Advances in Life Science and Technology
ISSN 2224-7181 (Paper) ISSN 2225-062X (Online)
Vol 7, 2013

Growth patterns, Sex ratios and Fecundity estimates in Blue Crab (*Callinectes amnicola*) from Yewa River, Southwest Nigeria.

Emmanuel Olugbenga Lawson* Rashidat Taiwo Oloko
Department of Fisheries, Faculty of Science, Lagos State University, Ojo. P.O. Box 001, LASU Post Office Box, Lagos, Nigeria. Tel: +2348089667287
*E-mail of the corresponding author: ollulawson@yahoo.com

Abstract
The present study investigates the growth patterns, sex ratios and fecundity estimates in Blue crab, *Callinectes amnicola* from Yewa River, Southwest Nigeria, between June 2011 and May 2012. Specimens were collected from Yewa River with basket traps (with non returned valve), gill and cast nets at depths between 1 and 15 metres. Morphometric data, body weight measurement, sex and number of ripe eggs (fecundity) were estimated from the crabs following standard methods. A total of 250 individuals measuring between 5.2 and 14.8 (10.75±1.98) cm long and weighing 8.2-165 (74.16±33.5) g in body weight were caught from Yewa River. The length-weight relationships were LogW=Log-0.96+2.72LogL (r=0.95) for males and LogW=Log-0.48+2.27LogL (r=0.95) for females. Growth was a negative allometry in *C. amnicola* with males exhibiting a better growth pattern. Condition factor variations were 2.14-9.48 (5.92±1.03) in males and 2.99-8.51 (5.49±0.95) in females. A total of 102 males and 148 females were encountered, given a sex ratio of 1male:1.45females. The sex ratio was significantly different ($X^2_{cal=8.46} > X^2_{tab\ (df=1,\alpha=0.05)=3.86}$) from the expected and theoretical 1male:1 female ratio. Fecundity estimates ranged from 260,000 to 2,150,692 (1,269,345.25±592.39) eggs for mature females. The linear relationships between fecundity/carapace length; and fecundity/body weight were LogF=Log0.383+3.21LogL (r=0.463) and LogF=Log0.333+1.38LogW (r=0.461) respectively. Conclusively, blue crab (*C. amnicola*) in Yewa River exhibited variations in their growth patterns, sex ratios and fecundity estimates when compared with the counterpact reports from the neighbouring water bodies.
Key Words: Length–weight, condition factor, morphometry, allometry, estuary.

1. Introduction

Callinectes amnicola is a famous blue crab of the family Portunidae. It is one of the most economically important swimming crabs inhabiting coastal waters of the tropical, subtropical and temperate regions, where it is a key resource in local fisheries. Blue crab, *Callinectes amnicola* is an inshore and demersal estuarine crab species. It occupies a variety of aquatic habitats from the lower reaches of freshwater rivers, estuaries to coastal marine waters and are highly mobile, making it feasible for them to move between areas and to select habitats (Micheli & Peterson, 1999; Ryer, *et al.,* 1997). It inhabits muddy bottoms in mangrove areas and River mouths (Defelice, *et al*., 2001). It is one of the most abundant estuarine macro invertebrates that support valuable commercial and recreational fisheries along the Atlantic and Gulf coasts (Guillory & Perret, 1998). 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 & Houde, 1999; Smallegange & Van Der Meer, 2003). Its morphology, abundance and size distribution form the basis for fish stock assessment. Blue crab forms one of the most important sea food organisms and readily available in large quantity in West African markets. The distribution of the population is greately influenced by the salinity of the environment and climatic conditions. Reviews on *C. amnicola* include Powell (1983), Jonathan & Powell (1989) on its taxonomy and distribution; Idoniboye-Obu & Ayinla (1991), Alfred-Ockiya (2000) and Oduro, *et al.* (2001) provided information on its nutritional composition. However, several reports on its ecology (Okafor, 1988; Arimoro & Idoro, 2007), morphometrics (Akin-Oriola, *et al*., 2005, Lawal-Are, 2009) and food and feeding (Chindah, *et al.,* 2000; Lawal-Are & Kusemiju, 2000; Arimoro & Idoro, 2007) were also documented. Blue crab provides an important potential link, transferring energy between benthic and pelagic food chains within the estuarine system (Longhurst, 1958; Scott, 1966; Pillay, 1967; Vankul, *et al.,* 1972; Warner, 1977; Baird & Ulaanowicz, 1993). Size composition, growth patterns and maturity of a related species, *Callinectes latimanus* was documented by Kwei (1978) in two Ghanaian lagoons. Chindah, *et al.* (2000) gave accounts of the food habits of *C. amnicola* from the New Calabar River, Lawal-Are & Kusemiju (2000) reported its size composition, growth pattern and feeding habits in Badagry Lagoon, Nigeria.

Yewa River in the Southwest Nigeria provides means of livelihood to the artisanal fishermen. Documented reports on fishes and fisheries of this important river are lacking, the present study therefore provides first documented reports on the growth patterns, sex ratios and fecundity estimates in Blue crab (*Callinectes amnicola*), one of the shell fishes that are found readily available in this water body. Baseline data from the study will provide useful source of information in fisheries biology and management; and other components of fish population dynamics and fish stock assessment.

