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Studies on Age and Growth of African Pike *Hepsetus odoe* in Ado Ekiti Reservoir

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Abstract: *Age and growth pattern of African pike Hepsetus odoe from Ado-Ekiti Reservoir, Nigeria, were studied from May 2002 – May 2005. Samples were collected from the landing centres of fishermen in the reservoir. Age and growth were determined from length frequency distribution using Pauly's Integrated Method. Regression coefficient (3.61) showed positive allometric growth of the species. Condition factor significantly correlated with fish weight ($P \leq 0.05$, $r = 0.60$) and varied with season. Four distinct modes indicating the presence of four year classes at length 17.0cm, 21.8cm, 24.9cm and 27.3cm corresponding to age 0^+, 1^+, 2^+sand 3^+ respectively were observed. The asymptotic length ($L\infty$) was 35.30cm with growth coefficient of 0.36 per year.*
Keywords*: Age, growth, Hepsetus odoe, Ado-Ekiti Reservoir*

I. Introduction

The African pike, *Hepsetus odoe* (Bloch, 1974) is the only species of the Family Hepsetidae. It is a freshwater fish widely distributed in rivers and freshwater lagoon systems of Africa [1,2, 3, 4,5,6,7,8, and 9].

Age determination in fish species is essential for good fisheries management [10]. [11]Stated that more complete understanding of factors affecting maximization for fish growth would contribute importantly to fundamental biology of one of the more successful animal groups and give improved insight into various problems of fish culture and fisheries management. Age and growth studies are of practical importance for describing the status of fish population and for predicting the potential of fisheries [12]

Determining the age of tropical fishes is of particular concern as it is often difficult because there are no definite demarcated seasons and hence no clear annual rings on the hard structures [13, 14, and 15]. The Integrated Method of length frequency by [16] is adequate for aging and determining the growth pattern of fish. The greatest merit of this method is that it is very economical to use since only length measurements have to be taken; the costly process of age interpretation from hard parts of fish is avoided. The method also overcame the primary disadvantage in the use of hard parts for age determination of fish species since the fish must be sacrificed and to some degree mutilated. If samples are to be collected where there are commercial fish processing facilities, mutilation may make the fish less marketable.

Many workers have used length frequency method to estimate the age of many tropical fish species whose reproductive period is confined to a short period during the year. These include[17] on the clupeid, *Ethmalosa fimbriata*,[18]on catfish *Clarias walkeri,*[19] on the ten ponder *Elops lacerta*, [20] on the African bony-tongue *Heterotis niloticus*, [21] on the snout fish, *Mormyrus rume*, and [22] on the butter fish, *Schilbe mystus*. Previous studies on *H. odoe* have been concentrated on food and feeding habits [23] in Volta Lake , [24] in Kainji Lake, [25] in Lekki Lagoon; [5] in Zambezi River flood plain and [7] in Ado-Ekiti Reservoir.

H. odoe is an economically important fish in Nigerian freshwaters and particularly in Ado-Ekiti Reservoir where it forms part of the major commercial catch. Despite its importance, there is dearth information on this species from the reservoir. The present study was carried out therefore to investigate the age and growth of *H. odoe* in Ado-Ekiti Reservoir to provide information on the age of species in the reservoir, pattern of growth and maximum age/size attainable, also mortality. These are useful in the exploitation and management of the fish species in the reservoir.

II. Materials and Methods

Study Area

Ado-Ekiti Reservoir was constructed by damming River Ireje in Ado-Ekiti, Ekiti State, Nigeria in 1958. The Reservoir is a major source of water supply for domestic uses and also supports artisanal fisheries [26, 8]. The Reservoir lies between latitude 7^0 35′– 7^0 36′ North and Longitude 5^0 12′– 5^0 13′East at an altitude of about 440m above sea level (Figure 1). The Topography of the reservoir is undulating and surrounded by highlands. Ado-Ekiti lies within the tropical rainforest zone of South-Western Nigeria and experiences a distinct dry season (from November to March) and rainy season (from April to October).

