Sex Ratio, Length-Weight Relationship And Condition Factor Of Ethmalosa Fimbriata In The Cross River Estuary, Nigeria.

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Abstract: *A total of 855 samples of Ethmalosa fimbriata were collected from the Cross River Estuary between January to August 2014 for length-weight, sex ratio and condition factor determinations. The males dominated the populations with a total of 315 followed by 304 juveniles and 236 females with a corresponding sex ratio of 1:1:1.3. E. fimbriata exhibited negative allometric growth pattern with exponent b=2.303, a=0.086 indicating that the growth was not proportional in all directions and that the species was slimmer as it grows. The mean condition factor revealed that the species was in good condition with a corresponding values of 0.81± 0.147, 0.978 ± 0.745, 0.98 ± 0.121, 1.22 ± 1.38 and 1.06 ± 0.84, respectively, for the males, the females, the pooled sex, juveniles and the three categories merged together. The variations in growth of E. fimbriata could be attributed to climate change and prevailing ecological conditions of the environment.*
Key Words: *Ethmalosa fimbriata, sex ratio, length-weight, condition factor*

I. Introduction

Ethmalosa fimbriata a Clupeid fish popularly known as Bonga is found almost everywhere in African waters with salinity ranges of 1‰ to about 38 ‰. It constitutes 23 % of the catches of artisanal or small scale fishing in the Cross River Estuary and 50 % of the purse-seine fishery in the coastal waters of the Cross River estuary (Ama-Abasi, 2002; 2004).

Several works have been done by several authors on the physiological parameters and the relationship between length and weight of different fish species in different locations (King 1996; Ama-Abasi 2004; Odedeyi et al, 2007; Abowei 2009; Ofem et al 2009; Ajah and Udoh 2012; Obashohan et al 2012; Emmanuel and Rashidat 2013). King (1996) conducted a study on the length and weight relationship of bonga in Nigerian coastal waters and found out that bonga exhibited an allometric growth; Ama-Abasi (2004) faulted this due to the narrow size range and small sample size. Ama-Abasi (2004) on the length weight relationship of bonga in Cross River estuary concluded that it exhibited an isometric growth since the growth was proportional in all directions. Abowei (2009) had a study on the morphology, abundance, length-weight relationship and condition factor of *E.~~thmalosa~~ fimbriata* and reported an isometric growth with b value equal to 3.199 which agreed with that of Ama-Abasi (2004). Abowei, (2009) on *Ilisha africana* observed a negative allometric growth pattern. Obashohan et al (2012) on *Parachanna obscura*, *Oreochromis niloticus*, *Papyrocranus afer*, *Tilapia mariae* and *Malapterurus electricus* from Ibiekuma stream in Edo state Nigeria found out that these species exhibited negative allometric growth pattern. They also showed that the physiological well-being of the two species *P. afer* and *P. obscura* were below 1.0, an indication that they were not in good condition in their environment but the other three species: *M. electricus*, *T. mariae* and *O. niloticus* were evidenced by the values of their condition factor. Odedeyi et al (2007) found that elephant fish *Mormyrus rume* species exhibited an allometric growth pattern. Ajah and Udoh (2012) on the LWR using standard length measurement for both *Mugil cephalus* and *Pseudotolithus elongatus* species had lower allometry (2.734, 2.823) than those with total length (3.001, 3.145), respectively, for *M. cephalus* and *P. elongatus* with condition factors of 0.946 and 1.006, respectively

Odedeyi et al (2007) noted that the mean condition factor varied with seasons thus indicating that seasonal variations affects condition factor of a fish. More interestingly, they concluded that the condition factor decreases with increase in individual sizes. Oni et al (1983) clearly pointed out that in a fish population, the physiological well-being of a fish constantly vary in a particular period of time and it might be affected by biological and non-biological factors.

Knowledge on the length and weight relationship of *Ethmalosa fimbriata* in the aquatic ecosystem will be useful in fish management, assist scientifically in checking the reproductive potentials and controlling the exploitation rate of the species in the estuary year in year out and add to the already existing information on the family Clupeidae. It is very important in studying the biology of fresh water and marine fishes and it can be used to foretell weight from length measurements made in the yield assessment (Pauly, 1993). Fish can attain either isometric growth, negative allometric growth or positive allometric growth. Ajah and Udoh (2012) opined that positive or negative allometriesm is a function of whether or not standard or total length measures were adopted.

Isometric growth reveals that there is no body change or shape as the organism grows meanwhile a negative allometric growth implies that the fish becomes slimmer as it increases in length. A positive allometric growth means the fish becomes deeper-bodied as it grows (Riedel et al., 2007).

The condition factor of a fish is an important tool in observing its feeding capability, and the rate at which the fish is growing (Anene, 2005; Ajah and Udoh 2012). It is to a large extent affected by biological and non-biological factors and the condition of the environment can be used as an index to evaluate the status of the complex community of the fish. Evaluations of the conditions at different body lengths and weight can give valuable information regarding the maturation and spawning in the life span of the fish, whereas a closer look at condition of a fish at different months can give definite clues regarding the breeding seasons.