2. Materials and Methods

2.1 Discription of Yewa River

Yewa River is a trans-boundary river between Republic of Benin and Nigeria. It lies approximately within latitudes N6^{0}22′ and 6^{0}36′ and longitudes E2^0 50′ and 2^0 54′ of the Greenwich Meridian. The basin has a total catchment area of approximately 5000 km^2 and is located within the West African tropical climate, which is under the influence of the tropical continental air mass and the tropical maritime air mass. Located around Yewa River are several fishing villages such as Atan, Ilaro, Ado-Odo, Apamu, Igunnu Akabo and Badagry town, whose inhabitants are mostly artisanal fisher folks from Awori, Egun, Ijaw, and Ilaje tribes. The river is known for logging and sand mining activities, these coupled with fishing make Yewa River a great economic interest to its inhabitants.

Yewa River is inhabited by several plants. Its major biotopes include the sedges (*Cyperus articulatus*, *C. papyrus*, and *Paspalum vaginatum*); the ferns (*Achrosticum* sp, *Marsilea* sp, *Cyclosorus* sp, and *Ceratopleris* sp) and the palms (*Pandanus candelabrum*, *Raphia hookeri*, and *Phoenix reclinata*). Atan and Ilaro streams in the north are the major sources of water to Yewa River, while it is drained by Badagry Creek (Nigeria) or Port Novo Creek (Benin Republic) in the south which empties into Atlantic Ocean via Lagos harbour. Despite an increased fishing activity on this water body, there was no documented report especially on its fishes and fisheries.

2.2 Collection of specimens

The nocturnal and diurnal collections of crab specimens were conducted on Yewa River between June, 2011 and May, 2012. Fishing gears such as non-return valve traps, gill and cast nets were implored in their collections, fishermen operating along the river were employed for the setting of gears and crabs collections. The specimens were preserved in 10 % formaldehyde in the field prior to their identifications.

2.3 Laboratory procedures

The specimens were identified and sexes sorted following Kwei (1978) and FAO (1990), the free encyclopedia (Wikipedia, 2011) was implored as a guide for further taxonomic identifications and descriptions of the species. The fishing gears were identified with reference to Catalogue of Small Scale Fishing Gears in Nigeria by FAO (1994). The morphometric measurements of the crabs such as lengths of the carapace, dactylus and palm; distance of the orbit; frontal, postero- and antero-lateral margins followed FAO (1990). The measurements of individuals were recorded to the nearest 1 cm. Body weight (BW) measurement was obtained from a Sartorious balance (Model: 1106) and recorded to the nearest 0.01 g.

2.4 Statistical analyses

The Statistical Package for Social Science (SPSS version 17) and Microsoft Office Excel software (Window 7) were applied in length frequency histograms, length-weight relationships (LWRs), sex ratios, and fecundity estimates of *C. amnicola*. All the statistical analyses were considered at significant level of 5% ($P<0.05$).

2.4.1 Carapace length frequency distribution

Length frequency distribution patterns of Carapace of *C aminicola* were determined from the carapace length measurements. The length frequency histograms were plotted from the class groups or cohorts of 0.0-4.9, 5.0-5.9, 6.0-6.9, 7.0-7.9, 8-8.9,………….., and 14-14.9 cm.

2.4.2 Carapace length- Body weight relationship

Growth coefficient or parameters of the length-weight relationship (LWR) was estimated from the regression equation:

$W = aL^b$ (Ricker, 1973) ……………………..(1)

The values ‘a’ and ‘b’ were estimated from logarithmic transformation of equation (1) using the Least Square Linear regression equation (Zar, 1996):

LogW = Loga + bLogL (r,n) ……………(2)

Where, W = crab body weight (in grams), L = carapace length (in centimetres), a (intercept) and b (slope) are growth coefficients; r=correlation coefficient, n=sample size.

The values of b determined growth allometry (b<3 or b>3) or isometry (b=3) of crabs in this study.

2.4.3 Condition factor (K)

The Condition factor (K) of the crabs was determined from the relationship between carapace length and body weight measurements using the equation:

$$K = 100.W.\ L^{-3} \text{ (Pauly, 1993)}$$

Where, W = crab body weight (in grams), L = carapace length (in centimetres).

2.4.4 Sex ratio

The sexes were distinguished by making use of the species conspicuous external morphological features, male by a T-shaped abdomen and females with their triangular or rounded aprons (Kwei, 1978, FAO, 1990). The sex ratio was expressed in term of the total numbers of males to females. The Chi-square (χ^2) test of fitness was applied to determine a departure from the expected or theoretical 1male:1female ratio. χ^2 was expressed as:

$$\chi^2 = \sum_i (O_i - E_i)^2/(E_i)$$

Where, $\sum_i$=Summation, O_i =Observed ratio, E_i=Expected ratio. The calculated and tabulated χ^2 values were compared at α=0.05 to determine level of significance.

2.4.5 Fecundity estimates

Fecundity of the total number of ripe eggs prior to spawning was estimated following Bagenal (1978). Relationships between fecundity and carapace length, and body weight measurements were expressed as:

LogF=Loga+LogL…………………………...(i)

LogF=Loga+LogW…………………………..(ii)

Where, F=fecundity estimates (eggs), L=carapace length (in centimetres), W=body weight (in grammes), 'a' and 'b' are derived from intercept and slope respectively.

3. Results

3.1 Morphometric measurements in *C. amnicola*

Table 1 presents summary of morphometric measurements of *C. amnicola* from Yewa River. The crab dactylus varied between 0.5 and 4.2 (2.40±0.51) cm, while palm, 0.2-4.0 (2.44±0.54) cm long. Distance of the orbit ranged from 1.3 to 2.3 (1.73±0.20) cm. Other measurements included: 1.2-4.8 (2.19±0.59) cm for frontal, 1.2-4.8 (2.72±0.83) cm for postero-lateral and 2.2-9.0 (4.53±1.15) cm for antero-lateral margins.