The adjourning vegetation is dominated by: Elephant grass (*Pennisetum purpureum*), Giant star grass (*Cynodon plectostachyum*), Rhodes grass (*Chlorisguyanana*) and Siam weed (*Eupatorium odorantum).* The ichthyofauna consists of the tilapias, *Tilapia zillii, Sarotherodon galileaus, Sarotherodon melanotheron* and *Oreochromis niloticus;* catfishes, *Chrysichtys nigrodigitatus, Clarias gariepinus*, and *Heterobranchus bidorsalis; H. odoe* as well as the barb*, Barbus* sp.

Collection of fish samples

Weekly samples of *H. odoe* were obtained from the landing centres of fishermen from the reservoir between May 2002 and May 2005. The specimens were transferred in an ice chest for preservation by deep freezing prior to examination. In the laboratory each specimen was measured, weighed and given a registration number. The total length was taken as the distance from the tip of the snout with mouth closed to the end of the longest projection of the caudal fin while the standard length was taken as the distance from the snout with mouth closed to the base of the caudal fin. Both measurements were to the nearest tenth of a centimetre. The weights were taken on a Santorious Sensitive Balance to the nearest tenth of a gram. The length-weight relationship of the species was represented by the equation.

$W = aL^b$

Where

W = weight in grams,

L = length in centimetres and ‘a’ and ‘b’ are regression constants.

This relationship was transferred into a linear form by the equation.

$\text{Log}W = a + b\ \text{Log}L$

The condition factor (k), which refers to the degree of well-being of a fish (Fulton, 1902) was calculated monthly. Calculations were made separately for both sexes and combined sexes. The condition factor was calculated using the formula.

$K = \frac{100W}{L^3}$

Where K = condition factor,

W = weight in grams and

L = standard length in centimetres

Length frequency distribution (Peterson method)

Monthly charts of the various standard lengths of the specimens were recorded with the frequency with which each length occurred.

Length – frequency polygons were obtained and the mean of such progressions were plotted against time to obtain the growth rate of species [27]. The method assuming that the peaks on the length frequency data represent distinct age groups.

The Integrated Method of length frequency [16] which combines the Peterson Method and Modal class Progression Analysis was also used in interpretation of growth pattern. This method is an attempt to draw a growth curve with a curved ruler directly upon the length – frequency obtained from samples sequentially arranged in time. The modal lengths were interconnected by peaks which corresponded to various ages and they were read off the curve.

The Integrated Method helps to overcome some of the uncertainties faced by both Peterson Method and Modal class progression Analysis.

Growth parameters

The length frequency data was subjected to [28] growth formula described by[16].

$L_t = L_\infty [(1 - e^{(-k)}(t - t_o)]$

Where

L_∞ = mean fish length if they were to grow to a very old age (i.e. infinitely old fish).

K = growth coefficient (that shows how fast the fish approaches L_∞)

t_o = the “age” the fish would have at length zero, if they had always grown according to the equation (i.e. time when fish has zero length).

L_t = Length at age t (cm)

Then, the growth annually is gotten from:

$$L \frac{(t + 1.0)}{1.0} = L_{(t)}$$

The growth rate is defined by the equation:

$$\frac{\Delta L}{\Delta t} = \frac{L(t+\Delta t)-L(t)}{\Delta t}$$ cm / year

The mean length is obtained thus,

$$\frac{L(t+1)+L(t)}{2}$$

The parameters L_∞ and K were obtained from Gulland – Holt plot of growth rate against the mean length k = b (the negative slope).

Estimation of total mortality was made by applying formula of [29].

$$Z = \frac{K(L\infty - L}{L - L^1}$$

Where

L_∞ and K = parameter of Bertalanffy's growth equation

L = mean length in catch (cm)

L^1 = smallest length that were fully represented in catch samples

Z = total mortality

The growth performance index (GPI) of the species was computed from the formula described in [30]:

GPI = LogK + 2 Log L_∞

III. Result

Age determination from Peterson Method

The length frequency distribution of *H. odoe* (Fig.2) shows different peaks / modes. Mean length at each mode and age were 17.0cm (Age 0^+), 22.0cm (Age 1^+), 25.0cm (Age 2^+) and 28.0cm (Age 3^+).

