Age and growth of catfish *Synodontis schall*, (Bloch and Schneider, 1801) in the Lower Benue River, at Makurdi, Nigeria

Akombo P.M, Akange E.T, Atile J.I

Abstract

The age and growth of *Synodontis schall* in River Benue at Makurdi were studied over a 24-month period (January, 2009-December, 2010). A total number of 635 specimens comprising of 329 males and 306 females with the size range of 6.1 - 30.40 cm (mean = 12.04 ± 0.11) were studied. The weight ranged from 53.0 - 864g (mean = 57.71 ± 2.26). Asymptotic length (L∞) was 30.05cm, 30.00cm and 28.50cm in the females, males and combined sexes respectively. Growth rate (K 1-yr) was found to be 0.580, 0.570 and 0.430 while the growth performance index (Ø') was 2.756, 2.645 and 2.946 in the females, males and combined sexes respectively. The t₀ (a time in the growth history of fish at which the fish would be zero sized) values were all positive as follows 0.830 in the females, 0.39 in the males and 0.00 in the combined sexes.

Keywords: Asymptotic length, growth rate, growth performance index, *Synodontis schall*, River Benue.

1. Introduction

The genus *Synodontis* is the most common of the three genera of the *Mochokidae* family. It is among the most favoured edible fish in northern Nigeria (Reed et al., 1967) [35], owing to their overwhelming abundance in the artisanal fisheries. The genus consists of 23 species in the Nigerian waters (Idodo–Umeh, 2003) [22]. *Synodontis* species only occur in Africa and apart from the species present in River Nile; they are restricted to water systems within the tropics (Willoughby, 1974) [42]. The genus is commercially important in the inland waters of West Africa and in River Benue at Makurdi. *S. schall* is one of the species that can be seen in the fish markets throughout the year.

Hard parts such as scales, otoliths, spines, opercular bones, fin rays and vertebrae are used in age and growth determination by many authors. The age and growth of some scale-less fishes have been determined by the use of otoliths, opercular bones, spines, fin rays and vertebrae by Fagade (1979) [16], Araoye et al., (2002) [8] and Nargis (2006) [29]. Adeyemi and Akombo (2012) [6] used scales and opercular bones to determine the age and growth of dominant Cichlids in Gbadikere Lake, Kogi state, Nigeria. Despite the commercial importance of *S.schall* in River Benue at Makurdi, its age and growth have not been studied in order to access its production potentials. This paper therefore aims at determining the age and growth of *S.schall* in River Benue at Makurdi using opercular bones and length frequency data methods.

2. Materials and Method

The study was carried out in the Lower Benue River at Makurdi, Nigeria. The Lower Benue River is the portion of the Benue River that is contained within the Benue and Kogi States of Nigeria. River Benue originates from the Adamawa Mountains of Cameroun and flows west across East-Central Nigeria. It is the largest tributary of the Niger which it joins at Lokoja in Kogi State, Nigeria.

The River has extensive alluvial plain stretching for many kilometers, which covers a distance of approximately 187 kilometers. The extensive flood plain forms breeding grounds for many fish species (Beadle, 1974) [12]. The highest water levels are in August to September and the Lowest are in March to April.
2.1 Sampling method

The *S. schall* specimens were purchased from fishermen at Wadata fish landing site, Makurdi, which is one of the landing sites on the bank of River Benue. The fishes were caught with gill nets, cast nets, hooks and lines as well as other fishing gears. They were procured fortnightly for 24 months and transported to the Biology Laboratory in Benue State University, Makurdi for identification and measurements. Identification was done using the keys by Reed et al., (1967) [5], 308 Holden and Reed (1972) [21], Babatunde and Raji (1998) [9] and Idodo-Umeh (2003) [22].

2.2 Length-Weight Measurements

The standard lengths (SL) of the fish samples were measured using a measuring board. The anterior tip of the fish was placed against a stop at the beginning of the measuring scale with its mouth closed. SL was taken as the length from the tip of the fish’s snout to the end of the caudal peduncle and this was measured to the nearest 0.1 centimeter. The total weight (TWT) was measured using a digital electronic weighing balance (Adam AFP 4100L). This was read to the nearest 0.1 gramme.

2.3 Sex determination

The different sexes of *Synodontis* species were identified after dissection. Thus the fishes were dissected and the gonads were inspected using the keys of Nikolsky (1963) [27]. According to him, in the young males, testes are thin, thread like with very small projections, whitish in colour and extend to about 1/3 of the abdominal cavity. In adult males, the testes are creamy in colour with very conspicuous granules. The young females have thin, pink to white tubular gonads occupying about 1/5 of the abdominal cavity. In adult females, that are about to spawn eggs are readily discernable in the ovaries which increase in size and fill most of the abdominal cavity (Bagenal, 1978; Halim and Guma’a, 1989) [10, 19].

