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A Study of Growth Pattern Sex Ratio and Condition Factor of Swimming Crab (*Callinectes amnicola*) from Iwofe Fish Landing Site, Rivers State Nigeria

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Abstract

Samples of *Callinectes amnicola* were collected from Iwofe fish landing site in New Calabar River for the study of its growth pattern, sex ratio and condition factor. A total of 624 crab specimens were collected once in amonth, for the period of 3 months between May and July 2017 from fishers that obtained catches from the wild. They were identified using standard fish identification keys. Lengths-weights, sex ratios and condition factor were calculated according to standard methods. Data were subjected to Food and Agricultural Organisation (FAO)-ICLARM Stock Assessment Tools (FISAL II and Microsoft Excel for regression analysis. The overall "b" values were 2.0269 (July), 1.7207 (June) and 2.0679 (May) for equation "W=a+b"CL. The "b" values showed negative allometric growth pattern. The "k" values for the combined months ranged between 3.76 and 15.95 (K>0.5), showed that C. *amnicola* from Iwofe fish landing site is healthy and sustained good environment.

Keywords: Length-Weight relationship; Allometric growth; Health condition; Sex; Callinectes amnicola; New calabar river; Nigeria.

1. Introduction

Most marine crabs belonging to the family of Portunidae are of large species which are edible and of commercial important. The swimming crab is a populous crustacean known as blue crab, inhabits areas close to shore in brackish water environments thereby attracting commercial and recreational fisheries in West Africa [1]. They are major source of protein in the diet of the coastal states in Nigeria.

Callinectes amnicola are known to live in muddy bottom in mangrove area. The life study of this blue crab shows that it is one of those organisms whose sexes are separate (gonochoristic). In Nigeria, *Callinectes latimanus*, *C. amnicola*, *C. pallidus* and *C. marginatus* are swimming crabs known as common crab species found in brackish and marine environments [2]. According to Chindah, *et al.* [3], years back crab fishery was not exploited because value was not placed on it as presently is. Harvesting was done by women but currently, all ages with basket trap, wire trap and lift net. *Callinectes* species are abundant all year round in its indigenous water body especially in the water mouth where it is caught in large quantity.

According to Bello-Olusoji, *et al.* [4] studies of relative growth in distinguishing features are of particular importance in commercially valuable crustaceans. The most frequently assessment are the body eight, total length and carapace length. These can be useful for further studies in providing reliable data to know the age and other aspect of crustacean population dynamics. Such knowledge can be useful in the development of suitable fisheries management programme which aids to figure out the condition, reproduction history, life history and the general health of the fish species.

Studies have showed that the spacing of the crab population is highly caused by the salinity of the environment changes and climatic conditions [4]. Due to the complex life cycle, hardiness and economic value of *C. amnicola*, many physiologists have also used it for experimental purpose [5]. Length-weight relationship studies morphometric analysis which used in stock assessment model in estimating the population size of aquatic species. This is an important fishery management tool and its importance is pronounced in estimating the average weight of fish at a given length group [6]. Moslen and Miebaka [7], had earlier stated that LWR is also important in studies of gonad development, rate of feeding, metamorphosis, maturity and well-being of fish and crustaceans. It was also reported that weight of crustaceans is related to the metabolism in each species and the environment where they live.

2. Materials and Methods

2.1. Study Area

The study was carried out at Iwofe Fish Landing Site of the New Calabar River, River State, Nigeria (figure1). The area is located between latitude 6º–5 5"E to longitude 4^0–49"N in Port Harcourt, Rivers State, Niger Delta,

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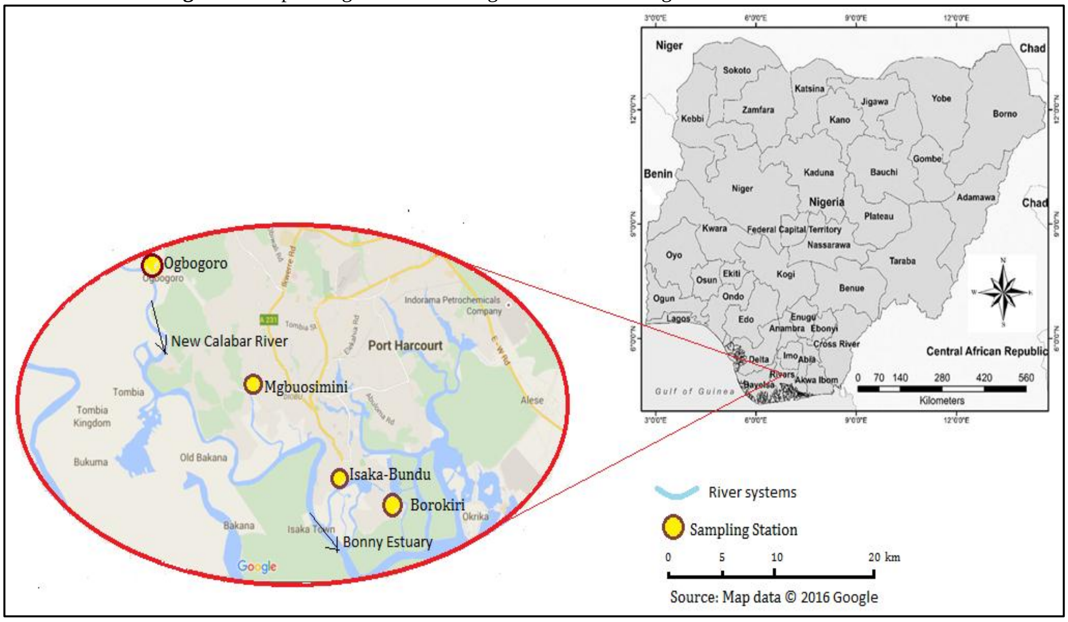
Nigeria. The area is in the oligohaline reaches, of mud-flat with mangroves such as *Rhizophora racemosa*, *R.mangle*, *Laguncularia racemosa*, etc. It also contains soft mud, sand, peat, etc. This area has a salinity ranging from 3 to 14.3 $^{0}/_{00}$ [8].

