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# Some Growth Parameters of *Macrobrachium mcrobrachion* (herklots, 1851) from Luubara Creek in Ogoni Land, Niger Delta, Nigeria.

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**Abstract:** Some Growth parameters of *Macrobrachium mcrobrachion* from Luubara Creek in Ogoni Land, Niger Delta, Nigeria was studied for a period of two years (January, 2006 - December, 2007). The parameters were evaluated using different applications in the FiSAT package such as the Powell-Wetheral plot; the ELEFAN 1 Scan, and the Non-Seasonalized Version of the Von Bertalanffy growth function (VBGF) to ensure accuracy. Powell-wetheral plot gave estimates of L∞ as 81.53 mm TL), K was 2.06 per year, Z/K was 1.07 while the growth performance index, Φ was 4.01. The growth parameter obtained from the ELEFAN 1 Scan were L∞ = 83.36 mm; K = 2.25 per year; Φ = 4.02 and Rn = 0.13. The growth parameters obtained for the non-Seasonalized Version of Von Bertanlanffy growth function (VBGF) were L∞ = 34.61 mm; K = 0.28 per year; = 0.26 while the growth performance index was 2.5.1. The results from the length - at - age data showed that L∞ = 40 mm K = 0. 38 per year and $t_0$ = -0.71. The overall estimates are L∞ = 82.65 mm; r = 0.95; K = 1.98 per year; $t_0$ = 0.48; z/k = 1.07; Φ = 3.9 and Rn = 0.14 gave estimates of L∞ as 81.53 mm TL), K was 2.06 per year, Z/K was 1.07 while the growth performance index, Φ was 4.01. The growth parameter obtained from the ELEFAN 1 Scan were L∞ = 83.36mm; K = 2.25 per year; Φ = 4.02 and Rn = 0.13. The growth parameters obtained for the non-Seasonalized Version of Von Bertanlanffy growth function (VBGF) were L∞ = 34.61 mm; K = 0.28 per year; = 0.26 while the growth performance index was 2.5.1. The results from the length - at - age data showed that L∞ = 40 mm K = 0. 38 per year and $t_0$ = -0.71. The overall estimates are are L∞ = 82.65 mm; r = 0.95; K = 1.98 per year; $t_0$ = 0.48; z/k = 1.07; Φ = 3.9 and Rn = 0.14. For 2006 the mean predicted extreme length was 81.63 mm while 2007 it was 83.33 mm. The overall predicted mean extreme length for *M. macrobrachion* in Luubara creek was 82.48 mm (TL) while the mean observed extreme length was 81.37 mm. The probability of having this length is put at 95% and the condition i.e., interval is between is 76.63-93.51%. The observed total lengths had a mean of 79.5 mm in 2006 and mean of 83.25 mm in 2007.

**Key words:** Growth parameters, Luubara Creek, *Macrobrachium mcrobrachion*, Niger Delta, Nigeria, Ogoni Land

## INTRODUCTION

The fresh water shrimp; *Macrobrachium macrobrachion* belongs to the Phylum, *Arthropoda*; Class, *Crustacea*; Subclass, *Malacostraca*; Series, *Eumalacostraca*; Order, *Decapoda*; Suborder, *Natantia*; Section, *Caridea*; Family, *Palaemonida*; Genus, *Macrobrachium*; Sp., *M. macrobrachion* Powell (1980). It can also be found in low salinity brackish water (Powell, 1985).

The body is divided into three main divisions: the head, thorax and abdomen. The head and thorax are joined to form a cephalothorax, which carries the mandibles, flagella, rostrum and the eyes containing a stalk and has five pairs of walking legs. The abdomen has six body segments with the last segment bearing a uropod or telson. The other five segments bear swimming apparatus known as swimmerets. A definite feature of *Macrobrachium* is that the second walking legs are modified to form the chelae. Most species are distinctively colored having either blue or brownish colors. The legs also have definitive features such as hairs or furs.

Significant differences exist between the male and female. Mature males are considerably larger than females and the second walking leg is much thicker. The cephalothorax is also proportionally larger in the male than female while abdomen is narrower in the female. The

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genital pores of the male are between the bases of the fifth walking leg (New and Singholka, 1982). The female's genital pores situates at the base of the third walking legs. The pleura of the abdomen are lower and broader in the female than in the male. The pleura of the female form a brood chamber in which the eggs are carried between laying and hatching. A ripe ovigerous female can easily be identified because the ovaries can be seen as large orange-colored mass occupying a large portion of the cephalothorax.