The study of sex ratio gives information on the fish life food, rate of growth, size at maturity, parasite infestation, overall population of given species and reveals concinnity the total number of the separate sexes, their profusion and multiplicity in a given population (Vicentini and Araujo, 2003, Morgan, 2008).

Since the work of Ama-Abasi (2004) there has been no report on the fecundity, the physiological well-being and the sex ratio of *E. fimbriata*. There is every need to have regular monitoring of these basic reproductive indices of the species to detect sharp changes, more importantly with the advent of climate change in global warming. This study is therefore conducted to determine the current fecundity rate, condition factor and sex ratio of bonga to find out if there is any major deviation from the work of Ama-Abasi (2004) that was done over a decade ago.

II. Materials And Methods

Description of the study area:

This study was carried out in the Cross River Estuary which lies within latitudes 4° and 5° N and longitudes 7° 30' and 10° E. Ajayi (1998). It is the largest estuary in the Gulf of Guinea covering an estimated area of 54,000 km^2 and about 39,000 km^2 of the estuary while the remaining 14,000 km^2 lies in Cameroon. It also has a long coastline with fringing mangroves of about 960 km coastline of Nigeria, (Dada and Gnanadoss, 1983,) 129 km lies in the Cross River Estuary, with a characteristic muddy bottom. (Fig.1).

Collection of samples

A total of 855 samples of *Ethmalosa fimbriata* comprising 236 females, 315 males and 304 juveniles were collected from January to August under fresh conditions from the catches of artisanal fishery at Ibaka beach, a major landing point in the outer estuary.
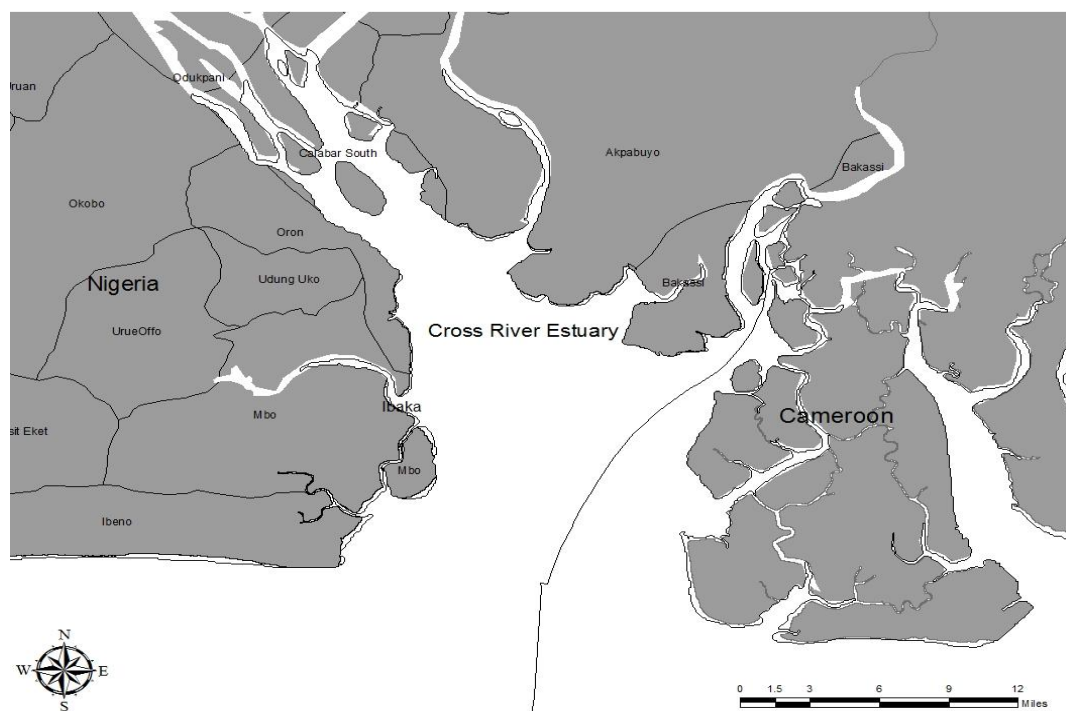
FIG. 1: Map showing the study site

Identification of the fish species and their sexes

Identification of *Ethmalosa fimbriata* was based on the identification key given by Fischer et al. (1987) and sexes were differentiated based on internal features such as gonad. The fish was cut open to determine sexes by physical examination of the gonads.

Measurement of biometric indices of *Ethmalosa fimbriata*

The following parameters were measured accordingly for each specimen. The Total length was measured in centimeters while the total weight was measured in grams. Measurement of the total length of the fish was taken from the snout to the tip of the caudal fin using a calibrated meter rule in centimeters. Metlar 2000D electronic weighing balance was used to obtain the weight of the specimens in grams.