Figure-1. Map of Niger Delta showing Iwofe Fish Landing Site of New Calabar River



2.2. Sampling

Crabs used in this study were purchased monthly from local fishers in Iwofe between May and July 2017. A total of 624 crab specimens were examined. The crabs were caught with traditional gear such as basket trap; wire trap and circulation lift net. The collected samples were transported to the laboratory of Department of Fisheries and Aquatic Environment, River state University in a plastic ice-chest box.

Identification was carried out using an illustrated guide [9].

The specimens were identified by separating the sex of each crab: male and female, keys were used as a guide for further taxonomic identifications and descriptions of the species. Plate 1 shows the dorsal view of *C.amnicola* while Plate 2-3 shows the ventral view of male and female *C.amnicola* respectively.

The morphometric characteristics were measured such as, carapace length (CL) in centimeters (cm) and total weight (TW) in grams (g). The carapace length was measured to the nearest 0.1 cm from the tip of one lateral spine to the tip of the other lateral spine using sliding vernier caliper. The body weight (W) was weighed on an electronic kitchen Scale, (BO5-Model China) to the nearest 0.01 g.

2.3. Length-Weight Determination

Length frequency distribution patterns were determined from the carapace length measurements. Growth coefficients of the Length–weight relationship (LWR) were estimated from the regression equation:

Log W = Log a+ b Log L (r, n,) - - - - - (1)

Where W = weight (g) of the carbs, L = carapace length (cm), a = intercept (constant), b = slope of growth coefficient, r = correlation coefficient and n = sample size.

The values "a' and "b" were estimated from logarithmic transformation of equation (1) using the least square linear regression equation. The "b" values were used to determine the growth pattern (b=3-Isometric growth, b>3=Positive allometric growth or b <3=negative allometric growth). Zar [10] regression equation was used to analyses the Length-Weight Relationship. The condition factor (K) of the crabs was determined from the relationship between carapace length and body weight measurements using the equation:

K = 100.W. L. [11]

Where: K = Condition factor, W = Crab body weight (g) and L = Carapace length (cm)

The sexes were distinguished by using the species conspicuous external morphological features of male (T-shaped abdomen) and females (triangular or rounded aprons) [9]. The chi-square (x^2) analyses were to compare male and female ratio.

$X^2 = \Sigma (O_i - E_i)^2/_{Ei}$

Where: Σ = Summation, O_i = Observed ratio, E_i = Expected ratio.

2.4. Statistical Analyses

Data collected was subjected to FAO–ICLARM Stock Assessment Tools (FISAT 11) for length-weight relationship and Microsoft Excel (2007) was used to analyse data for sex ratio, analysis of variance (ANOVA), means standard error, minimum, maximum and range of lengths-weight and condition factors.

Plate-1. Dorsal view of *C. amnicola*

Plate-2. Ventral view of male *C. amnicola*

Plate-3. Ventral view of Female *C. amnicola*

3. Results

3.1. Length-Weight Relationship

The body weight of *C. amnicola* ranged between 44.38 g and 49.5 g with range value of 5.17 g (Table 1.1). The lowest mean carapace length (7.86±0.13 cm) was recorded in the month of July while the highest mean carapace length (8.19±0.11 cm) was observed in the month of June. In the month of July, the lowest mean body weight

(44.38±1.70 cm) was observed while the highest mean body weight (49.54±1.35 g) was recorded in the month of June as showed in Table 1.2.