2.4 Length-Weight relationship (LWR)

The LWR of the fishes were calculated using the equation

\[ W = aL^b \]  

Where \( W \) = the observed total weights for each fish, 
\( L \) = the observed standard lengths. 
\( a \) and \( b \) are constants (Bagenal, 1978) [10]. 
\( b \) is the slope usually between 2 and 4 and \( a \) is the intercept on the length axis (Bagenal, 1978) [10]. The logarithmic transformation of the equation (1) gives a straight line relationship.

\[ \log W = \log a + b \log L. \]

When \( \log W \) is plotted against \( \log L \), the regression coefficient is \( b \), and \( \log a \) is the intercept on the Y axis.

2.5 The Condition Factor (K)

The condition factor (K) was computed from the equation:

\[ K = \frac{100W}{L^b} \]

Where \( W \) = the observed total weight for each fish. 
\( L \) = the observed standard length for each fish. 
\( K \) = the Condition Factor (Bagenal, 1978) [10].

2.6 Age and Growth

In aging, opercular bones were used in conjunction with length frequency, length-weight relationships, length at age and Von Bertallanffy’s growth model available in LFA/FiSAT computer programmes.

Treatment of the opercular bones was done as in Nargis (2006) [29]. The left opercular bones from the specimens were removed using a knife and immediately put in hot water for 2-3 minutes and washed. The bones were allowed to dry, then put in numbered envelopes and stored. The age rings on the bones were observed under a microscope projector to detect the growth marks.

Photographs of clear growth marks were made, and the opercular radius and the radius of the growth marks were measured.

Scatter diagrams of opercular radii against fish length were made. This relationship is always linear, but does not intercept at the origin, therefore back calculations of the length at specific ages were computed using the formula:

\[ \ln = \frac{3n(1-a)}{S} \]

Where \( L_n \) = length of fish when annulus “n” was formed 
\( l \) = length of fish when opercular sample was taken 
\( S_n \) = radius of annulus “n” 
\( S \) = total opercular radius 
\( a \) = intercept at the length axis (Bagenal, 1978[10], Araoye et al., 2002) [8].

The maximum distance between the centre of the bone and its margin was taken as the length of the bone. The relationship between bone length (Y) and SL (X) was established and the age groups were considered as 0+, 1+, 2+, 3+ etc. The yearly increase in length for each of the age groups was found by subtracting the mean length of each group from the next older age groups.

The growth parameters describing the fish populations were estimated from length frequency, length-weight relationships, and length at age using the Bhattacharya’s, Von Bertallanffy’s, Powell-Wetherall and Ford-Walford methods. All of these are available in the length frequency based stock assessment computer software programme FISAT II (1996).

2.7 Length at Age

The length at age was calculated using the Von Bertallanffy’s growth model in the LSA/FiSAT computer programmes. The Von Bertallanffy’s growth model of (1957) described growth curves as expressed by the formula:

\[ L(t) = L_\infty (1-e^{-kt}) \]

Where \( L(t) \) = length at age \( t \) 
\( L_\infty \) = asymptotic or maximum attainable length, assuming fish growth is indefinite. 
\( k \) = rate at which the asymptotic length is approached. 
\( t_0 \) = a time in the growth history of fish at which the fish would be zero sized. 
\( e \) = exponential and 
\( t \) = age in years.

Growth curves were fitted to the Von-Bertalanffy model and tested with Walford plots (Ricker, 1975) [33]. From the Walford plots, trials \( L_\infty \) were obtained.
From the trial \( L_\infty \), five values were obtained by successive addition of 1 to the trial \( L_\infty \) twice and subtraction of 1 twice from it. Trial plots of \( (L_\infty - L_t) \) against age were done using the method of Ricker (1975) [37], where the line of best fit was selected by eye to obtain the true \( L_\infty \). The gradient \( \log_e L_\infty + Kt_0 \), is the intercept, then

\[
\frac{Y - \text{Intercept}}{K} = t_0
\]

\( K \) is the gradient of the line of best fit from the trial plots of \( \log_e (L_\infty - L_t) \) against age.

By these the Von-Bertalanffy growth parameters \( L_\infty, K \) and \( t_0 \) were obtained.