Determination of length-weight relationship and condition factor

Calculations were first made for the males, females and the juveniles of bonga thereafter the three sets of the data were pooled together for the determination of the parameters.

The expression $W=aL^b$ was used in the determination of the length (L) and weight (W) relationship (Pauly, 1984)

Where   W= the weight of the fish (g)

L= the total length of the fish (cm)

a= constants, b= exponent of the length weight relationship.

"a" and "b" values will be gotten from a linear regression in the graph of the length and weight of the fish.

Determination of condition factor (k) for the males, females and pooled sex of *E. fimbriata* using: $K= 100 W/L^3$

Where: K=condition factor, W= weight of fish (gm) and L= length of fish (cm)

Statistical analysis

The nature and degree of relationship between the length and weight of the males and females and pooled sexes of *E. fimbriata* were determined using a correlation and regression analysis. One way analysis of variance (ANOVA) was used to test for significance of the value of b and the condition factor of the species.

III. Results

A total of 855 samples of *E. fimbriata* were collected between January and August from the Cross River Estuary comprising of males, females and juveniles. In this study the minimum size was 3.9cm and the largest size for the length weight relationship was 30.0cm giving a very wide range of 26.1cm. The size range in the determination of the sex ratio was between 12cm to 30.0cm .The males were found to range from 12.3cm to 30.0 cm in total length and 90g to 285g in weight. For the females, the total length and weight ranged was between 15.9cm to 29.6 cm and 40g to 254g respectively giving an indication that the males were slightly bigger than the females in length. The overall population showed that the males were 315 while the females were 236 with a ratio of male to female as 1:3

The length and weight relationship for *Ethmalosa fimbriata* in the Cross River Estuary are shown in figures 2,4,6,8 and 10 with their corresponding values for each category. The log transformation of the length and weight relationship of the different categories (i.e Male, Female, combined sex, Juveniles and the three categories pooled together) are shown in figures 3,5,7,9 and 11. The equation thus derived in respect of length-weight relationship is as follows:

Female $W= 0.017L^{2.814}$, $R^2 =0.928$ (Fig. 2)

Male $W= 0.026 L^{2.6836}$ R2= 0.701 (Fig.4)

Combined sex (Male and female only) $W= 0.02L^{2.772}$ $R^2= 0.814$ (Fig.6)

Pooled sex   (Male, female and juveniles) $W= 0.086L^{2.303}$ $R^2=0.862$ (Fig.8)

Juveniles $W= 0.79L^{1.513}$ R2 $=0.679$ (Fig.10)

The corresponding logarithmic regression equation for the male, female, combined sex, juveniles and the three categories pooled together is represented as follows

- The logarithmic regression equation for the female sex
  = Log W =2.814±1.752LogL (R2=0.928) (Fig. 3)
- The logarithmic regression equation for the male sex
   = Log W =2.683 ±1.580 log L (R^2=0.701) (Fig.5)
- The logarithmic regression equation for the combined sexes of *E. fimbriata* (male and female)
      = Log W =2.772±1.698 LogL (R^2=0.814) (Fig. 7)
- The logarithmic regression equation for the three categories: male, female, and juveniles.
          = Log W=2.303±1.064 LogL(R^2 0.863) (Fig.9)
- The logarithmic regression equation for the juveniles
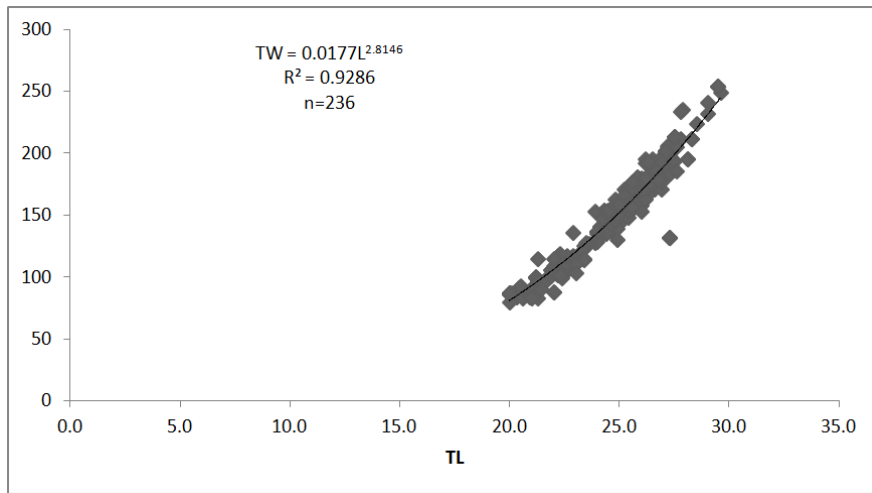   =Log w =1.513 ±0.10LogL (R^2=0.679) (Fig 11)

