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LENGTH-WEIGHT PARAMETERS AND CONDITION FACTOR OF BONGA, *ETHMALOSA FIMBRIATA* IN THE CROSS RIVER ESTUARY, NIGERIA: IMPORTANCE OF LARGE VOLUME OF DATA

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ABSTRACT

Length-weight parameters for bonga, *Ethmalosa fimbriata* in Cross River Estuary were estimated. Weight growth in *Ethmalosa fimbriata* was found to be isometric, with exponent b= 3.0 and a = 0.00967. This indicates that growth is proportional in all directions. The value of (a) was the same as that of the condition factor, providing a biological interpretation to the parameters of the length-weight relationship. The importance of using large volume of data in the estimation of the parameters of length-weight relationship in any fish species as well as the implication of these findings with regards to the possibility of applying conventional fish population dynamics models to the analysis of bonga population are demonstrated.

KEYWORDS: Length-weight parameters, condition factor, bonga, Cross River Estuary, large data

INTRODUCTION

Bonga, *Ethmalosa fimbriata* occurs throughout tropical West Africa, from Mauritania to Angola (Irvine, 1947; Longhurst, 1965; Shotton, 1984). It inhabits waters ranging in salinity from 2% to 35 % (Talarczare & Mizuuishi, 1976). It prefers warm water (≥35%) and its abundance is not limited by high turbidity (Boely & Freon, 1980). They are found in shallow marine & brackish waters (Williams, 1975), particularly where rivers bring large amounts of detritus into the sea. The main concentrations in West Africa are in the non-upwelling zones off Sierra Leone to Liberia & from Nigeria to Cameroon (the Central Gulf of Guinea). Other areas of abundance are off the coasts of Ivory Coast and Senegal to Gambia.

Bonga supports important fishery in the Cross River Estuary and other coastal waters of the Gulf of Guinea. It accounts for about 23 % of the artisanal fishery landings in the Cross River Estuary and 50 % of the purse-seine fishery in the coastal waters off the Cross River Estuary (Ama-Abasi, 2002).

Length-weight relationship (LWR) and its parameters are often required in practical assessment of stocks of aquatic species. Pauly (1993) has listed several stock-assessment situations when LWR may be needed. These include: (1) the conversion of length of individual fish to weight, (2) estimating the mean weight of the fish of a given class, (3) conversion of growth equation for length into growth equation for weight, and (4) morphological comparison between populations of the same species, or between species.

However, in many such situations or when attempting to compare some species, it is usually difficult to find the required LWRs in the literature (Pauly, 1993). This situation is also true for bonga, *E. fimbriata*, which is very important to both artisanal and purse seine fisheries in the Cross River Estuary and the Nigerian coastal waters. Moreover, estimates to date of LWR and their parameters for bonga seem unreliable because of the fewer sample size, and the narrow size range considered.

Previous reports on length-weight relationship of bonga of Nigerian coastal waters indicate that the growth of this species is allometric (King, 1996). But such conclusions were based on a small volume of data and also on a narrow size range or without appropriate statistical analysis. This study was carried out with a comparatively larger volume of data to assess the LWR and its parameters on *E. fimbriata* for the Cross River Estuary and the adjacent Gulf of Guinea.

MATERIALS AND METHODS

The study area is the Cross River Estuary and its adjacent coastal waters. The Cross River Estuary lies approximately between latitudes 4° and 5 ° N and longitudes 7° 30′ and 10° E (Fig. 1). It is the largest estuary along the Gulf of Guinea covering an estimated area of 54,000 km^2 and 39,000 km^2 lies in Nigeria while the remaining 14,000 km^2 lies in Cameroon. It also has a long coastline with fringing mangroves. Of the about 960 km coastline of Nigeria, (Dada and Gnanadoss, 1983,) 129 km lies in the Cross River Estuary, with a characteristic muddy bottom. The hydrology of the Estuary is described by Lowenberg and Kunzel (1992.) Akpan and Offem (1993) have given a detailed description of the ecology of the Estuary.