3.2 Carapace Length frequency distribution

The histograms of carapace length frequency distribution of *C. amnicola* in Yewa River are presented in Figure 1. The size of the crabs varied between 5.2 and 14.8 cm long, the mean value was 10.75±1.98 cm. Carapace length measurements ranged from 5.2-13.8 (9.07±1.84) cm in males and 8.3-14.8 (11.86±1.11) cm long in females. The figure presents histograms showing a unimodal size group.

3.3 Carapace length- Body weight relationship

In the present study the carapace measured between 5.2 and 13.8 (9.07±1.84) cm long, and 8.2-165 (48.10±28.64) g body weight for males, and 8.3 to 14.8 (11.86±1.11) cm long and weighed between 30.7 and 144.3 (92.12±28.28) g in females. A logarithm transfornations indicated a linear relationship between crab carapace length and body weight measurements. The relationships are expressed as:

LogW=Log-0.96+2.72LogL (r^2=0.95, n=102) for males……….. (Figure 2) and

LogW=Log-0.48+2.27LogL (r^2=0.79, n=148) for females ……… (Figure 3).

Growth coefficient (b) in *C. amnicola* showed negative allometry values (i.e. b=2.72 for males and b=2.27 for females). The regression equations revealed high correlation coefficient (r>0.70) values (i.e. r=0.95 for males and r=0.79 for females).

3.4 Condition factor (K)

Summary of the Condition factor in *C.amnicola* from Yewa River is presented in Table 2. Better values of K were exhibited by the female crabs, values between 2.14 and 9.49 (5.92±1.03) gcm $^{-3}$ were recorded for males and 2.99- 8.51(5.49±0.95) gcm^{-3} for female crabs.

3.5 Sex ratios

A total of 102 male and 148 female individuals were encountered giving a sex ratio of 1male:1.45females. Female crab was the dominant sex; however, the sex ratio was significantly different ($X^2_{cal=8.46} > X^2_{tab\,(df=1,\alpha=0.05)=3.86}$) from the expected and theoretical ratio of 1male:1female.

3.6 Fecundity estimates

A total of 122 female individuals with ripe eggs were encountered in the present study. These individuals represent 82.43 % of the total (148) female crabs encountered. Fecundity estimates varied between 260,000 and 2,150,692 (1,269,345.25±592.39) eggs for individuals measuring 8.2-14.8 cm long and 65-122 g body weight respectively.

The fecundity-carapace length relationship is presented as:

LogF= Log0.383+3.21LogL (r=0.463, n=122)……………….Figure 4.

The fecundity-body weight relationship is given as:

LogF=Log0.333+1.38LogW (r=0.461, n=122)……………….Figure 5.

Where, F=fecundity (in eggs), L=carapace length (in centimetres), W=body weight (in grammes).

4. Discussion

The morphometric profile of the *Callinectes amnicola* such as lengths of dactylus (0.5 and 4.2, 2.40±0.51 cm) and palm (0.2-4.0, 2.44±0.54 cm); and distance of the orbit (1.3-2.3, 1.73±0.20 cm). 1.2-4.8 (2.19±0.59) cm for frontal, 1.2-4.8 (2.72±0.83) cm for postero-lateral, and 2.2-9.0 (4.53±1.15) cm for antero-lateral margins obtained from this study (Table 1) may provide one of the useful tools when one considers taxonomy and racial study of crabs. Apart from Akin-Oriola, *et al*. (2005) on morphometric and meristic studies of two crabs, *Cardiosoma armatum* and *Callinectes pallidus* in adjacent Badagry Creek, the present study provides additional an report on morphometry of *Callinectes amnicola* from Yewa River. Morphometric measurements and meristic counts are some of the useful tools applicable in carrying out taxonomy and systematic study of fish (Lawson, 1998; Lawson, 2010; Lawson, *et al.,* 2011).

The size of the crab, 5.2-14.8 (10.75±1.98) cm long and 8.2-165 (74.16±33.5) g body weight reported in the present study compare favourably with other previous studies (Abowei & George, 2009). Size variations observed in Yewa River as supported by Tagatz (1968) and Murphy & Kruse (1995) may be indicative of high fishing mortality. Direct fishing mortalities from illegal harvest of blue crabs and indirect fishing mortality have important management implications because many juveniles approaching matured sizes are impacted and probably results in reduced catch of larger size crabs. Temperature, molting frequency, food availability nutritional quality and life stage of the individual may affect growth in crabs. Growth primarily occurs during molting, although small weight increases occur through relative changes in tissue content during the intermolt period (relative increases of whole body protein compared with moisture).

The length frequency distribution showed a unimodal size distribution and majority of the crabs were in the medium size group (Figure 1). Similar observation was reported by Lawal-Are & Kusemiju (2000) in Badagry Lagoon. However, Kwei (1978) reported only one predominant generation of crab sampled in Mukwe and Sakumo lagoons in Ghana. Linear relationship observed in the present study indicates corresponding increases in carapace length and body weight measurements.