The gear used for collecting the shrimp is locally known as "Kara". It is cone shaped and has two non-return value mechanisms at the center of the trap. The trap is constructed from either the blades of bamboo plant or blades of raffia fronds which are woven around three round frames made from cane. The total length of each trap was between 0.95 m and 1m while the opening aperture was between 25 and 30 cm. Fresh palm oil fruits were used as bait to set the trap along the creek lets against the water current.

Shrimps and prawns of the genus *Macrobrachuim* and *Penaeus* are highly cherished by the people of the Niger Delta. They are used as condiments in the preparation of food because of their high protein value (Umoh and Bassir, 1977; Deekae and Idoniboye-Obu, 1995). They are highly priced and are in high demand in the market (Marioghae, 1990). It has been observed that there is significant reduction of the natural stock of shrimps in our coastal waters (Nwosu, 2007). This may be due to environmental degradation which is detrimental to the abundance and life cycle of *M. macrobrachion*. Also, there are few fishers now to exploit the available species as a result of rural migration.

The unfriendly fishing methods of local fishers who use poisons and chemicals are affecting the shrimp catch. Therefore understanding the biology, environmental parameters and population structure is essential to optimize production from the wild. The shrimp *M. macrobrachion* is exploited in Luubara creek Rivers State in large quantities yet there are no reports on the population biology of this species in the area. A study of the mortality, exploitation of *Macrobrachium macrobrachion* from Luubara creek provides base line data for management decision in the management of the species in the area and similar water bodies.

Growth information provides a lot of tools that are used in fishery management. Carlendar (1955) noted that the data on age of a fish or shrimp can provide the following tools in fishery management:

- The general background information needed for management decisions.
- It aids in diagnosis of management needs such as the recognition of overcrowding and stunting.
- It provides information for evaluating the effects of various environmental or hereditary factors by comparing growth rates and year - class abundance.
- It provides information to evaluate the effect of abundance
- Age data can give growth and mortality rates which can be used to estimate optimum yields and possible effects of catch regulations.
- Age and growth data can be used to predict year - class abundance.
- Production rates can be determined with estimates of the age and growth data.

In the temperate regions growth can be estimated by counting of the growth zones or annual marks which appear on the hard parts of fishes or shrimps as a result of definite climate seasons. This is not the case in the tropical regions where climatic seasons are not clearly defined. Some methods have evolved and are used for the estimation of age in fishes and shrimps. According to Bhukaswan (1980) the methods of age and growth determination are:

- Interpretation of and counting of growth zones or annual marks, which appear in the hard parts of fishes.
- Marking or tagging and recapture
- Comparison of length frequency distribution.

The age of fishes can be determined by the examination of hard parts of the fish such as scales, otoliths, spine and finrays, opercular bones and vertebrate. The examination of annual marks on scale is a popular method used in aging fish (Fagade, 1974; Krupka, 1974; Bastl, 1974; Beamish and Fournier, 1981; Rao and Tapia, 1999). Many authors have reported to use otolith as a method to determine age (Itoh and Tsuji, 1996). According to Megalofonou (2006), the aging of fish through the use of hard parts poses some problems for fisheries scientists in the tropics because there are no definite seasons which can show growth differences. In the temperate regions age and growth can be estimated by counting of growth zones or marks of the fish as a result of definite climatic seasons. This is not the case in the tropical regions where the climatic conditions are fairly constant. Thus aging fish based on the hard parts has some limitations in the tropics.

Marking, tagging and subsequent recapture has been reported to be used to determine age and growth in fish, shrimps and other crustacean (King, 1995; Siddek, 1990). The method can be used on large size fishes but where the fish is small, marking or tagging may become a problem. It may cause mortality of fish and the fish may loose their marks. When the marks are lost fishermen may not be able to recognize the fish (or shrimp) and the method may not be useful.