Samples of bonga used for this study were obtained from catches of the artisanal gill net and boat seine fisheries in the Cross River Estuary and the catches of

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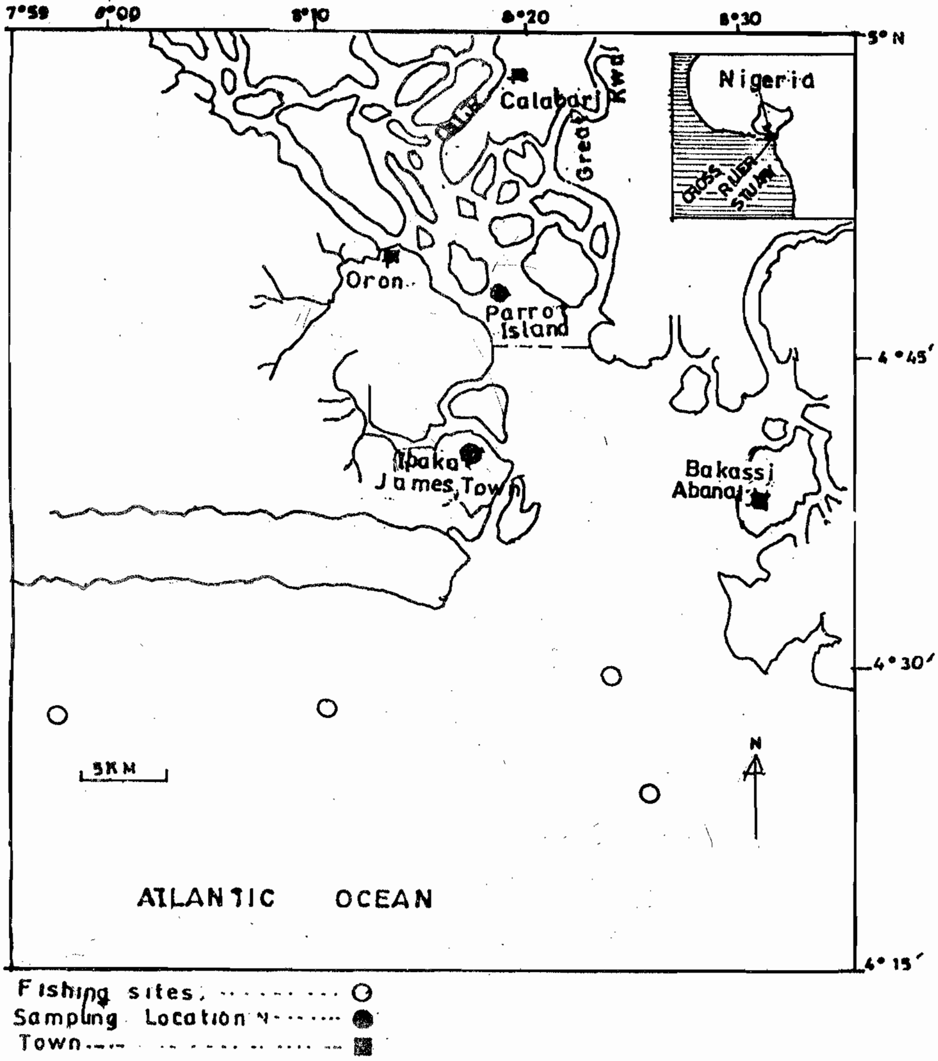

Fig. 1: Map of the Cross River Estuary showing the study area

the purse seine in the coastal waters adjacent to the Estuary. Fish samples obtained from the artisanal gill net fishery were collected each month from January through to June 2000. Adult fish were collected from purse seine catches from October 1999 to February 2001. The post-larvae of sizes 3–8 cm were collected between November 1999 and April 2000 from the boat seine fishery. Fish lengths were measured with a metre rule to the nearest 0.1 cm while weight was obtained by weighing with an electronic balance to the nearest 0.1g.

The total length-weight relationship of *E. fimbriata* was established by a power function and also by least squares regression of the logarithmic transformed version of the variables. The fitted equation has the form

$$W = a L^b \quad \text{.................... 1}$$

where w = weight (g) L = length in (cm) and a and b = parameters of length-weight relationship.

The length–weight relationship was first calculated for the males, females and juveniles of bonga. These three sets of samples were thereafter pooled together and the length-weight relationship recalculated from the pooled data.