The growth patterns of *C. amnicola* indicate negative allomery in males (b=2.72) (Figure 2) and females (b= 2.27) (Figure 3). This is supported by Arimoro & Idoro (2007) who reported a negative allometric growth in *C. amnicola* from Warri River and Lawal-Are & Kusemiju (2000) reports on Badagry Lagoon, Nigeria. However, the present study contradicts Akin-Oriola, *et al.* (2005) on Ojo Creek who reported positive allometric growth (b>3) in their study. The growth coefficient (b) values have some implications and significant impacts on the well being of fishes (including shell fish) and fishery. The negative allometric allometry (b<3) means the crabs were lighter than their body weights. Fish with high b (b>3) values are heavy for their lengths, while those with low b are lighter (Wootton, 1998). Positive allometry is an indication of crab's heaviness and by implication the crabs are heavier than their lengths. The change of *b* values depends primarily on the shape and fatness of the species, seasons or time of the years, temperature, salinity, food (quantity, quality and size), sex and stage of maturity (Sparre, 1992). The parameter *b*, unlike the parameter *a*, may vary seasonally, and even daily, and between habitats. Thus, the length-weight relationship is affected by a number of factors including gonad maturity, sex, diet, stomach fullness, health, and preservation techniques as well as season and habitat (Bagenal & Tesch, 1978; Gonçalves, *et. al.,* 1997; Taskavak & Bilecenoglu, 2001; and Özaydin & Taskavak, 2007). Others include seasonal variability of the environment and food availability (Mommsen, 1998; Henderson, 2005), sample size and the length interval within different areas (Morey, *et al*., 2003) or habitat suitability (Nieto-Navarro *et. al*., 2010). The LWR parameters may also vary within the same species due to feeding, reproduction and fishing activities (Bayhan, *et al*., 2008), environmental changes, individual metabolism, sexual maturity and age (Franco-Lopez, *et al.,* 2010).

The mean condition factor (K), 5.92±1.03 for males and 5.49±0.95 gcm $^{-3}$ for females (Table 2) showed that male crabs exhibited a better well being than the females in Yewa River. This is in agreement with reports of Lawal-Are & Kusemiju (2000). In fact, Warner (1977) reported that in true crabs, the males showed higher condition factor than the females. In contrast, Arimoro & Idoro (2007) reported higher K values in female crabs although their values in relation to sex did not show any significant difference. Like growth coefficients, K has impacts on the well being of some aquatic organisms. It varies from species to species, and changes according to morphology, sex, age, reproductive state associated with gonadic maturity stages variations (Frederick & Thomas, 1987; Wootton, 1999). Variations in K may also be indicative of food abundance, adaptation to environment and gonadal development of fish (King, 1995). Low K means the fish are light for their lengths, and indication of low feeding intensity and spawning activity. High K value is an assumption of high feeding intensity and gradual increase in accumulated fat that also suggests preparation for a new reproductive period (Braga and Gennari-Filho, 1990).

Sex ratio in the present study showed females as a dominant sex, this could be attributed to the vast movement of the females into their nests to spawn while the male exhibited territorial behavior (Kwei, 1978). Higher number of females may be due to their movement in search of food to replenish weight lost in gonadal development and spawning. Wet season may prompt females searching for male partners for purpose of reproduction, for this reason more female crabs could be caught. This is in agreement with Knuckey (1996). Sex and size distribution provide information on productivity, longevity, period of maturity, recruitment of various classes and determination of potential yield.

The present study indicates that *C. amnicola* was a low fecund crab, although 82.43 % of the females were riped with eggs. The fecundity estimates were 260,000-2,150,692 (1,269,345.25±592.39) eggs; these findings can be relatively compared with reviews of others. Truitt (1939) reported that egg production during a single spawning ranged from 723,500 to 2,173,300, but total number of females examined and possible reasons for fecundity variation were not discussed. 1.75×10^6 and $2x\ 10^6$ eggs per spawning were reported by Churchill (1921), Pyle & Cronin (1950) and Van Engel (1958). Kwei (1978) reported a total of 1.9-2.82 million eggs in *Callinectes latimanus* from two Ghanaian Lagoons. Fecundity between 1.75-2.0 million eggs was reported from western Atlantic estuaries (VanMonfrans, *et al.,* 1995). A mean fecundity of 3.2 million eggs was documented by Guillory, *et al.* (1996) for another related species, *C. sapidus*. These variations in fecundity among the brachyuran crabs may be caused by factors such as climatic regimes, habitat and biological constraints (Shields, *et al*., 1990). There were significant relationships between body weight and fecundity and carapace length (Figure 4) and body weight (Figure 5). This was in addition to the findings of Arimoro & Idoro (2007) who also reported significant correlation between fecundity and length, and body weight.

Conclusively, our findings showed that crab, *C. amnicola* in Yewa River showed variations in their growth patterns, sex ratios and fecundity when compare with studies from other water bodies. Therefore, the present study has provided first documented information on aspects of the biology of Blue crab, *C. amnicola*. Baseline data from the study will provide useful source of information in fisheries biology and management; and fish population dynamics and stock assessment. In furtherance to this study, we have embarked on a research programme at molecular level of analysis (e.g. Randomly Amplified Polymorphic DNA (RAPD) primers, RAPD markers) to provide better or more precise results on genetic and morphological diversities among the populations of different crabs in Yewa River, Southwest Nigeria.

References

Abowei, J.F.N. & George, A.D.I. (2009). The morphology, abundance, size and sex distribution of *Callinectes amnicola* (De Rochebrune, 1883) from Okpoka Creek, Niger Delta, Nigeria. *Current Research Journal of Biological Sciences* 2(1), 27-34.

Akin-Oriola, G., Anetekhai, M.A. & Olowonirejuaro, K. (2005). Morphometric and Meristic studies in two crabs: *Cardiosoma armatum* and *Callinectes pallidus*. *Turkish Journal of Fisheries and Aquatic Sciences* (5), 85-89.