Age determination from Integrated Method

The growth curve drawn directly upon length frequency data sequentially arranged in time is illustrated in Figure 3. Four distinct modes were observed. A smooth curve interconnecting the peaks cut succeeding horizontal lines at lengths 17.0cm, 21.8cm, 24.9cm and 27.30cm corresponding perhaps to age 0^+, 1^+, 2^+ and 3^+ respectively.

Von Bertalanffy Growth Methods

Growth parameters obtained is fitted into Von Bertalanffy growth model. The fastest growth rate (4.80) was between age 0^+ and 1^+, followed by the rate between 1^+ and 2^+. The slowest rate of growth was between age 2^+ and 3^+ (see table 1). The mean length of the fish in the reservoir (23.11cm) falls within the age 2^+ as could be seen in Table 1. This was the most frequent length.

Gulland – Holt plot of the growth rate against the mean length is illustrated in Figure 4. The growth curvature coefficient parameter (K) was 0.36. The mean fish length L_∞ of 35.30cm was obtained if they were to grow to a very old age.

Mortality of the species in the reservoir was $0.37yr^{-1}$.

The growth performance index (GPI) was 2.62.

Length – Weight Relationship

647 specimens of *H.odoe* (standard length 12.50 to 29.80cm body weight, 10 to 385g) were examined for their length – weight relationship and condition-factor. Longarithmic transformation of length weight reslationships of female and male *H.odoe* and both sexes combined are represented by the following regression equations.

Males: LogW = -2.57 + 3.50 LogL (r = 0.89, n = 342)

Females: LogW = - 3.00 + 3.81Log L (r = 0.92, n = 305)

Both sexes ; LogW = -2.73 + 3.61 Log L (r = 0.90, n = 647).

IV. Condition Factor

The mean condition factor (K) for male, female and combined sexes were 1.28 ± 0.25, 1.24 ± 0.22 and 1.26 ± 0.24 respectively. The relationship of the fish's condition factor and body length for males, females and combined sexes were insignificant r=0.26, r = 0.46 and r = 0.33 respectively (P>0.05 level). The correlation coefficient between the fish's condition factor and body weight were significant for both females and males and combined sexes of *H.odoe* (r = 0.69, r = 0.57, r = 0.62 respectively).

Monthly variation in the condition factor is illustrated in Figure 5. In all the years involved in sampling (2002, 2003 and 2004), condition factor was highest in April followed by May and June (1.57, 1.38 and 1.41). The only exception to this was a high value of 1.41 recorded in September 2003. Lowest values (1.12 and 1.11) were recorded in October 2002 and 2003 respectively. Generally condition factor was higher in rainy than dry season.

V. Discussion

The Integrated Method of[16] used for the analysis of length frequency data of *H.odoe* indicated that the growth is at first rapid, and then decreased with time. Previous studies of age and growth of fish have confirmed this assertion [31, 32, 21, 14, and 33]. The Integrated curve on the length-frequency distribution produced modal lengths on the curve. The curve intersects each of the horizontal lines indicating 4 age groups.

Length frequency distribution has been used in estimating the age of many tropical fish species whose reproductive period is confined to a definite short period during the year [17, 21, 22, and 33].[34]Reported that age classes could be identified from length frequency histograms with sufficient accuracy. [16] Integrated Method expressed the length – at – age of the particular stock. The length – at – age determined is usually fit into the Von-Bertalanffy growth equation, highly popular among Fisheries Biologist [35, 36].

The Von-Bertalanffy model makes use of growth parameters L_∞, t_o k, which are calculated or obtained graphically. It is the growth curvature parameter, k (which expresses how fast the fish approaches, L_∞ its determinate length if they are to grow to a very old age i.e. infinitely old fish) that is of immense value in the study of age and growth, t_o is 'age' the fish would have at length zero i.e. time when fish has zero length. [37] Noted that some species, most of the short-lived, almost reach L_∞ in a year or two and have high value of k. Others could have a flat curve with low k-value and need many years to reach anything like L_∞.