Fulton's condition factor (CF) of *E. fimbriata* was calculated using the means of total length and weight of 438 specimens of bonga obtained above and the following formula was employed:

$$CF = W * 100/ L^3 \quad \text{................ 2}$$

W = mean ungutted weight (g) and L = mean total length (cm) of *E. fimbriata* (Pauly, 1986., Wootton, 1992.). All the correlation coefficients (r) obtained from the various linear regression and power analyses were tested for significance using the Students t-Test. The exponent (b) of the length-weight relationships for the separate sexes were tested for departure from isometry (i.e. b= 3) using a t-statistics function given in SACHS (1974) (See Pauly, 1984), as follows

$$= \frac{s.d.(x)}{s.d(y)} * \frac{[b-3]}{\sqrt{1-r^2}} * \sqrt{n-2} \quad 3$$

where s.d (x) is the standard deviation of the log L

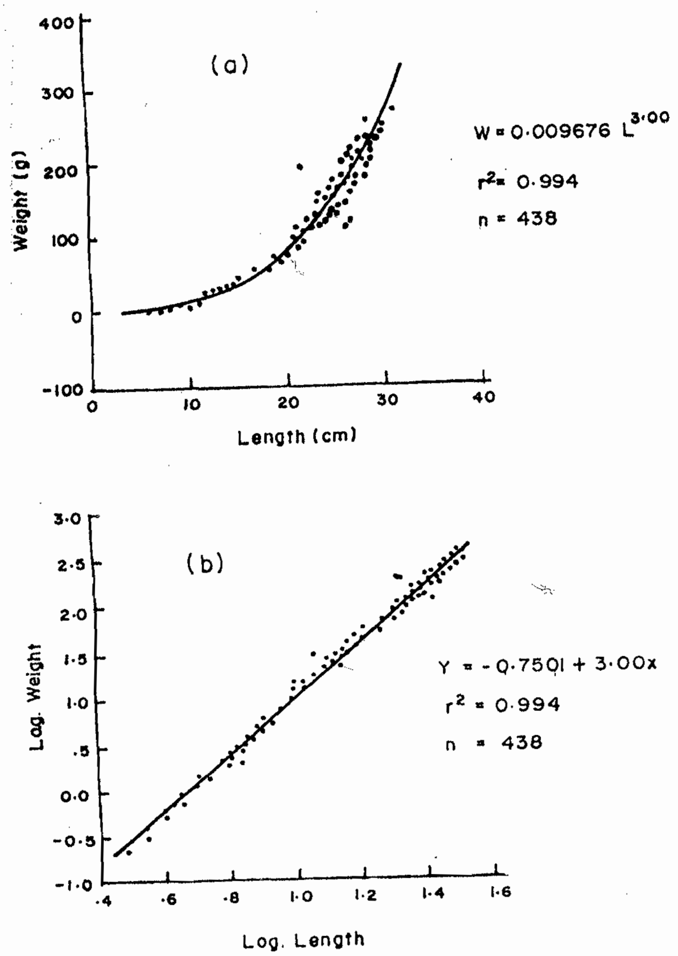

Fig. 2: Length-weight relationship in Ethmalosa fimbriata of the Cross River Estuary and adjacent coastal waters. (a) non-linearized version (b) linearized version after log-transformation.

as an assemblage, the Nigerian coastal water fishes exhibit allometric LWR, i.e. they tend to become thinner with increasing length. The result of the length-weight relationship in this study is in contrast with King (1996). The work of King (1996) drew the conclusion without the appropriate tool for test of significance. Secondly the sample size used was small and the range was low. The widest range was 15.5 (15-31.5 cm) and the smallest range was 2.9 (8-10.9cm). In this study the minimum size was 3 cm and the largest size for LWR was 32.2 cm giving a very wide range of 29.2 cm. The narrow size range in King (1996) was responsible for the erroneous conclusion, which included bonga of Nigerian coastal waters as exhibiting allometric growth.

It is interesting to find that the exponent b significantly departed from isometric condition for the separate sexes of bonga, but when the samples were merged together, the result showed that the exponent b is isometric as it was exactly 3.00. There are two reasons for such a difference. The sample size when combined rose to 438 specimens. In the separate sexes the sample size were 109, 179 and 150 for males, females and juveniles respectively. According to Carlander (1969, 1977), values of b < 2.5 or b > 3.5 are generally based on very small range of sizes and /or that such values are most likely erroneous. Therefore, the allometric condition shown by the separate sexes and the juveniles, is not a true picture of the LWR in bonga but is as a result of low size range and small sample sizes.

A characteristic of the length-weight relationship in fishes and invertebrates is that the value of the exponent (b) is 3 when growth in weight is isometric (without changing shape). If b value is different from 3, weight growth is said to be allometric (fish changes shape as it grows larger). Allometric growth may be negative (b<3) or positive (b>3).