Table-1.1. Overall Carapace lengths and body weights of *C. amnicola* from Iwofe fish landing site

Biometric index	N	Mean±SE	Min	Max	Range
Carapace length (cm)	624	8.02±0.10	7.86	8.19	0.33
Body weight (g)	624	46.49±1.56	44.38	49.54	5.17

N-number of samples; SE-standard error; Mini-minimum; Maxi-maximum

Table-1.2. Mean carapace lengths and body weights of combined sexes of *C. amnicola* from Iwofe fish landing site

	Carapace Length (cm)					Body Weight (g)				
Month	N	Mean± SE	Mini	Maxi	Range	N	Mean ±SE	Mini	Maxi	Range
May	161	8.02±0.14	1.1	11.6	10.5	161	45.56±1.70	5.91	99.09	93.18
June	289	8.19±0.11	0.5	11.9	11.4	289	49.54±1.35	6.82	103.18	96.36
July	174	7.86±0.13	4	12.6	8.6	174	44.38±1.70	6	128	122

N-number of samples; SE-standard error; Mini-minimum; Maxi-maximum

Figure-2. Length-weight relationship of *C. amnicola* from Iwofe fish landing site in the month of May

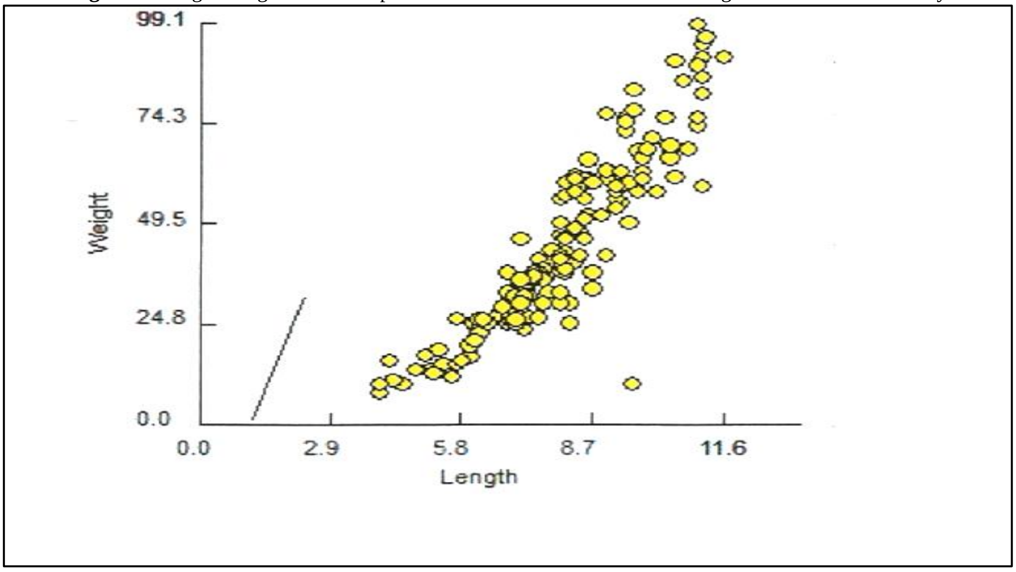


Figure-3. Length-Weight relationship of C. amnicola from Iwofe fish landing site in the Month of June