Data of length frequency distribution of fishes and shrimps can be used to determine age. This method reported by Sparre *et al.* (1989). It is based on taking the length data of a shrimp or fish for a period, usually about

one year and pooling the data together. From the data, particular cohorts or different age groups can be determined when plotted on a graph. The length frequency method has undergone some modifications by being combined with the modal class progression analysis to produce the integrated length frequency method (Pauly, 1983; Jones, 1984). This method has been used to estimate the age of shrimps (Garcia and Reste, 1981; Garcia, 1985; Enin, 1995; Enin *et al*., 1995; Mohammed, 1979) and fish (Nawa, 1985; King, 1996a, b; Ezekiel, 2001 Abowei and Hart, 2007).

One advantage of the length - frequency method is that, it takes into account the influence of the whole spawning season and the production of several broods per annum, a characteristic of fishes and shrimps. Use of length frequency data has become a very important tool in aging of shrimps and fish in the tropics where growth marks and seasonal differences are not properly defined. It should be noted that it is only when samples are large that unbiased parameters can be obtained. Methods of obtaining data from length frequency distribution include the Bhattacharya's method; modal progression analysis; the probability paper and parabola method and computer - based frequency analysis.

This method involves producing a length frequency distribution graph of the sample. The Bhattacharya method basically separate normal distributions, each representing a 'cohort' of fish or shrimp from the overall distribution. The age of each group or 'cohort' can then be estimated by using mathematical formular such as regression analysis (Sparre *et al*., 1989).

Recently, computer programmes have been developed incorporating this method. Such packages include the (Length Based Fish Stock Assessment LSFA (Sparre, 1987), and the complete Electronic Length Frequency Analysis ELEFAN (Gayanilo *et al*., 1988).

The age of shrimps can be estimated by modal progression analysis. It is a modification of the Bhattacharya method. The mean lengths of the cohorts are determined from the Bhattacharya plots using the Von Bertanlanffy formular and regression analysis. Sparre *et al*. (1989) observed that modal progression analysis is suitable for short live species such as shrimps which do not have many 'cohorts' or age groups in the growth pattern.

This method was developed by Cassie (1954) as reported by Sparre *et al*. (1989). This method is based on the fact that when a normal distribution is plotted on a probability paper, the resultant curve becomes linear. It is easy to spot cumulated distribution on such a line. In the case of the parabola method the normal distribution is transformed by taking natural logarithms of the length frequency data. The parabolas are then fitted to the log- transformed numbers of the length frequency data.

Computer packages have recently been developed to determine the ages and other growth parameters of fishes and shrimp. These programmes include the complete Electronic Frequency Analysis (ELEFAN) written in the computer language BASIC (Gayanilo *et al*., 1988). It deals with the estimation of growth parameters using length frequency analysis. It is a revised version of ELEFAN I developed by Pauly and David (1981). There is also the Normal Separation of fish-length frequencies in distributed components (NORMSEP) programme developed by Hasselbald and Tomlinson (1971) which has been extended by Schnute and Fourner (1980) to include estimation of growth parameters and by Sparre (1987) to deal with time series and a seasonalized Von Bertalanffy growth curve. Sparre (1987) also introduced the Length Based Fish Stock Assessment (LSFA) programme in the Bhattic programmed and is also being used in length frequency analysis. There is also the FAO ICLARM Stock Assessment Tool (FiSAT) (Gayanilo and Pauly, 1997). It combines LSFA and complete ELEFAN into one package. It is now the recognized programme for fish stock assessment.

These computer programmes are being revised from time to time to ensure adaptation, efficiency and easy usage. Nevertheless, Sparre *et al*. (1989) has noted that computer based frequency analysis has some limitations. In computer analysis, the data is usually coded and when a large pool of data is used mistakes could be made when coding. Most population parameters can be generated after initial input has been made Sparre *et al*. (1989) observed that the researcher may be biased in selecting the population parameters as given by the computer. Another major problem of computer analysis is to resolve mixed distribution of fishes especially for tropical species which are multi-species. Separation into the various components is usually difficult and time consuming.

Growth studies are very important tools in fishery management. It is the growth of individuals in the population that determines the amount of stock available for the fishery (King, 1995). Growth studies provide information for the evaluation of production; stock sizes; recruitment; mortalities and the status of a shrimp population (Ling, 1969). The growth process is specific for each species of shrimp or fish.

Many factors affect the growth of aquatic organisms and include; food supply; parasitism; competition; predation and environmental factors (salinity; pH; rainfall). Others are presence of adequate anions and cations in the water body; amount of dissolved gases (especially oxygen) and the quantity of pollutants in water. Age and growth studies always go together since age is determined by growth.