Alfred-Ockiya, J.F. (2000). Nutritional changes in traditionally preserved shellfishes from the Niger Delta, Nigeria. *Journal of Aquatic Science* 15, 9-11.

Arimoro, F.O. & Idoro, B.O. (2007). Ecological studies and biology of *Callinectes amnicola*

(Family: Portunidae) in the lower reaches of Warri River, Delta State, Nigeria. *World Journal of Zoology* 2(2), 57-66.

Bagenal, T.B. (1978). Aspects of fecundity. *In: Methods of Assessment of Ecology of freshwater fish production*, Gerking, S.D. (ed), Blackwell Scientific Publications, Oxford. 75-101.

Bagenal, T.B. & Tesch, F.W. (1978). Age and growth. In: *Methods for assessment of fish production in freshwaters*, Bagenal, T.B. (ed) IBP Handbook No. 3, Blackwell Scientific Publications, Oxford. 101-136.

Baird, D. & Ulaanowicz, R.E. (1993). Comparative study on the trophic structure, cycling and ecosystem properties of four tidal estuaries. *Marine Ecology Programme Series* 99(3), 221-237.

Bayhan, B., Sever, T.M. & Taskavak, E. (2008). Length-weight relationships of seven flatfishes (Pisces: Pleuronectiformes) from Aegean sea. *Turkish Journal Fisheries and Aquatic Science* 8, 377-379.

Braga, F.M.S. & Gennari-Filho, O. (1990). Contribution to the knowledge of reproduction *Moenkhausia intermedia* (Characidae, Tetragonopterinae) in the Barra Bonita, Rio Piracicaba, SP. *Naturalist* 15, 171–188.

Chindah, A.C., Tawari, C.C. & Ifechukwude, K.A. (2000). The food and feeding habits of the swimming crab, *Callinectes amnicola* (Portunidae) of the New Calabar River, Nigeria. *Journal Applied Science Environmental Management* 4, 51-57.

Churchill, E. P., Jr. (1921). Life history of the blue crab. *Bulletin U.S. Bur. Fish.* 36, 95-128.

Defelice, R.C., Eldredge, L.G. & Carlton, V.T. (2001). Non-indigenous invertebrates. *In: Guidebook to the introduced marine species in Hawaiian water,* Eldredge L.G. & Smith, C. (eds), *Bishop Museum Technical Report* 21, 217-274.

Food and Agriculture Organization (FAO) (1990). *Field guide to commercial marine resources of the Gulf of Guinea*. RAFR/014/F1/90/02.

Food and Agriculture Organization (FAO) (1994). *Catalogue of small scale fishing gear in Nigeria.* RAFR/014/F1/94/02.

Franco-Lopez, J., Sanchez, C.B. Escorcia, H.B., Abarca-Arena, L.G., Ferreira, T.C. & Vazquez-Lopez, H. (2010). Biological and Ecological aspects regarding *Cynoscion nothus* Holbrook, 1855 (Perciforms: Sciaenidae). *Research Journal of Fisheries and Hydrobiology* 5(2), 66-75.

Frederick, C.S. & Thomas, D.M. (1987). Species profile: Life histories and environmental requirements of coastal fishes and invertebrates (Gulf of Mexico), sand seatrout and silver seatrout. *Fish and Wildlife Services Biological Report* 82, 11-72.

Gonçalves, J.M.S., Bentes, L., Lino, P.G., Ribeiro, J., Canario, A.V.M. & Erzini, K (1997). Weight-length relationships for selected fish species of the small-scale demersal fisheries of the south and Southwest coast of Portugal. *Fisheries Research* 30, 253-256.

Guillory, V. & Perret W.E. (1998). Management, history and status and trends in the Louisiana blue crab fishery *Journal on Shellfish Resources* 17(2), 413-424.

Henderson, P.A. (2005). The Growth of Tropical Fishes. *In: The Physiology of Tropical Fishes*, Val, A.L., Vera, M.R. & Randall, D.J. (eds.), Vol. 21, Academic Press, New York. 85-99.

Idoniboye-Obu, T.I.E. & Ayinla, O.A. (1991). Phospholipid and fatty acid composition of two brachyuran decapod crustaceans *Callinectes latimanus* (Rathburn) and *Cardiosoma armatum* (Herklots). *NIOMR Technical Paper* 73, 17.

Jonathan, G.E. & Powell, C.B. (1989). The crab larvae (Crustacea, Decapoda, Brachyura) of tidal freshwater and low-salinity estuaries in West Africa. *Tropical Freshwater Biology* 2, 158-168.

King, M. (1995). *Fisheries Biology, Assessment and Management*. Fishing News Books, Oxford, England.

Knuckey, I.A. (1996). Maturity in male mud crabs, *Scylla serrata* and the use of mating scars as a functional indicator. *Journal of Crustacean Biology* 16(3), 487-495.

Kwei, E.A. (1978). Size composition, growth and sexual maturity of *Callinectes latimanus* (Rath) in two Ghanaian lagoons. *Zoology Journal Linnaeus Society* 64, 151-157.

Lawal-Are, A.O. (2009). Racial Study of the blue crab, *Callinectes amnicola* (De Rocheburne,1883) from Badagry, Lagos and Lekki Lagoons, Southwest, Nigeria. *Nigerian Journal of Fisheries* 6, 44-48.

Lawal-Are, A.O. & Kusemiju, K. (2000). Size composition, growth pattern and feeding habits of the blue crab, *Callinectes amnicola* (De Rocheburne) in the Badagry Lagoon, *Nigerian Journal Science Research and Development* 5, 169-176.