The k – value $0.36yr^{-1}$ obtained in this present study indicates that the species is not like short-lived in the reservoir. From [37] were of the opinion that species that are short-lived are those whose k-values are ≥ $1.0yr^{-1}$. *H.odoe* could thus not say to be short lived in this Reservoir. This is equally confirmed from the theoretical maximal length, L_∞ of 35.3cm observed.

The mean length (23.35cm) of the year class 2^+ almost corresponded with the mean length of the species (23.1 ± 3.1 cm) in the reservoir. Since the specimens were sorted and purchased from landing centres of local fishermen over a period of time, analysis of lengths based on such samples could have been influenced by many factors such as selectivity of fishing gear and availability of fish. This equally explains the comparatively very low occurrence of large *H.odoe* whose standard lengths were greater than 26cm and small ones with standard length lower than 18cm. Small fishes are known to be captured by traps which are not used by fishermen in the reservoir. For objective and reliable information in stock assessment, [38] recommended the total removal methods, which favour electrofishing and poisoning or both at the same time. These methods of fishing are not allowed in Nigerian waters according to the Inland Fisheries Decree of 1992: Section 6. Mortality (Z) of *H.odoe* in the reservoir could be said to be low. This implies low exploitation of *H. odoe* in the reservoir. In fisheries, mortality is the most useful manner of expressing decay (= decrease) of an age group through time [39].

Statistical analysis of length-weight data showed that *H.odoe* exhibited positive allometric growth in Ado-Ekiti Reservoir; since the values of b (the exponent) of the regression equations for length-weight relationships were greater than 3. This finding is similar to that of Omotoyinbo (Unpublished) for *H.odoe* and [40] for *Sarothrodon galilaeus* in the same reservoir, suggesting that the reservoir is a good production habitat for fishes.

The condition factor showed the males to be healthier than females. This may be due to the fact that the feeding intensity (IF) of males was greater than females indicating that males consumed more food than females. This is similar to the report of [41] that the condition of the cichlids in Awba Reservoir was better when they consumed more food. Condition factor was more related to weight than length of *H .odoe* in Ado-Ekiti Reservior showing that weight of fish is a better measure of the state of well-being than length. Bigger fish were in better condition than smaller ones. The lower condition factor of 0.84 [42] reported from the population of *H. odoe* from Eleyele Reservior implies that Ado-Ekiti Reservior is a better environment than Eleyele Reservoir for *the* species.There was seasonal variation in condition factor of *H.odoe* in Ado-Ekiti Reservoir. According to [43] such differences in monthly values of condition factor give information on availability and abundance of food supply and changes in seasons.