Growth may be described as indeterminate for those organisms that have capacity for sustained though

diminishing growth throughout their lives if sufficient food is available. Members of such species may be of variable sizes at the same ages in contrast to fishes or shrimp which has determinate growth having more definite sizes at any one age. In other words, fishes and shrimps in contrast to birds and mammals of the terrestrial vertebrate groups do not cease growth after attainment of sexual maturity. They continue their growth though only at slow rates.

**Types of growth:**

**There are three types of growth:**

**Absolute growth:** This is considered as the average size of fish (or shrimp) at each age and is estimated as:

Abs. Growth = TLn + $_1$ – TL (Ehrhardt *et al*., 1983) (l)
Where$TL_n$ + $_1$ = Total length attained with new age
TL = Original total length

**Relative growth:** This refers to the increment between two age groups divided by the length at the younger age:

$$h = \frac{L_2 - L_1}{L_1} \quad \text{(Ehrhardt, } et\ al.\text{, 1983} \qquad (2)$$

Where; h = Relative growth
$L_1$ = Length-at-age one
$L_2$ = Length-at-age two

**Instantaneous Rate of Growth:** - It is also called growth co-efficient. It refers to the difference between the natural logarithms (ln) of length (or weight) for consecutive age groups:

g = $L_nL_2 - L_nL_1$ or $g = L_nW_2 - L_nW_1$ (Ehrhardt *et al*., 1983) (3)

where; g = Growth co-efficient
$L_nL_1$ = Logarithm of original length
$L_nL_2$ = Logarithm of final length
$L_nW_1$ = Logarithm of original weight
$L_nW_2$ = Logarithm of final weight

Length is the more frequently measured attribute of growth perhaps due to ease of measurement and the relationship that has been developed between length and weight.

Growth parameters are generally estimated using mathematical models (Ricker, 1975; Gulland, 1988; Abowei and Davies, 2009; Abowei and Hart 2009). These models are usually based on certain assumptions. These include.

- The models can give or predict the size in terms of length or weight at any given age which agrees with the observed data of size and age.
- The model should be able to make predictions close to reality.
- The model (mathematical form) must be such that it can be incorporated readily into existing models.

According to Sparre *et al*. (1989), the most popular growth equation is the Von Bertalanffy (1938) growth equation, VGBF, expressed as:

$$L(t) = \left[\left(L\infty 1 - \exp\left(-k\left(t - t_o\right)\right)\right)\right] \qquad (4)$$

where;
$L\infty$ = Asymptotic length
k = Growth co-efficient
$t_0$ = Hypothetical age at zero length
$L_{(t)}$ = Length at age (t)
exp = Constant

The importance of this model is that different growth curves can be created for each set of the growth parameters L∞, K and $t_0$. It is therefore possible to use the model to describe the growth pattern of both finfish and shellfish including shrimps. Growth parameters differ from species to species and from stock to stock and even differ within the same stock (Sparre *et al*., 1989; Abowei, 2010). In calculating the growth parameters of a stock of fish or shrimp, length frequency data are generally used. For example, data on length - at - age ($l_t$) are required to fit the three parameters - L∞, k, and $t_0$. Computer programmes now exist for solving the Von Bertalanffy growth parameters for better results.

This method was reported by Sparre *et al*. (1989). It is based on the original Von Bertanlanffy growth equation. It was noted that if fish length at one age was plotted against the length of next younger age, the result was a straight line for many populations. He observed that if the slope of the plot was less than one, a Von Bertanlanffy growth curve can be fitted to the data. The parameters L∞ and k are estimated from the Ford - Walford plot essentially consists of a rewritten version of VBGF as follows:

$$L_{t+1} = a + b_{Lt} \qquad (5)$$

where;
a = Regression constant (the intercept)
b = Co-efficient
$l_t$ = Length at age (t)
$L_{t+1}$ = Length at the next age

It is important to note that $l_t$ and $l_{t+1}$ must be separated by a constant time interval.

$$L\infty = \frac{a}{1-b} \quad (6)$$

The slope of a Walford line is equal to $e^{-k}$, thus the natural log of the Walford slope with the sign changed provides an estimate of growth co-efficient k written as:

$$K = \log^{e}.$$

The values of $t_0$ and $L_t$ may be estimated from the growth equation after estimates of K and L∞ have been made or a mathematical procedure may be used to solve for the three parameters simultaneously.