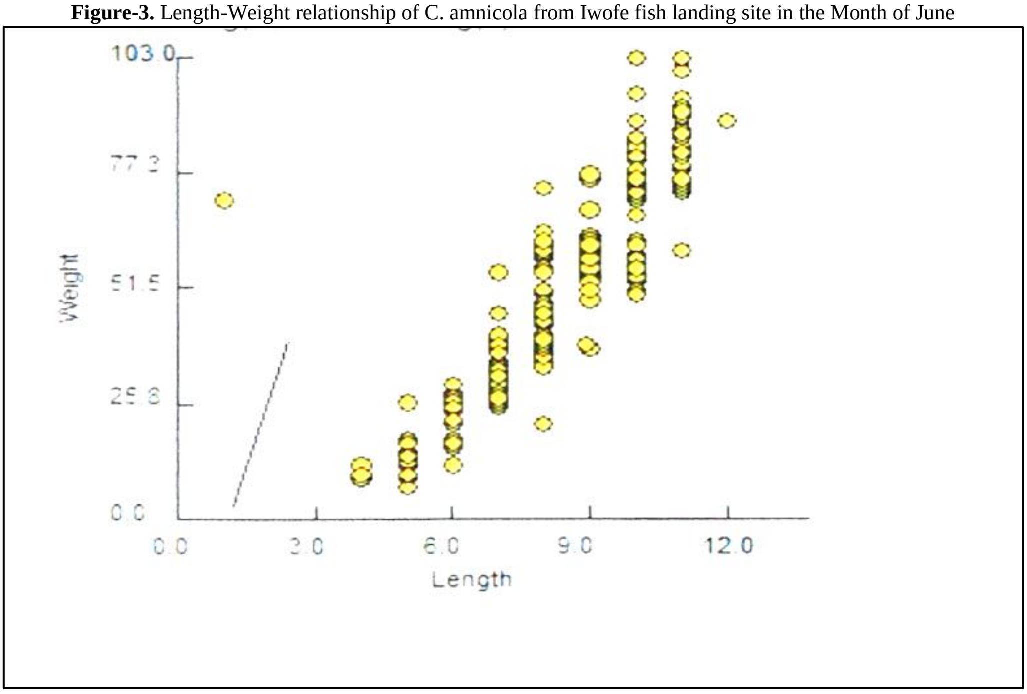
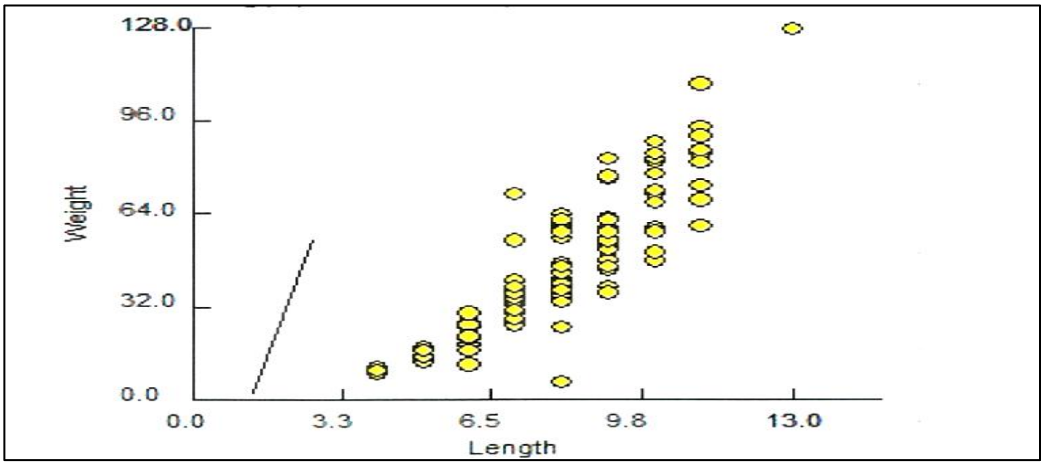


Figure-4. Length-Weight relationship of C. amnicola from Iwofe fish landing site in the Month of July



Length-weight relationship, minimum, maximum, number, range and mean ± SE used in the analysis are given in Table 1.2 to Table 1.4 for combined sex, male and female *C. amnicola* respectively and also shown in figure 5 6 7 8 9 10.

Table-1.3. Mean carapace lengths and body weights of male *C. amnicola* from Iwofe fish landing site

	Carapace Length (cm)					Body Weight (g)				
Month	**N**	**Mean± SE**	**Mini**	**Maxi**	**Range**	**N**	**Mean ±SE**	**Mini**	**Maxi**	**Range**
May	63	7.75	1.1	11	9.9	63	47.17	7.73	99.09	91.36
June	143	8.25±0.15	0.5	11.4	10.9	143	53.12±1.98	8.64	10.32	11.76
July	76	7.86±0.21	4.3	11.4	7.1	76	45.53±2.71	6	90.91	84.91

N-number of samples; SE-standard error; Mini-minimum; Maxi-maximum

Figure-5. Length-Weight relationship of *C. amnicola* from Iwofe fish landing site in the Month of May for males

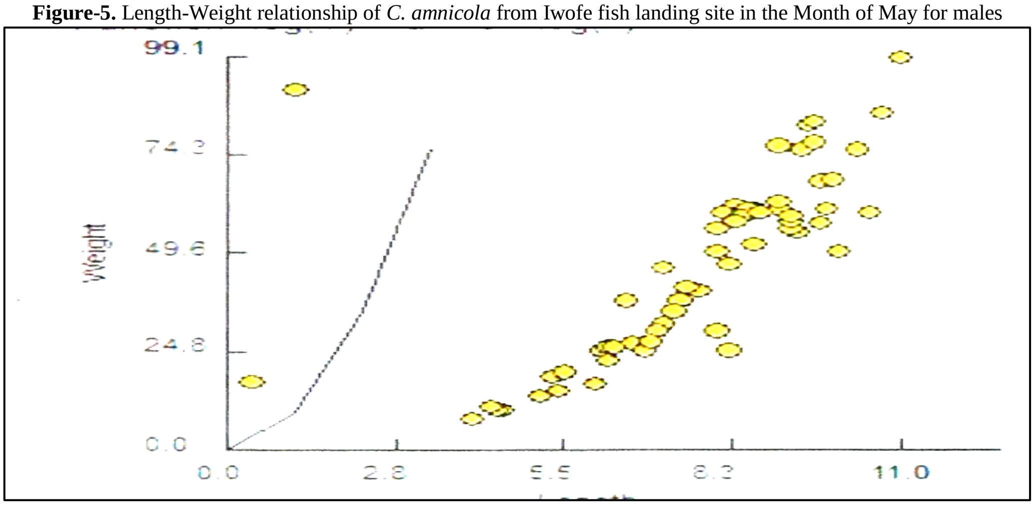


Figure-6. Length-Weight relationship of *C. amnicola* from Iwofe fish landing site in the Month of June for males