FIG. 2: Length weight relationship of female *E. fimbriata*
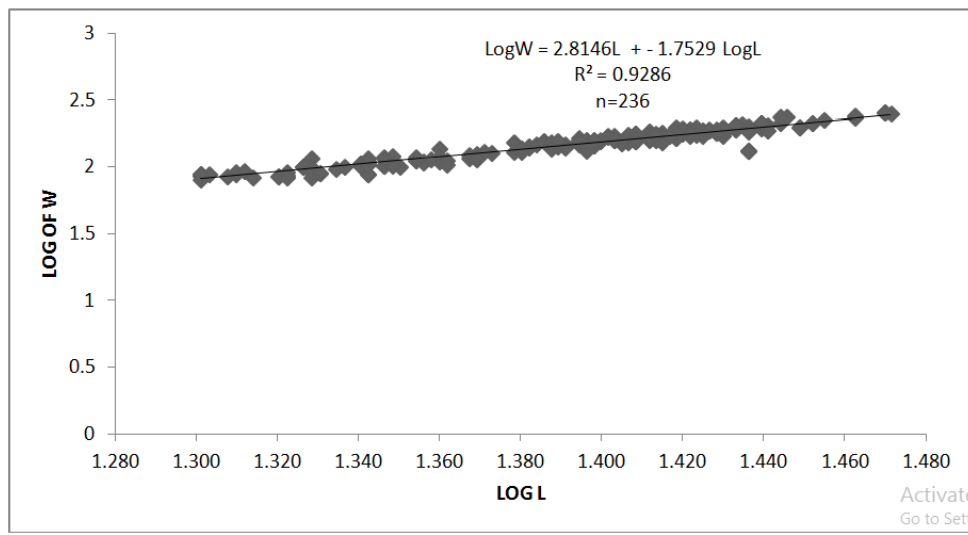