This method was suggested by Wetherall (1986) for the estimation of asymptotic length, L∞ and ratio of total mortality and growth co-efficient, Z/K. In using this method a large length frequency data is needed as a representative of a steady population usually by pooling samples obtained over many months. The length frequency data are then broken into several size classes. The lowest limit of each class size acts as the cut-off length ($L^1$). The mean length ($\bar{L}$) of all fishes or shrimp from each $L^1$ upward is computed. A series of pairs of $L^1$ and $\bar{L}$ are obtained. The difference between each pair of $L^1$ and $\bar{L}$ ($\bar{L} - L^1$) is plotted against the corresponding $L^1$ and a regression line is fitted to that part of the curve pertaining to fish (shrimp) fully recruited to the gear. When the regression line is fitted the point that the line cuts the $L^1$ gives the estimate of L∞. It also gives an estimate of Z/K which is given as:

$$Z/K = \left(\frac{1+b}{-b}\right) \quad (7)$$

The Wetherall method has been modified by Pauly (1986) and is now incorporated into the FiSAT computer programme.

## MATERIALS AND METHODS

**Study area:** The study was carried out in Luubara Creek in Ogoni Land, Niger Delta, Nigeria was studied for a period of two years (January, 2006 - December, 2007). The creek is a tributary of the Imo River and is located between longitudes 7º15′ - 7º32′E and latitudes 4º32′ - 4º37′ N in the eastern part of the Niger Delta. The upper part of the creek extends from Bori and meanders through Wiiyaakara, Luegbo, Duburo and joins the Imo River at Kalooko.

The creek is divided into two distinct sections brackish water and freshwater. The brackish water stretch is between Bane and Kalooko while the freshwater stretch extends from Bane to Bori. The brackish water area has the normal mangrove vegetation comprising of trees such as Rhizophora racemosa, Avecenia africana, Laguncularia racemosa etc. whereas the freshwater has dense vegetation comprising of large trees, various palms and aquatic macrophytes at the low intertical zone. In freshwater area are Cocos species, Eliasis species, Nymphea species, Lemna species and Raffia species.

It is characterized by high ambient temperature usually about 25.5ºC and above; high relative humidity which fluctuates between 60 and 95% and high rainfall averaging about 2500 mm (Gibo, 1988). This high rainfall often increases the volume of water in the creek hence providing good fishing opportunity for the residents. Fishing is one of the major activities going on along the creek because it is the main water route of the Khana people in Ogoni area of the Niger Delta.

The fishes caught in the area include *Chrysichthys auratus*, *C. nigrodigitatus*, *Hydrocynus forskalii*, *Clarias gariepinus*, *Pellonula leonensis*, *Malapterurus*, *electricus*, *Gymnarchus niloticus*, *Synodontis nigri Hepsetus odoe*, *Hernichromis*, *fasciatus*, *Tilapia zilli*, *Tilapia guineensis*; *Sarotherodon melanotheron and Eleotris senegalensis and shellfish (crabs and shrimps) especially Uca tangeri Callinectes amnicola, Goniopsis pelli*, *Cardisoma armatum M. macrobrachion*, *M. vollenhoveni*, *M. equidens*, *Palaemonetes africanus*, *Caridina africana and Desmocaris tripisnosa*.

**Specimen sampling:** The shrimp samples were collected fortnightly from three stations along the creek: namely Wiiyaakara, Luegbo and Duburo. Selection of the stations was purposefully based on fishing activities, ecological zonation and accessibility of site. For each station five fishermen were engaged and three traps were used. At each station the fisher men set the three sets of traps against the water current among aquatic macrophytes and left them overnight. The traps were retrieved the following day after about twelve hours corresponding to another low tide. The shrimps collected at each station were sorted into male and female; females were later separated into berried (ovigerous) and non-berried (non-ovigerous). Sampling lasted for twenty-three months from January 2006 to November 2007. The shrimp samples were then preserved in 4% formaldehyde and transported to the RSUST Fisheries laboratory for analysis after each day's sampling. The species was identified by use of the keys of Powell (1980, 1982) and Holthius (1980).