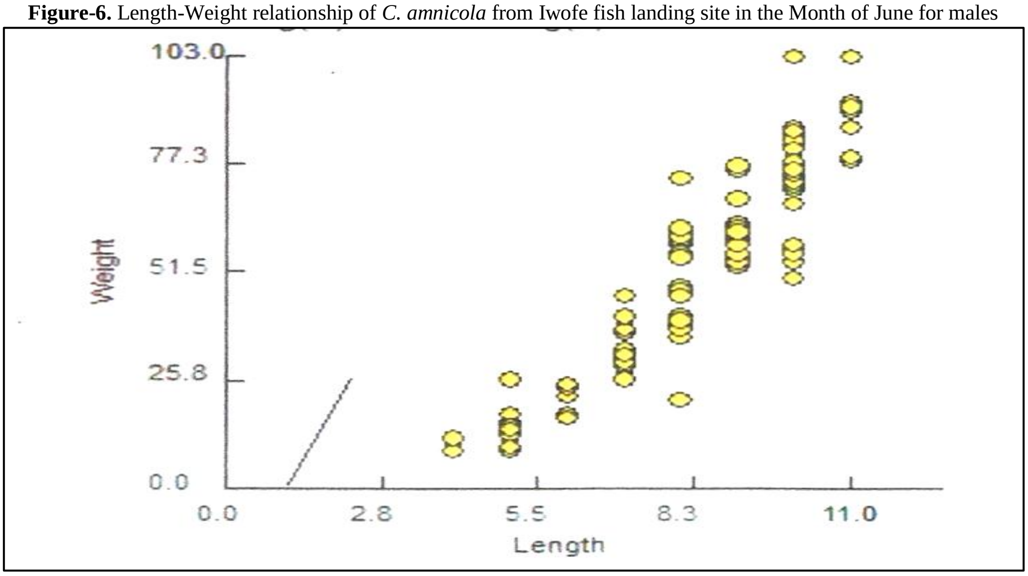


Figure-7. Length-Weight relationship of *C. amnicola* from Iwofe fish landing in the Month of July for males

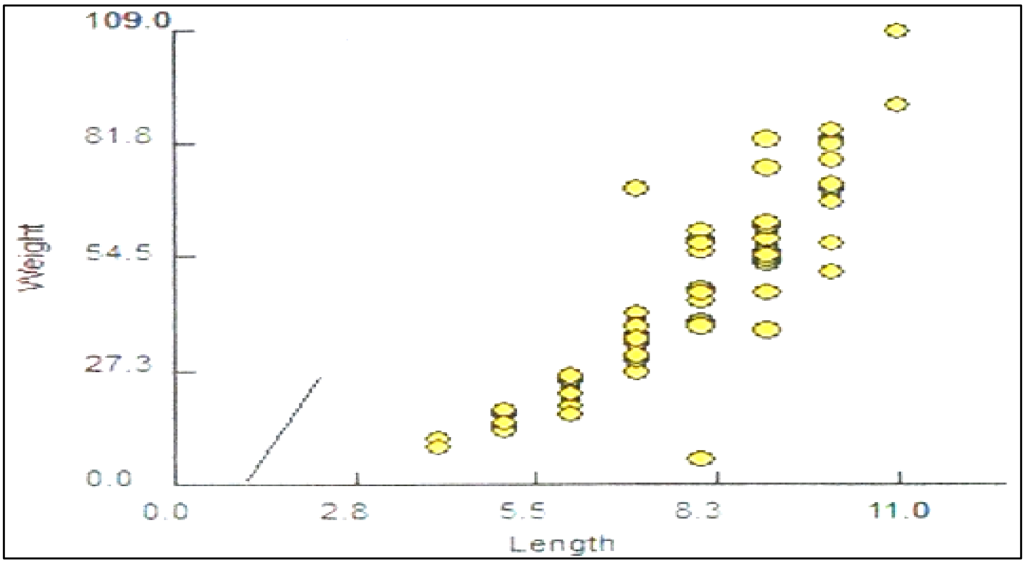


Table-1.4. Mean carapace Lengths and Body Weights of female *C. amnicola* from Iwofe fish landing site

	Carapace Length (cm)					Body Weight (g)				
Month	**N**	**Mean± SE**	**Mini**	**Maxi**	**Range**	**N**	**Mean ±SE**	**Mini**	**Maxi**	**Range**
May	98	8.74±0.24	5.6	11.1	5.5	45	50.05±3.01	11.82	94.09	82.27
June	146	8.13±0.15	4	11.9	7.9	145	46.09±1.81	6.82	99.55	92.73
July	98	7.86±0.16	8.6	12.6	4.8.6	98	41.96±1.91	6.82	94.09	87.27