FIG. 3: Log transformed data of Length-weight relationship of female *E. fimbriata*
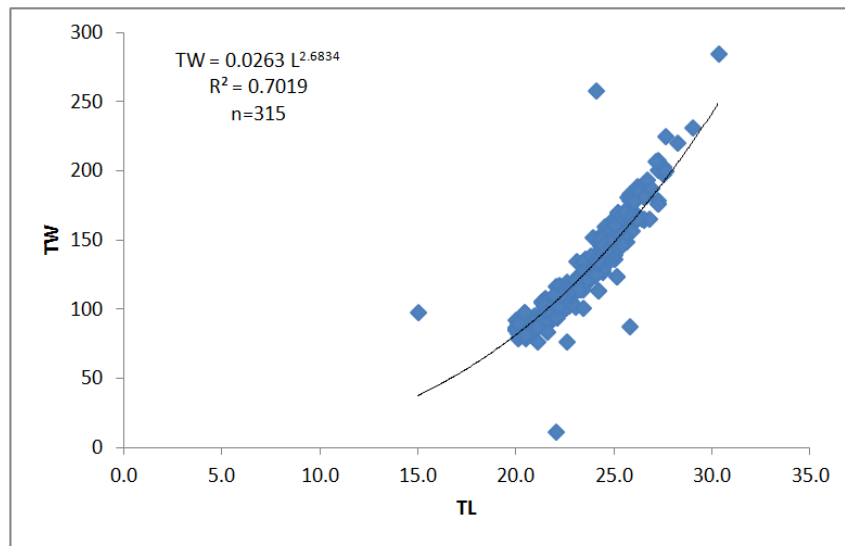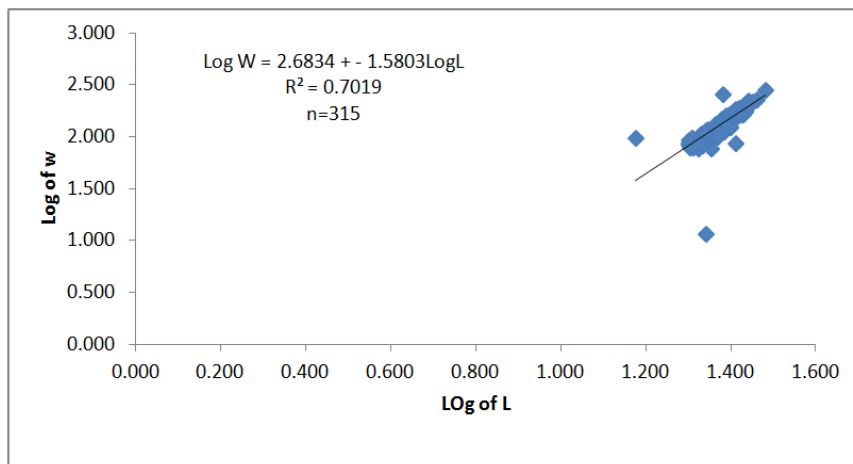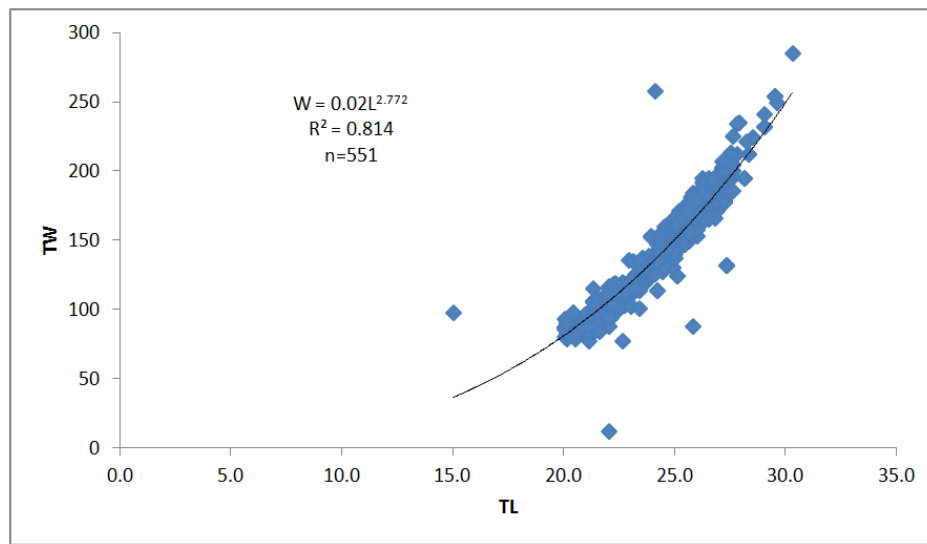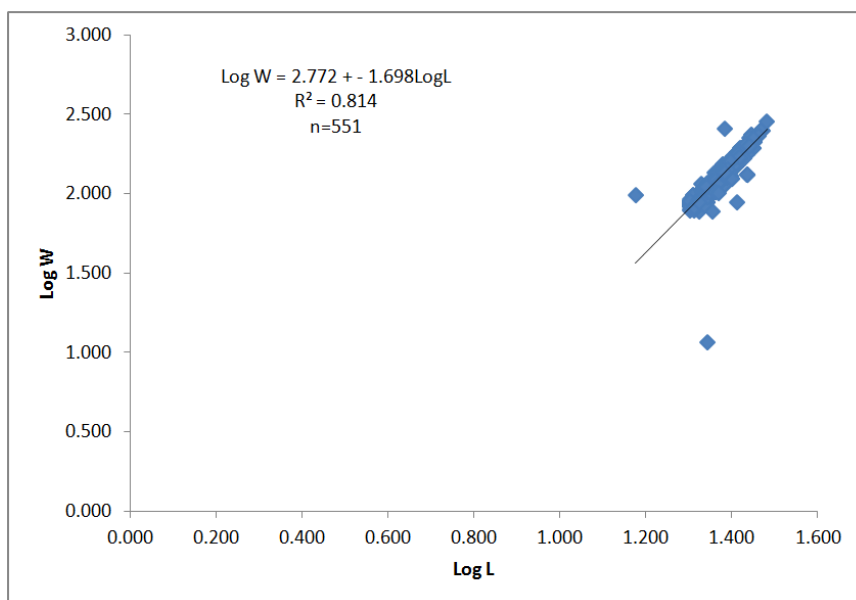

FIG. 4: Length weight relationship of male *E. fimbriata*

FIG.5: Log transformed data of length weight relationship of male *E. fimbriata*

FIG. 6: Length weight relationship of pooled sex (male and female)

FIG. 7: Log transformed data of length weight relationship (males and females) of *E.fimbriata*
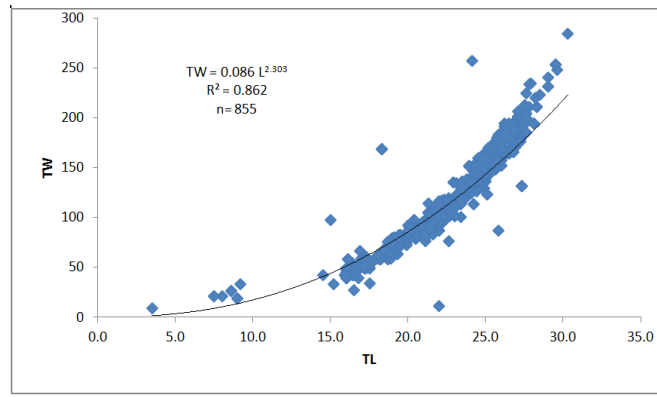
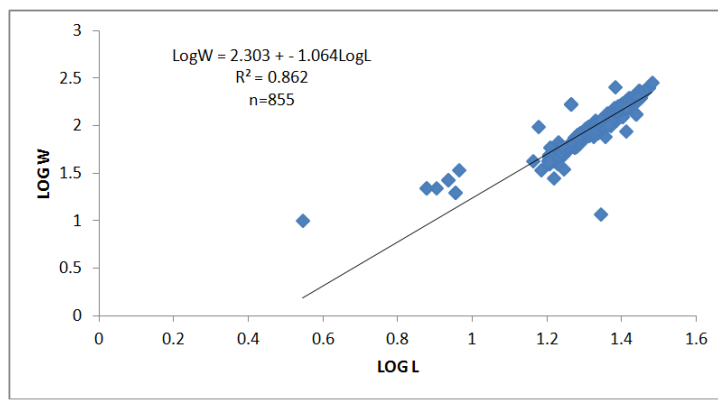**FIG 8:** Length weight relationship of the combined sexes (male,female and juveniles)