Lawson, E.O. (1998). Bioecology of the Mudskipper, *Periophthalmus papilio* (Pallas) in the mangrove swamps of Lagos lagoon, Nigeria. *Ph.D. Thesis*, University of Lagos, Nigeria, 180pp.

Lawson, E.O. (2010). Morphometric measurements and meristic counts in mudskipper (*Periophthalmus papilio*) from mangrove swamps of Lagos lagoon, Nigeria. *Journal of Applied Biosciences* 34, 2166 – 2172.

Lawson, E.O., Thomas, A.E. & Nwabueze, A.A. (2011). Seasonal abundance, morphometric measurements and Growth patterns in frill fin goby, *Bathygobius soporator* from Badagry Creek, Lagos, Nigeria. *Asian Journal of Biological sciences* 4(4), 325-339. doi: 10.3923/ajbs.2011.325.339

Longhurst, A.R. (1958). *An ecological survey of West African marine benthos*. Colonial Office Fishery Publication, Lagos.

Micheli, F. & Peterson, C.H. (1999). Estuarine vegetated habitats as corridors for predator movements. *Conservation Biology* 13(4), 869-881.

Miller, T.J. & Houde, E.D. (1999). Blue crab target setting. *Final report to USEPA Ref. (UMCES) CBL TS. 177-199.*

Mommsen, T.P. (1998). Growth and Metabolic. In: *The Physiology of Fishes,* Evans, D.H. (ed.), CRC Press, New York. 65-98.

Morey, G., Moranta, J., Massuti, E., Grau, A., Linde, M., Riera, F. & Morales-Nin, B. (2003). Weight-length relationships of littoral to lower slope fishes from the Western Mediterranean. *Fisheries Res*ources 62, 89-96.

Murphy, M.L. & Kruse, G.H. (1995). An annotated bibliography of capture and handling effects on crabs and Lobsters. *Fisheries Resources Bulletin.* 2(1), 23-75.

Nieto-Navarro, J.T., Zetina-Rejon, M. Arreguin-Sanchez, F., Arcos-Huitron, N.E. & Pena-Messina, E. (2010). Length-weight relationship of demersal fish from the Eastern coast of the mouth of the Gulf of California. *Journal of Fisheries and Aquatic Science* 5, 494-502.

Oduro, W., Ellis, W., Oduro, I. & Tetteh, D. (2001). Nutritional quality of selected Ghanaian crab species. *Journal of Ghana Science Assiociation* 3, 37-40.

Okafor, F.C. (1988). The ecology of *Sudanonautes africanus* (Cruastacea: Decapoda) in Southeastern Nigeria. *Tropical Ecology* 29, 89-97.

Ozaydin, O. & Taskavak, E. (2007). Length-weight relationships for 47 fish species from Izmir Bay (Eastern Agean Sea, Turkey). *Acta Adviatica* 47, 211-216.

Pauly, D (1993). Fishbyte section editorial. *NAGA ICLARM Q* 16, 26

Powell, C.B. (1983). Keys to the identification of Nigerian crabs. In: *Ecosystem of the Niger Delta*, Wilcox, B.H.R. & Powell, C.B. (eds). University of Port Harcourt Press, Port Harcourt. 238.

Pyle, R. & Cronin, E. (1950). The general anatomy of the blue crab, *Callinectes sapidus (*Rathbun Chesapeake) *Biology Laboratory Publication* 87, 40.

Pillay, T.V.R. (1967). *Estuarine Fisheries of West Africa*. *In: Estuaries*, Lauff, G.F.(ed), Ballkemi Press, Rotterdam. 639-646.

Ricker, W.E. (1973). Linear regressions in fisheries research. *Journal of Fisheries Resource Board of Canada* 30, 409-434.

Ryer C. H., Van Montfrans, J. & Moody, K.E. (1997). Cannibalism, refugia and the molting Blue crab. *Marine Ecology Programme Series* 147, 77-85.

Scott, J.S. (1966). *Report on the Fisheries of the Niger Delta Special Area. NDDB* Port Harcourt, Nigeria.

Shields, J.D., Okazaki, R.K. & Kurts, A.M. (1990). Fecundity and the Reproductive Potential of the Yellow Rock Crab, *Cancer anthony. Fishery Bulletin* 89, 299-305.

Smallegange, I.M. & Van Der Meer, J. (2003). Why do shore crabs not prefer the most profitable mussels ? *Journal of Animal Ecology* (72), 599-607.

Sparre, P. (1992). Introduction to Tropical Fish Stock Assessment Part I. *FAO Fisheries Technical Paper* 306/1. Rev 1. Rome.

Tagatz, M.E. (1968). Biology of the blue crab, *Callinectes sapidus* (Rathburn, 1896) in the St. John's River, Florida, *Fish Bulletin of Fisheries and Wild life Services* 67(1), 17-33.

Taskavak, E. & Bilecenoglu, M (2001). Length weight relationships for 18 Lessepsian (Red Sea) immigrant fish species from the eastern Mediterranean coast of Turkey. *Journal of the Marine Biological Association of the United Kingdom* 81, 895-896.

Truitt, R.V. (1939). The Blue Crab. *In: Our water resources and their consenation,* Chesapeake Biology Laboratory Contribution 27

Van Engel, W.A. (1958). The blue crab and its fishery in the Chesapeake Bay. Part I- Reproduction, early development, growth, and migration. *Commercial Fishery Reversed* 20(6), 6-17.