For each shrimp the Total length (the distance from the tip of the rostrum to the end of telson) and the carapace length (the distance from the base of rostrum to the first body segment) was measured with a Vernier caliper to the nearest 0.1 mm. The shrimps were then

weighed with an Ohaus balance to the nearest 0.1 g. Measurements were taken for each monthly collection and recorded accordingly.

The age structure of the shrimps obtained during the period of study was estimated using the modified Peterson method also known as the Integrated method (Pauly, 1983; Sparre *et al*., 1989). Monthly length measurements were pooled and plotted on a graph to obtain length frequency distribution for the period of study at 4mm class interval. The same process was repeated along the time axis on the assumption that growth pattern repeats itself from year to year. Pauly's Integrated frequency model is based on the assumption that growth in length in shrimps is rapid initially, then increasing smoothly, passing through most of the discrete peaks. The annual growth pattern can be obtained from the Von Bertanlanffy growth formula (Sparre *et al*., 1989) as follows:

$$L_t = L\infty\ (1 - \exp\ [-K\ (t - t_o)]$$

where;

$L_t$ = length - at - age
$t_o$ = is a constant and represents length - at - age zero
$L\infty$ = representing maximum possible length
K = growth co-efficient

$L\infty$ and K were obtained from the Von Bertanlanfly plots (Pauly, 1983; Sparre *et al*., 1989; King, 1995) using the formular:

$$L_t + 1 = a + bL_t \quad (8)$$

where;

a = Axis intercept
b = Slope of regression line
$L_t$ = Length- at- age t
$L_t + 1$ = Length - at- next age

$L_t$ and $L_t + 1$ are separated by a constant time interval of one year.
Hence:

$$= L\infty = \frac{a}{1-b} and\ K = -\log b \quad (9)$$

Estimate of $t_0$ was made by plotting:

$$t_o - t_o = \left[\frac{L\infty - L_t}{L\infty}\right] = a + bt \quad (10)$$

$$t_o = \left[\frac{L\infty - L_t}{L\infty}\right] \quad (11)$$

a = Axis intercept
b = Slope of regression line

This method is incorporated in the FiSAT programme and the values of $L\infty$ and K obtained. $L\infty$ was also estimated by using the method of Wetherall (1986) as modified by Pauly (1986). In Wetherall method the monthly length frequency data of the shrimps were pooled together. The length frequency pattern was then broken into different size classes. The lowest limit of each size class acts as the cut off length ($L^1$). The mean length ($\bar{L}$) of all shrimp from each cut off length ($L^1$) upwards is computed. A series of pairs of $L^1$ and $\bar{L}$ were obtained. The difference between each pair of $L^1$ and $\bar{L}$ ($\bar{L} - L^1$) was plotted against the corresponding $L^1$ and a regression line fitted to that part of curve pertaining to shrimp fully recruited to the gear. The regression line has the form $\bar{L}$-$L^1$ = a + b $L^1$. The point where $L^1$ cuts the regression line gives the estimate $\frac{Z}{K} = \frac{(1+b)}{-b}$ and $L\infty = \frac{-a}{-b}$ of $\bar{L}$ or can be presented as indicated:

The Wetherall method has been incorporated in the FiSAT computer programme (Gayanilo and Pauly, 1997) hence, used to obtain $L^1$ and t, and $\frac{Z}{K}$

## RESULTS

The estimated growth parameters for *M. macrobrachion* from Luubara creek is given in (Table 1). The parameters were evaluated using different applications in the FiSAT package such as the Powell-Wetheral plot; the ELEFAN 1 Scan, and the Non-Seasonalized Version of the Von Bertalanffy growth function (VBGF) to ensure accuracy. Powell-wetheral plot gave estimates of $L\infty$ as 81.53 mm TL), K was 2.06 per year, Z/K was 1.07 while the growth performance index, Φ was 4.01. The growth parameter obtained from the ELEFAN 1 Scan were $L\infty$ = 83.36 mm; K =2.25 per year; Φ = 4.02 and Rn = 0.13. The growth parameters obtained for the non-Seasonalized Version of Von Bertanlanffy growth function (VBGF) were $L\infty$ = 34.61 mm; K = 0.28 per year; = 0.26 while the growth performance index was 2.5.1. The results from the length - at - age data showed that $L\infty$ = 40 mm K = 0. 38 per year and $t_0$ = -0.71.