FIG. 9: Log transformed data of length weight relationship of the combined sexes (male, female and juveniles)
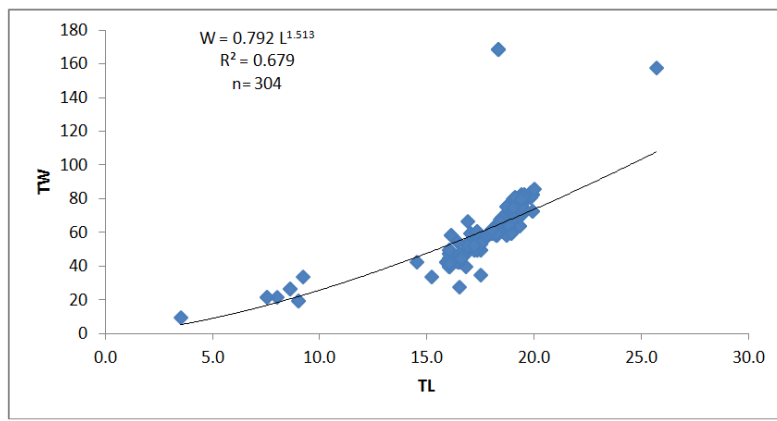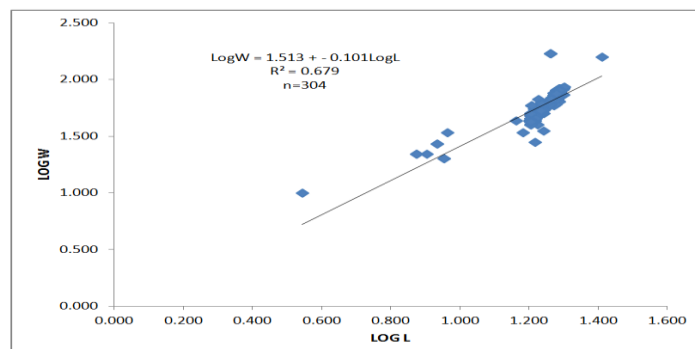

FIG. 10: Length weight relationship of the juveniles of *E. fimbriata*

FIG. 11: Log transformed data of length weight relationship of the juveniles of *E.fimbriata*

Condition factor of *Ethmalosa fimbriata*

The condition factor K for *Ethmalosa fimbriata* was calculated and examined for the females and it ranged from 0.64 with fish length of 27.3cm and weight 132g to 1.19 with fish length of 21.3cm and weight 115g. For the males of *E. fimbriata* the condition factor ranged from 0.096 with fish length of 26.5cm and weight 181g to 4.83 with fish length of 12.0cm and weight 90g. The mean condition factors were 0.978±0.075 for the females, 0.98±0.15 for the male, 0.98±0.122 for the combined sex (male and female), and 1.22 ±1.38 for the juveniles. The mean condition factor for the three categories, that is, ~i.e~ the male, female and juveniles merged together was 1.06±0.84 which is above an estimated value for Fulton's condition factor and it is an indication that the species is doing very well and is in good condition. The monthly condition factor (Table 1) showed that the month of March recorded the lowest condition factor during the study.

Table 1: Monthly Condition Factor

Month	Monthly mean condition factor	Total samples
January	0.95	61
February	1.02	79
March	0.02	165
April	1.05	142
May	0.97	88
June	0.98	95
July	1.03	56
August	1.38	169

Table 2: The parameters of length –weight relationship of *E. fimbriata*

Parameters	Males	Females	Males/Females	Juveniles	combined data
a	0.026	0.017	0.02	0.79	0.086
b	2.683	2.841	2.772	1.513	2.303
K	0.981	0.97	0.98	1.22	1.06
N	315	236	551	304	855