Wootton (1992) indicated that allometric growth is negative (b<3) if the fish gets relatively thinner as it grows longer and positive (b >3) if it gets plumper as it grows longer. Thus some indication of the health condition can be obtained from the length- weight equation. In the present study result indicates that bonga does not change shape, as it grows larger.

Another characteristic of LWR is that where weight growth is isometric (b=3), the parameter (a) can be interpreted as the condition factor of the fish by multiplying it by hundred (i.e. a.100), but if b is not equal to 3, the value (a) ceases to be an index of condition (Pauly, 1984; Enin, 1994). In the present analysis, the value of b is 3.00 for *Ethmalosa fimbriata.* It is little wonder therefore that the use of parameter (a) as an index of condition for *E. fimbriata* (i.e. CF= 0.0096761x100) gives a value of condition of 0.967 which is quite the same as the estimated value of Fulton's condition factor (CF= 0.960) obtained from mean length and mean weight in the sample.

It is not reasonable to describe the LWR of bonga to be allometric for the separate sexes while it is clearly isometric for the combined sexes. Rather the results for the separate sexes should be termed as erroneous due to inability to satisfy the conditions for accurate calculation of the LWR. It is suggested that for a precise and concise estimation of the length-weight relationship in any species of fish, due consideration should be given to the sample size, making it as large as possible, and the entire size range of the population should be represented. These two requirements must be regarded as a standard in the calculation of the length-weight relationship.

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values, and s.d. (y) is the standard deviation of the log W values in the computation, b is the estimated exponent of the LWR and r^2 is the coefficient of determination of the relationship. The value of b is different from 3 if the calculated t is greater than the tabled value of t for the degree of freedom n-2 (Pauly, 1984).

RESULTS

The parameters of length-weight relationship and the condition factor calculated separately for juveniles, males and females of *Ethmalosa fimbriata* are given in Table 1.

The values of the exponent b, for the separate sexes and the juveniles show that the relationship is negatively allometric in the adult and positively allometric in the juveniles. The test for isometry, □, indicates that the exponent b for these different categories is significantly different from 3. But for the pooled data the test for isometry shows that the value b is 3, hence isometric condition.

Fig. 2 gives the relationship between length and weight in bonga of Cross River Estuary and adjacent coastal waters. Fig. 2 (a) is non-linearized fit of equation (1) to the data of length-weight relationship. Fig 2 (b) is the linearized approach to the same data after log-transformation. The relationship between weight and length in *Ethmalosa fimbriata*, with all categories combined i.e. from the pooled data, is defined by the linear regression model :

$$\text{Log } W = -0.7501 + 3.00 \log L$$

Which is also written as the power function model:

$W = 0.009676\ L^{3.00}$; $a = 0.009676$, $b= 3.00$, $r^2 = 0.994$

A significant relationship was established, with the equation:

$W = 0.009676\ L^{3.00}$ (r^2=0.9941, t –Test, $P< 0.001$, d.f = 436), and the length–weight parameters estimated as a= 0.009676 and b= 3.00

The Fulton condition factor for the separate sexes is given also in Table 1. The Condition factor for the pooled data was the same as the parameter a.

DISCUSSION

The exponent b= 3.00 in the length-weight equation for *E. fimbriata* indicates that *E. fimbriata* of the coastal waters off the Cross River estuary has an isometric weight growth (Bagenal and Tesch, 1978). This means that bonga grows at the same rate in all linear dimensions, i.e. increase in length; width and height are proportional to each other (Gayanilo and Pauly, 1997). Thus it is normal to use the conventional fish population dynamics models to analyze the population of bonga in the Cross River Estuary. Fagade and Olaniyan (1972) mentioned weight-length relationship of bonga but did not give the exact value of parameters in their study.

King (1996) reports the parameters of length-weight relationship of bonga from Cross River Estuary alongside those of other fish species and concluded that

Table 1:

Parameters of length-weight relationship and condition factor in different sexes of *E. fimbriata*.

Sex	a	b	r^2	CF	n
Male	0.0393	2.56	0.803	0.924	109
Female	0.022	2.73	0.844	0.950	179
Juvenile	0.0058	3.25	0.993	1.340	150
Combined	0.009676	3.0	0.994	0.960	438

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