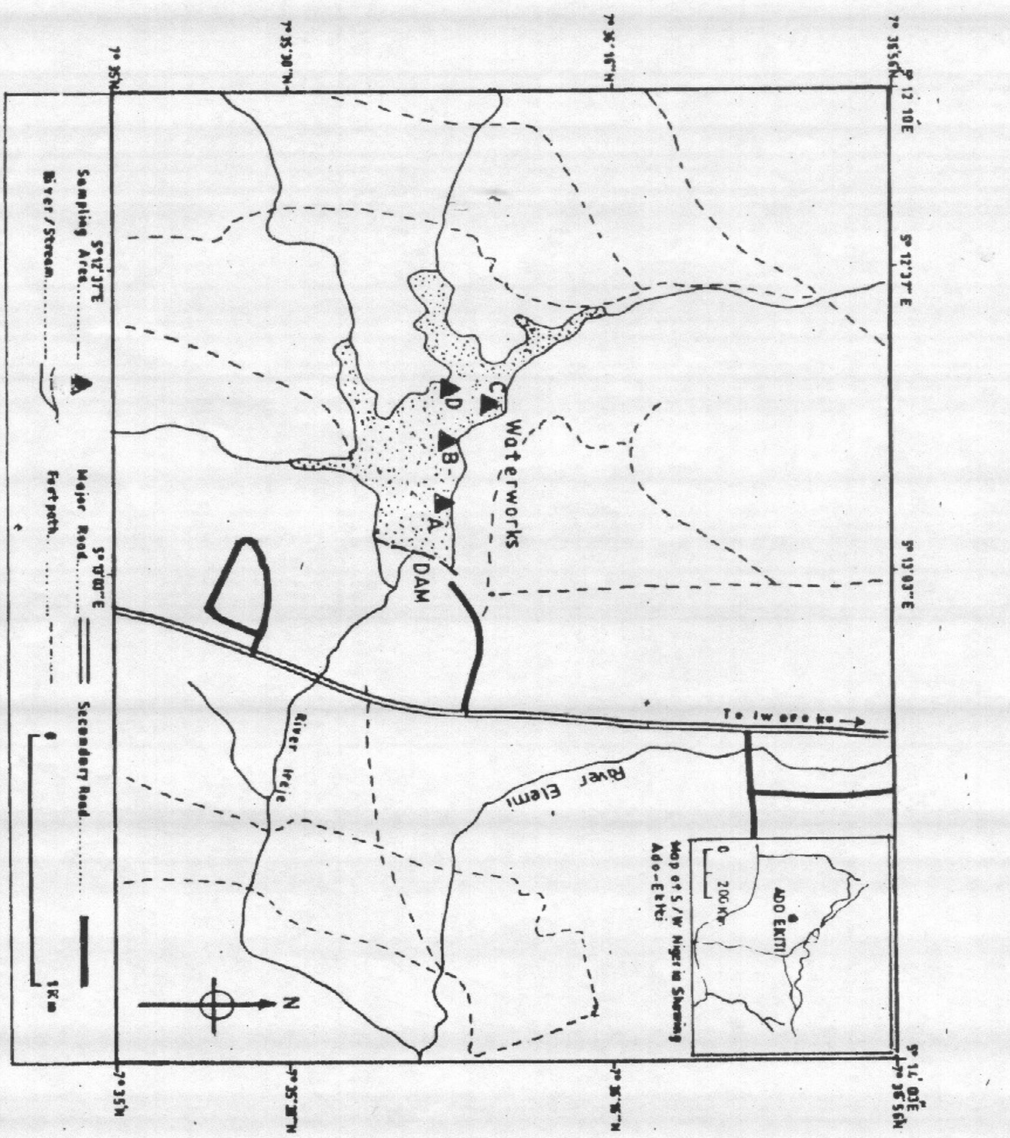

Fig.1 : Map of Ado-Ekiti Reservoir (shaded area) showing Sampling Stations (A, B, C, & D)

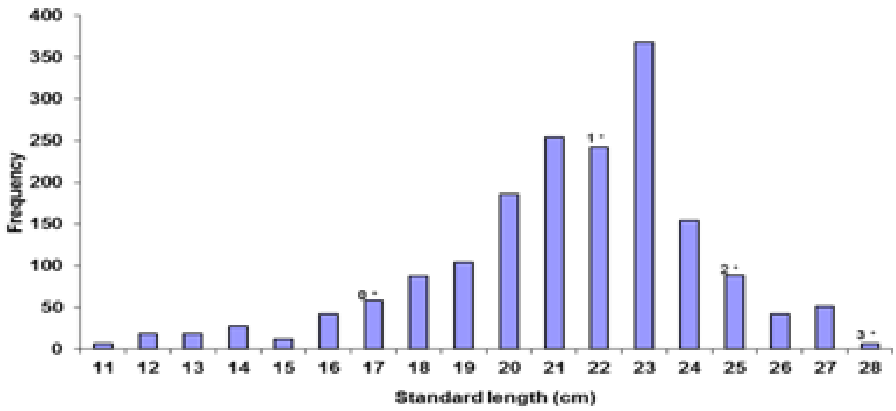

Figure 2: Length frequency data of *Hepsetus odoe* in Ado-Ekiti Reservoir showing peaks standing for age groups