2.9 Growth Performance Index

The growth performance index \( \phi' \) (Phi-Prime) was calculated using the formula of Pauly and Munro (1984) [34].

\[
\phi' = \log K + 2 \log L_\infty
\]

Where, \( K \) and \( L_\infty \) are parameters of VBGF.

3. Results

A total number of 635 specimens of \( S.schall \) comprising of 306 females and 329 males were examined. The results of the morphometric, growth parameters and mortalities were as shown in table 1.

Table 1: Morphometric and Growth Parameters of \( S.schall \) in the Lower River Benue at Makurdi.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SEX</th>
<th>COMBINED SEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. Sex Ratio</td>
<td>♀</td>
<td>♂</td>
</tr>
<tr>
<td>Length Range (cm)</td>
<td>6.6 – 30.4</td>
<td>6.1 – 21.5</td>
</tr>
<tr>
<td>Mean Length (cm)± SE</td>
<td>12.29±0.175</td>
<td>11.81±0.134</td>
</tr>
<tr>
<td>Weight Range (g)</td>
<td>8.4 – 864.5</td>
<td>5.3 – 406.9</td>
</tr>
<tr>
<td>Mean Weight (g)± SE</td>
<td>63.37±4.04</td>
<td>52.36±2.14</td>
</tr>
<tr>
<td>a</td>
<td>-1.0458</td>
<td>-1.0198</td>
</tr>
<tr>
<td>b</td>
<td>2.5290</td>
<td>2.4979</td>
</tr>
<tr>
<td>r</td>
<td>0.9333</td>
<td>0.9308</td>
</tr>
<tr>
<td>( K' )</td>
<td>2.874</td>
<td>2.838</td>
</tr>
<tr>
<td>( L_\infty ) (cm)</td>
<td>30.05</td>
<td>30.00</td>
</tr>
<tr>
<td>( K (1-yr) )</td>
<td>0.580</td>
<td>0.570</td>
</tr>
<tr>
<td>( t_0 ) (cm)</td>
<td>0.830</td>
<td>0.330</td>
</tr>
<tr>
<td>( \phi' )</td>
<td>2.756</td>
<td>2.645</td>
</tr>
</tbody>
</table>

\( a = \text{intercept on x-axis, b = slope, r = Coefficient of Regression, } K' = \text{Condition Factor, } L_\infty = \text{Asymptotic length, } K = \text{Growth curvature, } t_0 = \text{length at time 0, } \phi' = \text{Growth performance index.} \)

The correlation coefficient \( r \) for the females, males and combined sexes were positively correlated at 0.05% level (p<0.05%), while the regression coefficient \( b \) were all below 3 indicating a negative allometric growth pattern as shown in table 1 above.

The fishes were in good condition throughout the period of study with the average \( K' \)values of 2.874, 2.838 and 2.855 in the females, males and combined sexes respectively. The asymptotic lengths (\( L_\infty \)) from the Walford plots were 30.05cm, 30.00cm and 28.50cm for the females, males and combined sexes respectively. Growth rate (\( K (1-yr) \)) was slightly higher in the females (0.580) than the males (0.570), though there was no significant difference (p>0.05) between the two. The growth performance indices (\( \phi' \)) were 2.756, 2.645 and 2.946 for the females, males and combined sexes respectively. This was also slightly higher in the females than the males without a significance difference (p>0.05).

The photographs of the opercular bones of a two year (2+) and five year (5+) are shown in plates 1 and 2 respectively. The periods of slow growth are represented by the dark bands, while the periods of faster growth are represented by light bands which are wider. The growth marks were observed between July and October when water level was high due to the flood. As can be seen by the wider gaps in the first year, growth is rapid in the first year and slows down gradually in the subsequent years.

The relationship between the standard length and opercular radii for the females, males and combined sexes are presented in figures 1-3 below. The relationship is linear, but does not intercept at the origin. Therefore, back calculations of the length at specific ages were calculated (Table 3 below).
The slope relationship is described by the regression equations in Table 2 which are all positive.

### Table 2: Regression Equations for the Opercular Radius-Standard Length Relationship of *Synodontis schall* in the lower River Benue at Makurdi.

<table>
<thead>
<tr>
<th>Species</th>
<th>Sex</th>
<th>N</th>
<th>Regression Equation</th>
<th>Regression Coefficient (r)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. schall</td>
<td>♂</td>
<td>329</td>
<td>SL = 1.8049 + 8.4237 OR</td>
<td>0.9296</td>
</tr>
<tr>
<td></td>
<td>♂</td>
<td>306</td>
<td>SL = 1.5279 + 8.7105 OR</td>
<td>0.9371</td>
</tr>
<tr>
<td>Combined</td>
<td></td>
<td>635</td>
<td>SL = 1.6735 + 8.5662 OR</td>
<td>0.9327</td>
</tr>
</tbody>
</table>

SL = Standard Length, OR = Opercular Radius, ♂ = Male, ♂ = Female.