Van Montfrans, J., Epifanio, C.E., Knott, D.M., Lipcius, R.N., Mense, D.J., Metcalf, K.S., Olmi III, E.J., Orth, R.J., Posey, M.H., Wenner, E.L. & West, T.L. (1995). Settlement of blue crab megalopa in western

Atlantic estuaries. *Bulletin of Marine Science* 57(3), 834-854.
Vankul, P.S. & Hongpromgad, L. (1972). Preliminary Experiments in Pond Rearing and Some Biological Studies of *Syclla serata* (Fodskal). In: *Coastal Aquaculture in the Indo-Pacific region,* T.V.R. Pillay (ed.), Fishing News Books in collaboration with FAO, Rome. 362-374.
Warner, G.F. (1977). *The Biology of Crab*. Paul Elek Scientific Book Limited, London.
Wikipedia (2011). Fauna of Africa. [Online] Available: http://en.wikipedia.org/wiki/Fauna_of_Africa (October 5, 2012).
Wootton, R.J. (1998). *Ecology of Teleost fishes*. 2nd edition. Vol. 24, Springer Verlag, New York.
Wootton, R.J. (1999). *Ecology of Teleost fishes.* Fish and Fisheries Series, Kluwer Academic Press, London
Zar, J.H. (1996). *Biostatistical analysis*. Prentice Hall, New Jersey.

Table 1. Summary of morphometric measurements in *Callinectes amnicola* from Yewa River, Southwest Nigeria.

Morphomteric measurements	Range (cm)		Mean±SD
	minimum	maximum	
Length of the Dactylus	0.5	4.2	2.40±0.51
Length of the Palm	0.2	4.0	2.44±0.54
Distance of the Orbit	1.3	2.3	1.73±0.20
Frontal margin	1.2	4.8	2.19±0.59
Postero-lateral margin	1.2	4.8	2.72±0.83
Antero-lateral margin	2.2	9.0	4.53±1.15

cm= centimetres, ±SD =plus/minus standard deviation

Table 2. Summary of the Condition factor (K) in *C. amnicola* from Yewa River, Southwest Nigeria.

Sex	Range (gcm^{-3})		Mean±SD
	minimum	maximum	
Males	2.14	9.49	5.92±1.03
Females	2.99	8.51	5.49±0.95

g=grams, cm=centimeters, ±SD=plus/minus standard deviation

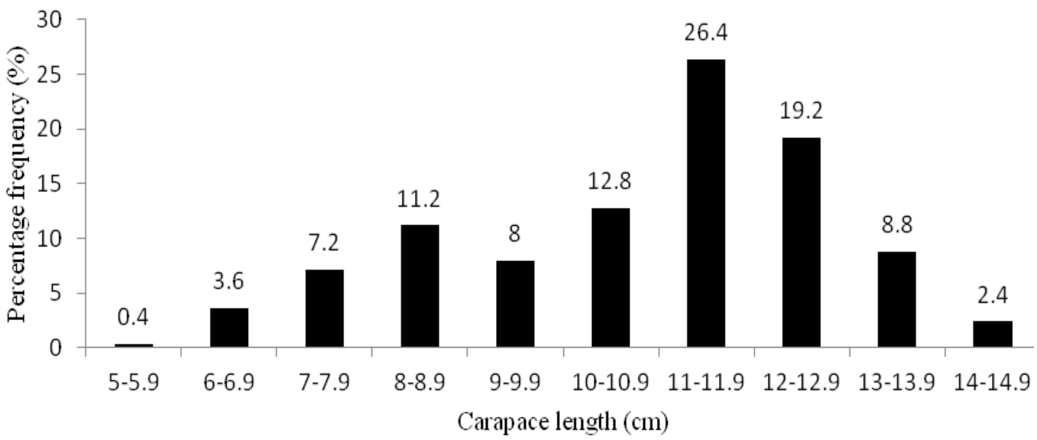

Figure 1. Histograms of the Percentage frequency distribution of carapace length in *Callinectes amnicola* from Yewa River, Southwest Nigeria.

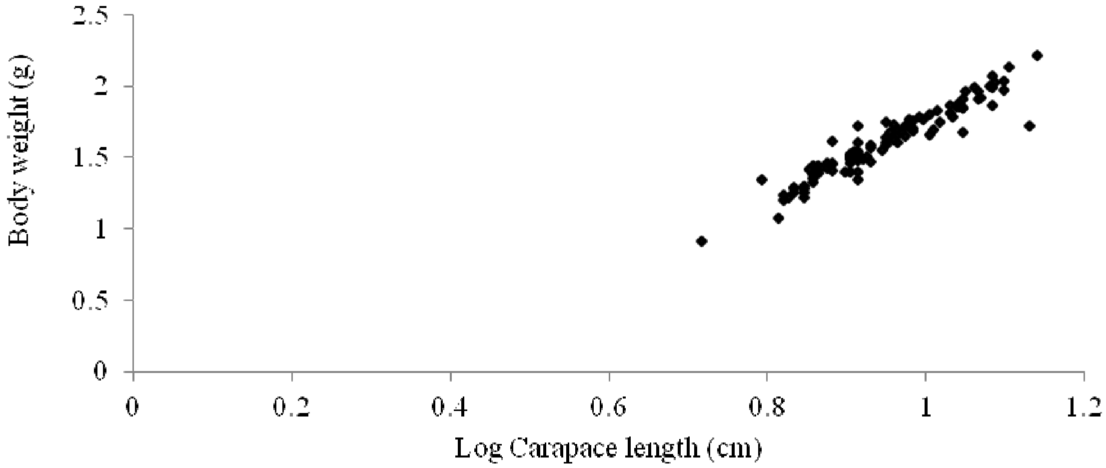

Figure 2. Log Carapace length-Log Body weight in males *Callinectes amnicola* from Yewa River, Southwest Nigeria.