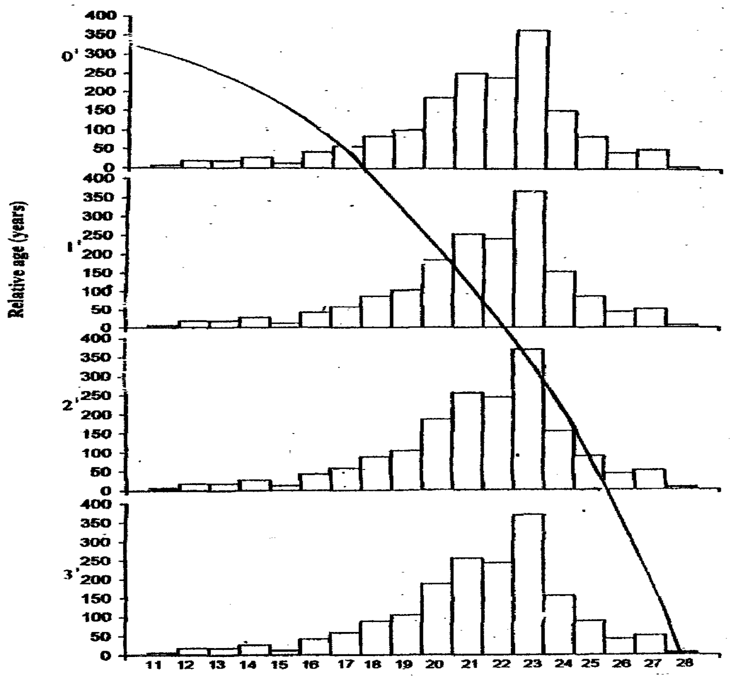

Figure 3: Age determination in *Hepsetus odoe* from Ado-Ekiti Reservoir using the Integrated Method

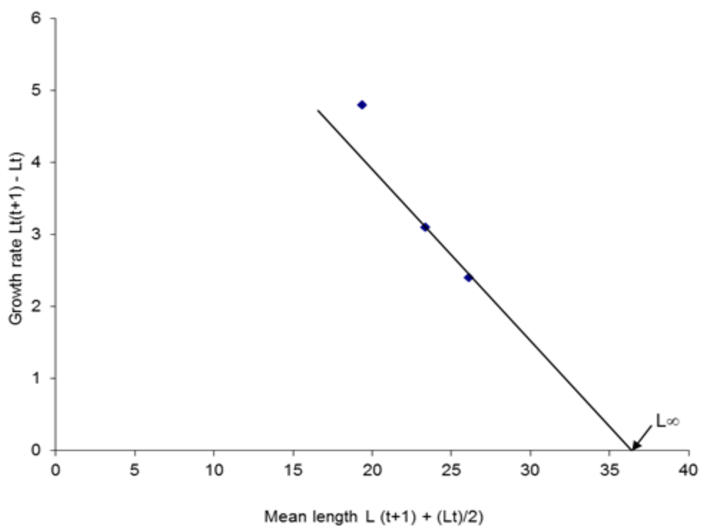

Figure 4: Gulland -Holt plot used in estimating the growth rate of *Hepsetus odoe* in Ado-Ekiti Reservoir

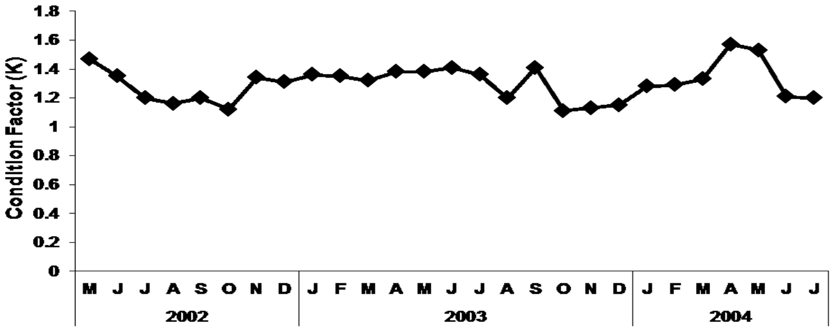

Figure 5: Monthly changes in condition Factor of *Hepsetus odoe* in Ado-Ekiti Reservior

Table1 Growth features corresponding to the age groups of *Hepsetus odoe* in Ado – Ekiti Reservoir

Age (t yrs)	L(t)=cm	Growth rate L(t+1) – Lt = cm/yr	Mean length L(t+1) + L(t)/2 = Lt = cm
0^+	17.00		
1^+	21.80	4.80	19.40
2^+	24.90	3.10	23.35
3^+	27.30	2.40	26.10

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