N-number of samples; SE-standard error; Mini-minimum; Maxi-maximum

Figure-8. Length-Weight relationship of *C. amnicola* from Iwofe fish landing site in the Month of May for Females

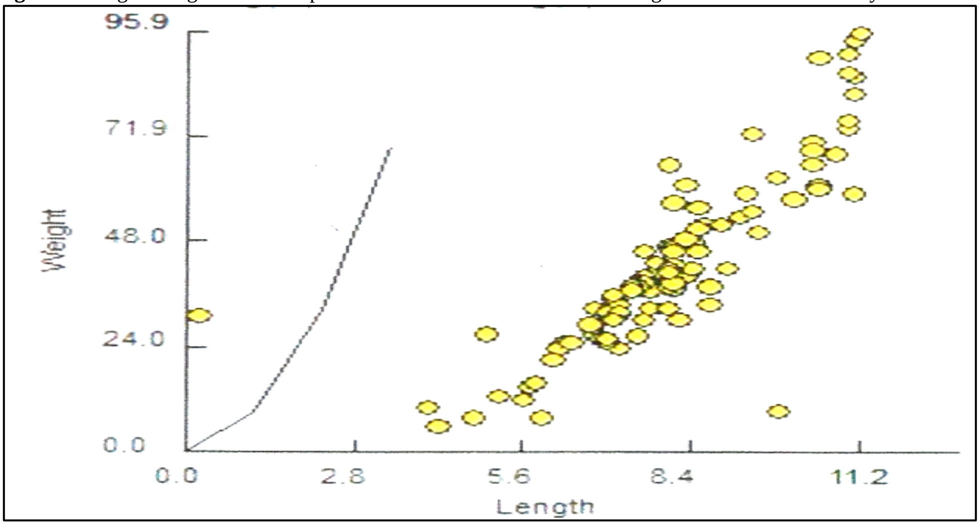


Figure-9. Length-Weight relationship of *C. amnicola* from Iwofe fish landing site in the Month of June for Females

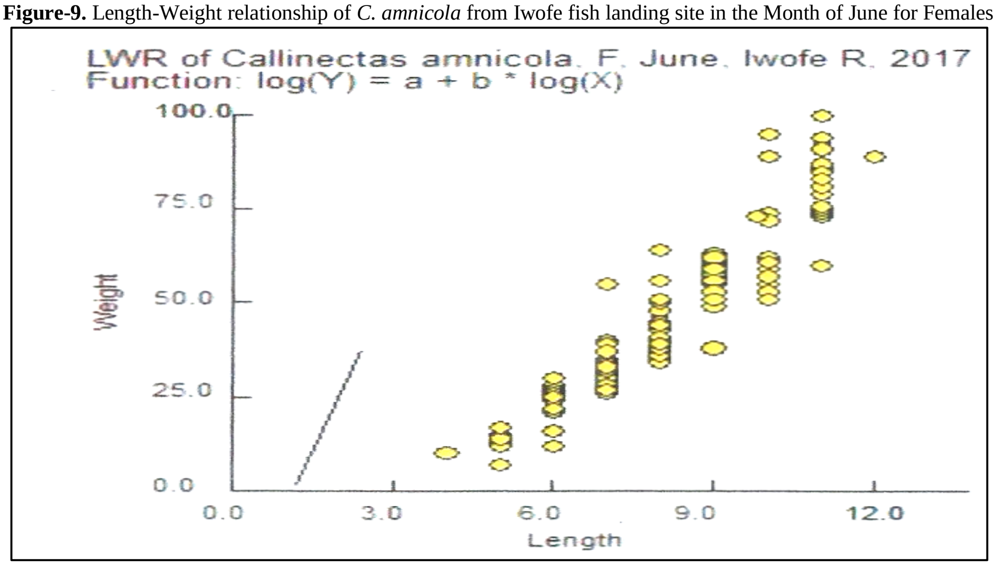
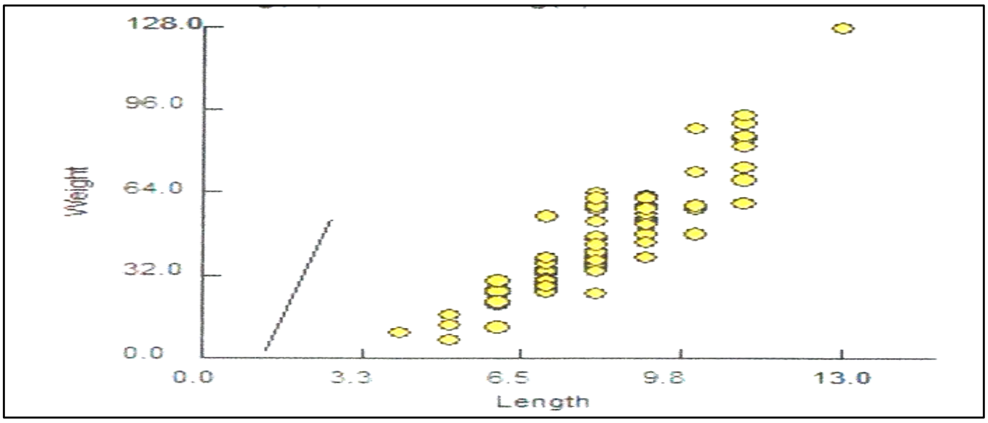