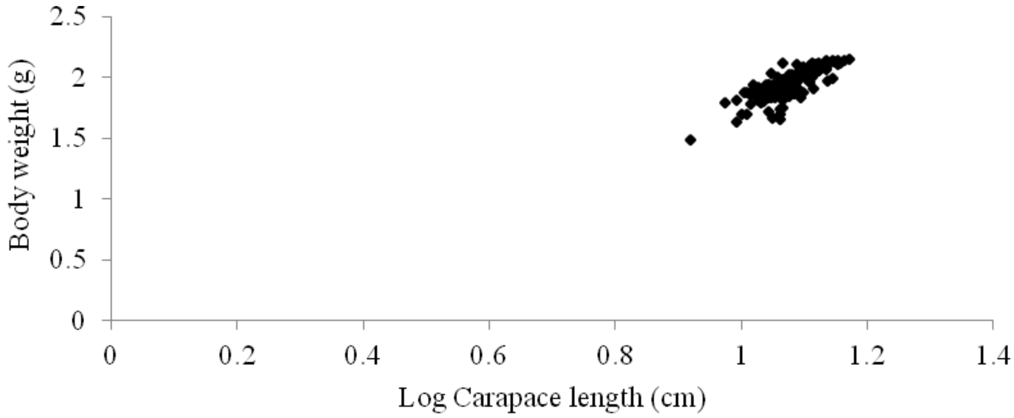

Figure 3. Log Carapace length-Log Body weight in females *Callinectes amnicola* from Yewa River, Southwest Nigeria

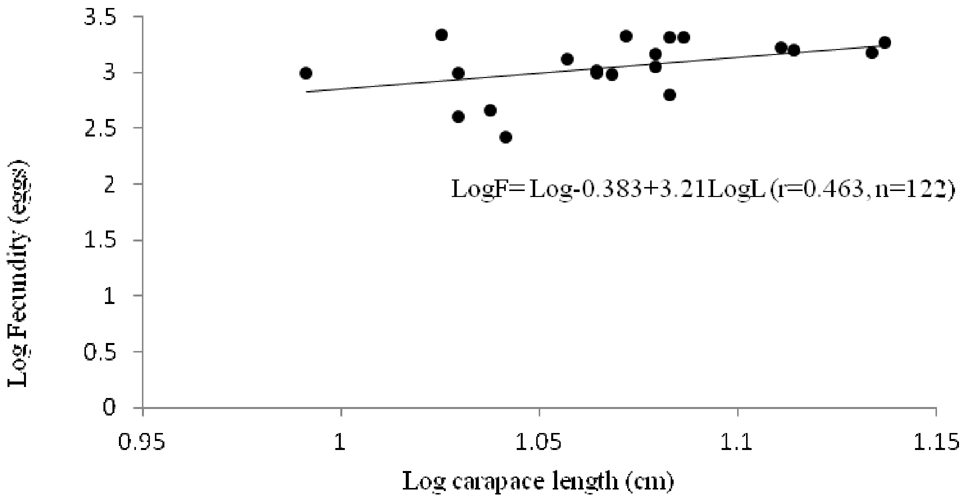

Figure 4. Log Fecundity-Log Carapace length relationship in *Callinectes amnicola* from Yew River, Southwest Nigeria.

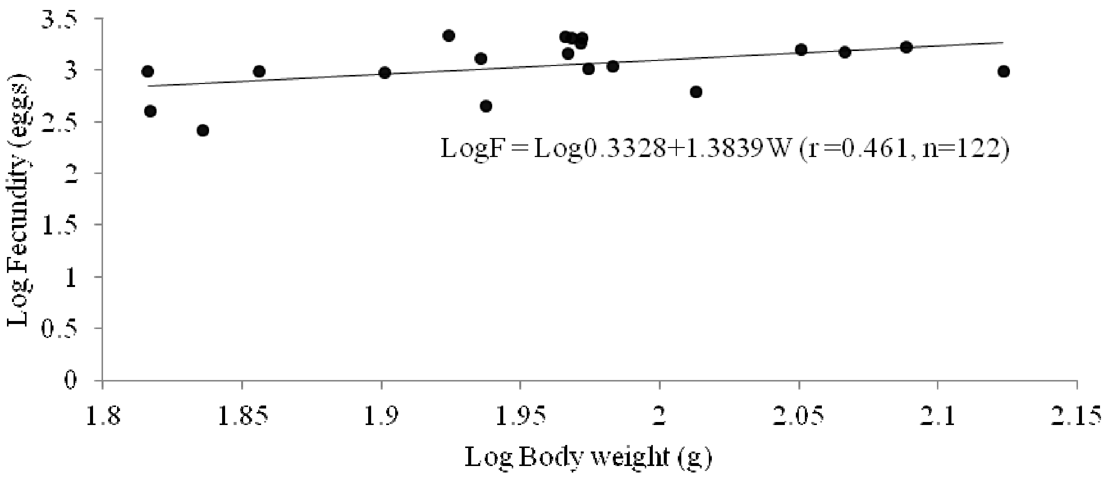

Figure 5. Log Fecundity-Log Body weight relationship in *Callinectes amnicola* from Yewa River, Southwest Nigeria.