IV. Discussion

The weight of a fish is seen to be directly proportional to length (Weatherly and Gill, 1987; Zafar et al., 2003). For an ideal fish which have an equal proportion of length and weight, the b value may not be less than 3.0. According to Thomas et al (2003) this dimensional equality has occasionally been observed as a value which is higher or lower than 3.0 which points to an allometric growth. Tesch, (1978) stated that a fish becomes lighter or slimmer when there is a deviation from isometry in this case the value is lower than 3.0 (negative allometric growth). On the other hand, if the value is above 3.0 it indicates that the fish has a thicker body meaning that increase in length is directly proportional to the increase in weight (positive allometric growth) (Wooton 1998; Zafar et al (2003). It was evident in this study that the growth of *E. fimbriata* is allometric. ~The b values for females, males and juveniles as well as the combined sexes showed a negative allometric growth with the general assumption that the specific gravity of the fish remained constant. This corroborated the view of Tesch (1978). More so it was observed in (Figs 2, 4, 6, 8 and 10) that the exponent b value significantly departed from isometric condition for the separate sexes of *E. fimbriata*, the combined sexes, and even with the juveniles. Interestingly, the b value was higher in the females (Fig. 2) than the males (Fig.4) and it may be due to the enormous growth of ovaries in the females compared to that of the testes in males. In the case of the juveniles, the b value was also observed to be high (Fig. 10) probably due to high feeding intensity of the juveniles. Wooton (1992) pointed out that allometric growth is negative (i.e b is below 3.0) if the fish becomes slender as it grows and positive (i.e. b is above 3.0) if the fish gets plumper as it grows longer. The results of this indicated that bonga did not change shape as it grows longer. This result is in contrasts with King (1996), who drew a conclusion that *E. fimbriata* exhibited an allometric growth pattern. The sample size the author used was small and the range was low. The widest range was 15.5 (15 cm -31.5 cm) and the smallest range 2.9 (8-10.9 cm). In this study, the minimum size range was 3 and the largest 30.0 cm (3.0 -30.0 cm) giving a wide range of 26.1cm. The negative allometric growth exhibited by bonga in the Cross River estuary may be attributed to changes in ecological conditions in the estuary. Ama-Abasi (2004) reported that the length weight growth of bonga in Cross River estuary was isometric with b = 3.0 and a=0.00967 and the author concluded that from all indications the growth of bonga was proportional in all directions. A comparison with the present study reveals that length weight relationship of bonga departed from the isometric conditions and the length weight growth

was not proportional. The difference between these findings and that of Ama-Abasi (2004) may be attributed to variations in salinity and ecological conditions in the estuary.

It is important to note that positive or negative allometriesm of any fish are not unconnected with the pattern of measurement adopted whether standard length or total length (Ajah & Udoh, 2012). They found out that the LWR using standard length measurement for both *Mugil cephalus* and *Pseudotolithus elongatus* species had lower allometry (2.734, 2.823) and positive when with total length (3.001, 3.145), respectively.

Out of the 438 samples studied by Ama-Abasi (2004), 109 (24.9%) were males, 179 (40.9%) females and 150 (34.2%) juveniles. In this study, a total of 855 samples were collected in which 315 (36.8%) were males, 236 (27.6%) females and 304 (35.6.%) juveniles. Variations may also be attributed to changes in ecological conditions such as water quality, food availability etc. as reflected in the range of condition factor obtained in the study. The Correlation and regression co-efficient of length- weight relationship was significant and positively correlated. One of the characteristics of length-weight relationship is that when weight is observed to be isometric (b=3.0) the parameter (a) can be interpreted as the condition factor of the fish by multiplying it by 100 but in the case were b is not equal to 3.0 the value (a) ceases to be an index of condition factor (Enin 1994).

The physiological conditions and the well-being of a fish are influenced by meteorological, oceanographic and biometric parameters (Ama-Abasi 2007). This also affects the length frequency distribution as well as the relationship between the length and weight of a fish. The mean condition factor for the males, females and juveniles showed that the fish was actually doing well. Even when the three groups were pooled together it still indicated that the species was doing very well unlike the values obtained for the weight-length relationship by Abowei (2009) and Ama-Abasi (2004) who both concluded that bonga exhibited an isometric growth pattern. Both isometric and allometric growth pattern have been reported by several other authors for different fresh water species in different locations. In Umuoseriche lake, King (1991) concluded in his study that a Tilapia species exhibited an allometric growth pattern. The same author reported an isometric growth for another fresh water species *Pseudotolitus elongatus* in an estuary. In the Cross River estuary, Ekeng (1990) reported an isometric growth pattern exhibited by *E. fimbriata* also Marcus (1984), obtained the same result for *Ethmalosa* from coastal and brackish water of Akwa-Ibom state. Shenouda et al. (1994) reported an isometric growth pattern for *Chrysichthys auratus* from the southern most parts of River Nile. The present study is comparable to Soyinka and Ebigbo (2012), who reported a positive allometric growth pattern for *Ethmalosa* and the mean condition factor showed that the fish was actually doing well irrespective of their habitat whether marine, brackish or freshwater. The correlation coefficient for this present study was positive and highly significant for the three categories of *Ethmalosa*, an indication that changes in standard length and weight of this fish species were proportional in one direction. Nikosky (1963) pointed out that a better physiological state of a fish can be seen in the value of its condition factor. In other words, if the value of the fish condition factor is high, the fish is in better condition. In this study the condition of the males were better than that of the female and their corresponding values were higher than that of the females.