Figure-10. Length-Weight relationship of *C. amnicola* from Iwofe fish landing site in the Month of July for females



3.2. Growth Pattern of C. amnicola Using Length-Weight Relationship

The growth pattern were attained using the logarithm equation Log W = a + b * Log, as observed (Table 2.1 and 2.2) for combined sex which showed negative allometry in the months. Growth pattern were observed in both males and females of *C.amnicola* as negative allometry.

The coefficient of correlation (r) obtained for combined sex, males and females were lesser or equal to 1. The length-weight relationship for *C. amnicola* gave a negative value of b that is than 3 for both sexes and for individual gender.

The monthly scattered diagram with the use of regression analysis relationships of log weight and log length are shown in figures above for combined sex (figures 2-3-4), males (figures 5-6-7) and females (figures 8-9-10) of *C. amnicola*.

Table-2.1. Overall Growth pattern using length-weight of *C. amnicola* in relation to months

Month	a	b	r^2	Growth pattern
May	-0.2486	2.0679	0.8544	Negative allometric
June	0.0894	1.7207	0.6957	Negative allometric
July	-0.1986	2.0269	0.8385	Negative allometric

Notes: a = y-intercept, b = growth coefficient, r2 = sample correlation coefficient

Table-2.2. Growth pattern using length-weight relationship of *C. amnicola* in males and females

Males					Females			
Month	a	b	r^2	Growth pattern	a	b	r^2	Growth pattern
May	0.8338	0.8432	0.3735	Negative allometry	0.8459	0.8211	0.3411	Negative allometry
June	-0.2912	2.1583	0.9021	Negative allometry	-0.1883	2.004	0.9083	Negative allometry
July	-0.1918	2.0277	0.8457	Negative allometry	-0.1304	1.9419	0.8911	Negative allometry

Notes: a = y-intercept, b = growth coefficient, r2 = sample correlation coefficient

The condition factor (K) shows the well-being of *C. amnicola*. The present study showed that the K values of combined sex, males and females ranged in various months (Table 3.1 and 3.2). From the study, the lowest “k” values were recorded in the month of May (8.34±0.16) for combined sex (Table 3.1), the month of June (8.85±0.16) for males and the month of May (7.44±0.27) for females (Table 3.2).

Table-3.1. Condition factor of *C. aminicola* from Iwofe fish landing site (combined sex)

Month	Mean ±SE	N	Mini	Max	Range
Combined sex	8.64±0.17	624	8.34	8.91	0.57
May	8.34±0.16	161	3.76	15.63	11.87
June	8.68±0.12	289	4.17	15.95	11.78
July	8.85±0.16	174	4.17	15.95	11.78

Table-3.2. Condition factor (K) of male and female *C. amnicola* from Iwofe fish landing site

Males						Females				
Month	N	Mean ±SE	Mini	Max	Range	N	Mean ±SE	Mini	Max	Range
May	63	9.18±0.27	4.53	15.62	11.09	45	7.44±0.27	4.32	14.48	10.16
June	143	8.85±0.16	4.17	15.95	11.78	145	8.51±0.19	4.94	15.37	10.43
July	76	9.35±0.25	5.6	15.62	10.02	98	8.58±0.22	4.3	15.37	11.07

A total of 624 specimen of *C. amnicola* consisting of 282 males and 342 females crabs were used to calculate of sex ratio. The ratio value of male to female in the month of May, June and July was 1:1.56, 1:1.02 and 1:1.29 as shown (Table 4.1). It was observed that female crabs were the abundant sex with a significantly difference (X^2-calculated = 5.78, X^2 Tabulated (df at P<0.1 = 5.578) from the expected and theoretical ratio of 1male:1female.

