may be the principal cause of density-dependent mortality during the early life history stages of the species. Similar observation was made by Enin (1998) on *Macrobrachium vollenhovenii* in his work on the status of the *Macrobrachium* fishery in the Cross River estuary. The fairly higher body dimensions showed by males and females of *C. amnicola* in Okpoka creek are probably due to the fact that the creek is productive and environmentally stable as suggested by Silva-Castiglioni *et al.* (2004).

Table 4: Growth parameters of *C. amnicola* in Okpoka Creek, Upper Bonny River, Niger Delta, Nigeria

Application	L_∞ (mm)	R	K y^{-1}	Z/K	t_o	ϕ	*Rn*
Powell-Wethral Plot	61.80	0.995	-	1.694	-	-	-
Length-At-Age Data	61.80	-	2.10	-	1.220	3.90	0.122
ELEFAN 1 SCAN ROUTINE	61.80	-	2.10	-	-	3.90	0.121
Non-Seasonalized VBGF	87.305	-	0.636	-	0.889	3.685	-

L_∞ = Asymptotic length (i.e, length to be attained at infinite age)
r = Correlation coefficient
k = Growth coefficient expressing rate of growth per year
t_o = Hypothetical age (year) at which length is zero
Z/K = Ratio of the coefficient of total mortality and growth coefficient
ϕ = Growth performance index
Rn = Goodness of fit index

The males and females *C. amnicola* live for three years (1+, 2+ and 3+). This varied slightly from other studies. Silva–Castiglioni *et al.* (2004) working on the Somatic growth of the mudflat fiddler crab (*Uca rapax*) from two subtropical mangroves in Brazil reported that the crabs from Hamambuca reached their maximum age in four years, five months (males) and five years (females). Further more they reported that crabs from Ubatumirim in Brazil, males lived four years and females, four years and three months. Montague (1980) observed that fiddler crabs from temperate zones rarely live more than two years, but *Uca pugnax* may live for more than four years.

The age similarities in sexes of the crabs observed can be attributed to stable habitat quality and food availability. This observation tallied with the reports of Bond and Buckup (1983) reported that sexual differences in age of crabs can be related to the habitat quality, food availability and physical or physiological stress. It was observed that difference in modal lengths existed among the various groups encountered. These differences may be due to the level of maturity, size and sex of the crabs and the abundance of the similar sizes as noted by George (1997). It was also observed from the estimated absolute and relative increments values that the rate of growth in length is faster in the younger ages of the male than the female. In all the sexes of *C.amnicola*, growth in length was observed to decrease with increasing age.

The growth coefficient K value (0.639 y^{-1}) estimated for *C. amnicola* is indicative that the species has a fast growth rate and is in contrast with values obtained for other species of crabs by Silva-Castiglioni *et al.* (2004). They reported K = 0.21 (males) and 0.16 for *Uca rapax* from Ita Mambuca mangrove in Brazil. These contrasting results are expected as reported by Sparre and Venema (1992).

Sparre and Venema (1992) reported that growth parameters differ from species to species and also stock to stock even within the same species as a result of different environmental conditions. In fact, Isaac (1990) is of the view that estimating growth parameters from ELEFAN 1 programme to give best K value is often biased. This was due to factors such as individual variability in growth parameters, seasonal oscillations in growth, size-dependent selection, variable recruitment period and large length-class intervals used in grouped length data.

He further reported that ELEFAN 1 programme, tend to overestimate L_∞ and underestimate K as the width of the length-class intervals increased. This tendency was however not observed in the study by Enin (1995) of *Macrobrachium macrobrachium* at the Cross River Estuary of Niger Delta.

In this study, the growth performance index ϕ of the species was 3.825. The Okpoka creek is a stable environment (Enin *et al.,* 1996; kingdom, 2006). The estimated longevity or maximum age (Tmax) value of (4.7 years), showed that *C. amnicola* from Okpoka creek are short-lived. The observation compared favorably with the report by Silva-Castiglioni *et al.* (2004) on *Uca rapax* from two subtropical mangroves. (Itamambuca and Ubatumirim) in Brazil. According to their report, the crabs from Itamambuca reached their maximum age in 1620 days (males) and 1800 days (females), while those from Ubatumirim, required 1440 days (males) and 1560 days (females).

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