The overall estimates are $L\infty$ = 82.65 mm; r = 0.95; K = 1.98 per year; $t_0$ = 0.48; z/k = 1.07; Φ = 3.9 and Rn = 0.14. gave estimates of $L\infty$ as 81.53 mm TL), K was 2.06 per year, Z/K was 1.07 while the growth performance index, Φ was 4.01. The growth parameter obtained from the ELEFAN 1 Scan were $L\infty$ = 83.36 mm;

Table 1: Sex, application and some Growth Parameters for *M. macrobrachion* Luubara creek

| Year | Sex | Application | L∞ | K($yr^{-1}$) | Z/K | $t_o$ | ϕ | Rn | r |
|---|---|---|---|---|---|---|---|---|---|
| 2006 | Male | Powell– Wetheral Plot | 78.73 | 1.70 | 1.03 | | 4.02 | | 0.98 |
| | Female | " | 77.82 | 2.58 | 1.23 | | 4.18 | | 0.80 |
| | B. female | " | 85.07 | 0.49 | 1.19 | | 3.55 | | 0.95 |
| | Both | " | 77.24 | 2.70 | 1.23 | | 4.20 | | 0.99 |
| | Mean | " | 79.77 | 1.86 | 1.17 | | 3.98 | | 0.93 |
| 2007 | Male | Powell– Wetheral Plot | 83.56 | 2.70 | 1.13 | | 4.28 | | 0.99 |
| | Female | " | 82.68 | 0.83 | 1.16 | | 3.75 | | 0.95 |
| | B. female | " | 88.01 | 0.48 | 0.78 | | 4.58 | | 0.97 |
| | Both | " | 79.22 | 5.0 | 0.86 | | 4.04 | | 0.99 |
| | Mean | " | 83.36 | 2.26 | 0.98 | | 4.01 | | 0.97 |
| | Both mean | " | 81.53 | 2.06 | 1.07 | | | | 0.95 |
| 2006 | Male | Non-seasonalised VBGF | 42.00 | 0.18 | | -0.18 | 2.49 | | |
| | Female | " | 42.00 | 0.19 | | -0.04 | 2.57 | | |
| | B. female | " | 30.75 | 0.30 | | -0.25 | 2.46 | | |
| | Mean | " | 38.25 | 0.22 | | -0.16 | 2.50 | | |
| 2007 | Male | Non-seasonalised VBGF | 32.69 | 0.39 | | -0.54 | 2.62 | | |
| | Female | " | 29.25 | 0.30 | | -0.16 | 2.42 | | |
| | Mean | " | 30.95 | 0.34 | | -0.36 | 2.52 | | |
| | Both mean | " | 34.61 | 0.28 | | 0.26 | 2.51 | | |
| 2006 | Male | Elefan 1 Scan | 78.73 | 1.70 | | | 4.02 | | 0.14 |
| | Female | " | 77.82 | 2.50 | | | 4.18 | | 0.13 |
| | B. female | " | 85.07 | 0.49 | | | 3.55 | | 0.16 |
| | Mean | " | 80.54 | 1.50 | | | 3.91 | | 0.14 |
| 2007 | Male | Elefan 1 Scan | 83.56 | 2.70 | | | 4.28 | | 0.13 |
| | Female | " | 82.68 | 0.83 | | | 3.75 | | 0.14 |
| | B. female | " | 88.01 | 0.48 | | | 3.57 | | 0.15 |
| | Mean | " | 79.22 | 5.00 | | | 4.50 | | 0.13 |
| | Both mean | " | 83.36 | 2.25 | | | 4.02 | | 0.13 |
| 2006 | Male | Length - at - age | 77 | 0.09 | | -1.40 | | | |
| | Female | " | 42 | 0.18 | | -0.84 | | | |
| | B. female | " | 37 | 0.26 | | -0.60 | | | |
| | Mean | " | 52 | 0.17 | | -1.09 | | | |
| 2007 | Male | Length - at - age | 29 | 0.69 | | -0.24 | | | |
| | Female | " | -- | -- | | | | | |
| | B. female | " | 27 | 0.50 | | -0.34 | | | |
| | Mean | " | 28 | 0.59 | | -0.26 | | | |
| | Both mean | " | 40 | 0.38 | | -0.71 | | | |
| | Overall | " | 82.65 | 1.98 | 1.07 | 0.48 | 3.98 | 0.14 | 0.95 |