The juveniles recorded the highest condition factor followed by the three category pooled together. The mean condition factor for the juveniles indicated that the species at that level was doing fine though their growth pattern was still allometric. August and February recorded high values of condition factor during the study. King (1995) corroborated a view that several factors responsible for variation in condition factor (K) may be due to the abundance of food, adaptation to the natural environment and development of the gonads. Though there were no much changes in the mean condition factor of the species. There are obvious variations in the well-being of a fish, therefore information on the condition or state of the body or bodily functions of the species with respect to its physiological well-being is important. From a nutritional aspect, there are accumulation of fatty degenerations and development stages of the gonads (LeCren, 1951). The mean condition factors for the three categories of this species with the condition factor on monthly basis ranging from 0.016-1.389 which was observed throughout the study is in contrast with the results from previous authors. Ajayi (1982), in his study reported that the value of the condition factor (K) was = 0.77-0.81 for *Clarotes filamentosus* in lake Oguta. Abowei (2009) reported K= 0.94, 0.6-1.00. Ama-Abasi (2004) reported K=0.96 in the Cross River estuary. Ajah & Udoh (2012) had K=0.946 and K=1.006, respectively, for *Mugil cephalus* and *Pseudotolithus elongatus*. These differences not withstanding Oni et al, (1983) pointed out that for a particular population over a specific period of time the physiological well-being of any species is never constant and this may be a resultant effect of biological and non-biological factors such as the frequency of feeding and the gonad maturity state (Saliu, 2001). The monthly abundance and sex ratio between the males and females showed that the males dominated in 5 months more than the females in 2 months. In the estuary, the abundance expressed as a percentage for the males was 58% while the females was 41 % and the sex ratio was in favour of the males. The sex ratio being in favour of males could be as a result of the males moving around in search for food and the differences in the growth of the separate sexes (Panfili et al., 2004). It is an undisputable fact that sex ratio usually reflects the

acclimation process in food availability which also depends on the density. In the present study the population of males was more than that of the females. This may be due to upstream migration into the sea.

V. Summary, Conclusion And Recommendations

This work has highlighted the sex ratio, length weight relation and condition factor of *Ethmalosa fimbriata* in the Cross River estuary. The mean monthly indices of condition, K values shows that there was an improvement in fish condition between February, April, July and August.(wet and dry season) the highest condition factor was recorded in August. In the period of the rainy season, the species experienced favourable condition due to abundance of food and improvement during the stages of development of the gonads (Gomiero and Braga, 2005). The b value was 2.303 and growth for this species was a negative allometric growth pattern. And this is attributed to variations in water quality parameters, sample size and several ecological conditions of the environment.

This observation agreed with the findings of Welcomme (1979) and Fagbenro et al. (1991). Both authors reported the same thing for many freshwater fishes in Africa. Lagler et al. (1977) related such differences in seasonal values of condition to availability and abundance of food supply, timing and duration of breeding cycle; physiological stress caused by changes in water quality properties within the habitat; sexual differences, age; changes in seasons and gonad maturity stages in fish.

Variations in the monthly fish condition observed in this study may be attributed to the availability of natural food in the habitat consequent upon flooding during the rainy season which resulted in the inundation of previously dry ground thereby altering a number of water quality properties which ensured growth and production of natural food. The negative allometric growth implied that the fish species did not increase in weight as it grows meaning that the fish grew longer but thinner in body size; growth was not proportional in ~~the senses~~ that the increase in length was not proportional to body size. There are also suggestions that fish condition can be influenced by certain extrinsic factors such as changes in temperature and photo period (Samat et al 2008). That length-weight relationship in fish may be affected by some factors which include gonadal development and maturity, sex, diet composition, stomach fullness, health, and preservation techniques as well as season and habitat were not taken into consideration in the present investigation. Nevertheless, the mean condition factor observed in this study indicated that the species is in good condition.

Conclusion

From this study, it is concluded that *Ethmalosa fimbriata* is an important food fish in Africa and it is a highly exploited species. Owing to different ecological and anthropogenic threat, the growth of *E. fimbriata* in the Cross River estuary is slightly affected and a mass awareness is highly needed among the fishers about the ongoing threat to permit better management and survival of this species in the near future. There exist some differences between this work and that of Ama-Abasi (2004) ~~ten years ago~~. Ama-Abasi reported that bonga has isometric growth conditions in the Cross River estuary but this work showed that the growth of bonga is a negative allometry. This may possibly be attributed to climate change and other ecological conditions.

Recommendations

The resultant variation in the ecological conditions in the estuary has affected the growth of *E. fimbriata* in the Cross River estuary. However, future work has to be done on the length weight relationship of bonga with emphasis on the influence of climate change and the collation of basic meteorological and oceanographic parameters which were not part of this work.

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