Table-4.1. Sex ratio and percentage (%) of *C. amnicola* in Iwofe, River State

Sex					**Percentage (%)**	
Months	**M**	**F**	**N**	**Sex Ratio**	**M**	**F**
May	63	98	161	1:1.56	39.1	60.9
June	143	146	289	1:1.02	49.5	50.5
July	76	98	174	1:1.29	43.7	56.3
Total	282	342	624	1:1.21	45.2	54.81

Table-4.2. Chi-Square test analysis on sex ratio from Iwofe, River State

Sex	**Observed Oi**	**Ep (Ei)**	**OE**	**$(O\text{-}E)^2$**	**$(O\text{-}E)^{2/E}$**
M	282	312	30	900	2.89
F	342	312	30	900	2.89
Total	624				5.78

4. Discussion

The observed carapace length and body weight of *C. amnicola* in the present study agreed with the previous study of Okon and Sikoki [12]. Differences in size observed in this study concorded with Murphy and Kruse [13] which might be due to high fishing mortality; which could be either from direct fishing mortalities of illegal harvest of *C. amnicola* or indirect fishing mortality which have important management and affects Juveniles approaching matured sizes which are impacted and may reduce catch of larger size crabs. Length-weight relationship (LWR) and growth pattern of *C. amnicola* was observed. The "b" value recorded in the present study showed negative allometric growth pattern of *C. amnicola* in agreement with Khairenizam and Norma-Rashid [14]. When the "b" value is less than 3, the fish has a negative allometric growth pattern, when it is above, has a positive allometric growth pattern but when it is equal to 3, has an isomeric growth pattern [14]. The "b" value obtained in *C. amnicola* in the present study concorded with Okon and Sikoki [12] on the study of length-weight relationship and condition factor of West Africa fidder crab *Uca tangeri* in Mbo River, Akwa Ibom State, Nigeria of "b" value 1.6431, indicating negative allometric growth. The study of Shinkari, *et al.* [15] on some aspects of biology of *Distichodas rostratus* in River Rama, North- Western Nigeria, agreed with the present observation of "b" values for combined sex, females and males. However, George, *et al.* [16] reported "b" values for all sexes ranged from 2.336 to 2.56 (males) and 2.2367 to 2.536 (females). The LWR showed negative allometric growth in all the sexes.

The growth coefficient "b" values have some implications and significant impacts on the well-being of fish (shell fish) and fishery. The negative allometric (b <3) means that the crabs are lighter than their body lengths. Positive allometric shows that crab are heavy and also implies that they are heavier than their lengths. The present study compare the study by Aderinola, *et al.* [17] for *Callinectes pallidus* in Ojo Creek Lagos State, which recorded "b" values of 22.73 (males) and 21.83 (females). Sparre [18], observed "b" values changes depends primarily on the morphometric: shape and size, species, seasons, water and atmospheric temperature, water salinity, food (quality and quantity), sex and maturity stage of the species. Bayenal and Braun [19], recorded that LWR is affected by several ecological factors physical, biological and chemical including maturity of gonad, sex, diet type, fullness of stomach, health and preservation techniques as well as season and habitat. However, Mommsen [20] and Henderson [21] reported that sample size and species length spacing within different areas or habitat suitability also affect their body weights. Bayhen, *et al.* [22], reported LWR parameters may also vary within the same species, due to feeding, reproduction and fishing activities, environmental changes, individual metabolism, sexual maturity and age.

The condition factors (K) showed the level of well-being of aquatic organisms. The present study indicated that *C. amnicola* of Iwofe fish landing site were healthy. In this study "K" values were concord with Aderinola, *et al.* [17] of *C. pullidus* in Ojo Creek, Lagos State, Nigeria from 63.33 as combined sex, 67.54 for males and 69.11 for females. High "K" value is an assumption of high feeding rate and gradual increase in accumulated fat that suggests readiness of a new reproduction period while low " K" means that the crab are lighter for their lengths an indication of low feeding intensity and spawning activity.

The male-female sex ratio in the present study showed females of *C. amnicola* as dominant sex. Kwei [9] reported that this could be criteria of the vast movement of the females into their nests to spawn while the male exhibited territorial behavior. Abundant females might be due to their movement in search of food to replenish weight lost in gonadal development, spawning and different habitat preferences between males and females. It is also observed mature females migrate for several periods of the year. Wet season may urge females searching for male partners for the purpose of reproduction and for this reason, more female crabs could be caught [23].

5. Conclusion and Recommendations

The present study of *C. amnicola* LWR shows that the crab growth pattern was negative allometric, indicating that, as the weight decreases, the length increases correspondingly. The LWR shows that *C. amnicola* is good for commercial aquaculture production as length. Length of crabs and not the weight determines the selling price of crabs as crabs are sold by length. The sex ratio of *C. amnicola* in this study indicates that the females are more abundant than the males, which will favour *C. amnicola* aquaculture in terms of female broodstock development. The "K" value was higher indicating a healthy environment for *C. amnicola* in this present study. Therefore, this serve as baseline data for *C. amnicola* LWR, sex ratio and condition factor from Iwofe Fish Landing Site. It has also provided useful information in fisheries biology and fish population dynamics stock assessment for comparisons with future studies. This study recommends proper assessment and management of *C. amnicola* in New Calabar River, Nigeria. Also, it suggests continuous maintenance of the biological integrity of the New Calabar River through environmental surveillance.

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