L∞ = Asymptotic length (i.e. length to be attained at infinite growth) = 82.65 mm
r = Correlation coefficient = 0.95
K = Growth coefficient expressing rate of growth per year = 1.98 per year
$t_0$ = Hypothetical age (Yr) at which length is zero = 0.48
Z/K = Ratio of the coefficient of total mortality and growth coefficient = 1.07
ϕ = Growth performance index = 3.98
$R_n$ = Goodness of fit index = 0.14

Table 2: Prediction of the maximum length from extreme values in *M. macrobrachion* in Luubara creek (2006-2007)

| Year | Sex | Observed extreme length (mm) | Predicted extreme length (mm) | Confidence interval (95% Prob. of occurrence) |
|---|---|---|---|---|
| | Male | 79.00 | 82.59 | 76.63-88.55 |
| | Female | 77.00 | 82.70 | 73.2-92.00 mm |
| 2006 | B. Female | 85.00 | 83.88 | 80.19-87.57 |
| | Combined sexes | 77.00 | 77.38 | 76.94-77.83 |
| | Mean | 79.5 | 81.63 | |
| | Male | 83.00 | 83.62 | 82.17-85.07 |
| | Female | 83.00 | 83.37 | 80.23-86.51 |
| 2007 | B. Female | 88.00 | 87.01 | 80.5-93.51 |
| | Combined sexes | 79.00 | 79.33 | 78.82-79.83 |
| | Mean | 83.25 | 83.33 | |
| | Overall | 81.37 | 82.48 | |

K = 2.25 per year; F = 4.02 and Rn = 0.13. The growth parameters obtained for the non-Seasonalized Version of Von Bertanlanffy growth function (VBGF) were L∞ = 34.61 mm; K = 0.28 per year; = 0.26 while the growth performance index was 2.5.1. The results from the length - at - age data showed that L∞ = 40 mm K = 0. 38 per year and $t_0$ = -0.71. The overall estimates are L∞ = 82.65 mm; r = 0.95; K = 1.98 per year; $t_0$ = 0.48; z/k = 1.07; Φ = 3.9 and Rn = 0.14.

The maximum length predicted for *M. macrobrachion* in Luubara creek is given in Table 2. For 2006 the mean predicted extreme length was 81.63mm while 2007 it was 83.33 mm. The overall predicted mean extreme length for *M. macrobrachion* in Luubara creek

was 82.48 mm (TL) while the mean observed extreme length was 81.37 mm. The probability of having this length is put at 95% and the condition i.e. interval is between is 76.63 - 93.51%. The observed total lengths had a mean of 79.5 mm in 2006 and mean of 83.25 mm in 2007.

## DISCUSSION

The growth parameters recorded for *M. macrobrachion* in Luubara creek were $L\infty = 82.65$ mm $K = 1.98$ per year $t_0 = -0.48$; $\phi = 3.98$ $R_n = 0.14$; $r = 0.95$ and $C = 0.05$. These results are comparable to those obtained by Enin (1995) for the species in Cross River estuary ($L\infty = 12.93$cm or 129.30mm, $K = 1.79$ per year, $C = 0.05$, $WP = 0.5$ and $R_n = 0.259$). There is dearth of data on growth parameters of tropical shrimps and it is difficult to compare results. However as the sizes of shrimps encountered in Luubara creek were smaller than those of Cross River estuary the value of $L\infty$ will be affected. When the results of this study are compared to Enin (1995), the values of K, C and $R_n$ are similar and within the expected limits.

The values of Z/K i.e., the ratio of total mortality and growth co-efficient were low (1.07). The growth performance index $\phi$ of 3.98 estimated for *M. macrobrachion* will allow for site specific comparison of growth performance among *M. macrobrachion* and other shrimp species in Nigeria when estimates are available. Enin *et al.* (1995) suggested that the performance index can be used to calculate $L\infty$ and K of related species when either of the parameters is available.

## CONCLUSION

- The sizes of shrimps present in Luubara creek were smaller compared to other results
- The growth parameters recorded for *M. macrobrachion* in Luubara creek compared favorably with other results.
- The values of K, C and $R_n$ are similar and within the expected limits.
- The values of the ratio total mortality and growth co-efficient were low compared to other studies..
- The growth performance index value will allow for site specific comparison of growth performance for both intra and inter shrimp species in similar water bodies.

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