### Table 3: Back-Calculated Lengths of *Synodontis Schall* in Lower River Benue

<table>
<thead>
<tr>
<th>Sex</th>
<th>Age</th>
<th>No of Fish</th>
<th>L0</th>
<th>L1</th>
<th>L2</th>
<th>L3</th>
<th>L4</th>
<th>L5</th>
</tr>
</thead>
<tbody>
<tr>
<td>♂</td>
<td>0+</td>
<td>7</td>
<td>5.98</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1+</td>
<td>207</td>
<td>6.55</td>
<td>6.04</td>
<td>6.55</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2+</td>
<td>96</td>
<td>7.53</td>
<td>11.81</td>
<td>13.68</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3+</td>
<td>11</td>
<td>10.06</td>
<td>16.76</td>
<td>20.36</td>
<td>21.85</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4+</td>
<td>13</td>
<td>11.03</td>
<td>18.34</td>
<td>22.73</td>
<td>24.72</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5+</td>
<td>-</td>
<td>17.94</td>
<td>23.92</td>
<td>26.91</td>
<td>27.91</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td></td>
<td>5.98</td>
<td>7.55</td>
<td>11.71</td>
<td>17.02</td>
<td>21.85</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5.98</td>
<td>1.57</td>
<td>4.16</td>
<td>5.31</td>
<td>4.83</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9.33</td>
<td>2.45</td>
<td>6.47</td>
<td>8.28</td>
<td>7.53</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td></td>
<td>5.98</td>
<td>7.78</td>
<td>14.87</td>
<td>20.40</td>
<td>25.82</td>
<td>27.91</td>
</tr>
<tr>
<td></td>
<td>Av. Ann. Increment</td>
<td></td>
<td>5.98</td>
<td>1.80</td>
<td>7.09</td>
<td>5.53</td>
<td>5.42</td>
<td>2.09</td>
</tr>
<tr>
<td></td>
<td>% Growth Increment</td>
<td></td>
<td>7.49</td>
<td>6.45</td>
<td>25.40</td>
<td>19.81</td>
<td>19.42</td>
<td>7.49</td>
</tr>
</tbody>
</table>

### 4. Discussion

In the temperate waters, it was assumed that during the cool months of winter when temperatures were low, the life functions of most fishes decreased to a minimum in which case growth was also reduced. Gado (1999) [17] explained that annual fluctuations of metabolic level and of water temperatures were the major factors explaining the occurrence of annuli in the hard parts. The periods of low growth are imprinted on the skeleton and scales in the form of rings or stripes, while the periods of faster growth are characterized on the scales and skeleton by wide fields or rings (Lagler, 1977) [26].

Even though there are small seasonal temperature and other environmental changes prevailing in the tropics, growth marks on the hard parts of tropical fishes can also be used in aging fishes. On the other hand, different hard parts are most appropriate for aging different species of fish. Thus, in this study the opercular bones were used in aging the *Synodontis schall*. Growth marks were observed on many opercular bones as can be seen in plates (1-2). These growth marks according to Araoye et al., (2002) [8] were usually formed between July and October when water level was high due to the flood. Blake and Blake (1978) [13] reported the presence of growth rings on the scales and opercular bones of *Labeo senegalensis* from Kainji Lake. They however commented that the scale marks were often indistinct and difficult to interpret while they observed at least two check marks per year on the opercular bones. Haruna (1992) [16] observed growth rings on the opercular bones of cichlids from Jakara Lake, Nigeria. Gado (1999) [17] used opercular bones to age many species of fish in the Hadeija Nguru wetlands including *Synodontis* species. Araoye et al., (2002) [8] also used opercular bones to age *S. schall* in Asa Lake, Ilorin. Nargis (2006) [29] reported that opercular bones method was superior to several other methods.
of determining age and growth of Carp (Cyprinus carpio), while Khan and Khan (2009) [23] showed that opercular bones were the most suitable structures for ageing Catla catla and scales were the most suitable in Labeo rohita in India.

Fagade (1974) [16] attributed the growth marks on hard structures in tropical fish as a result of factors such as reproductive activity, feeding intensity, lower salinity, increased turbidity and reduced temperature during the rainy season in the Lagos lagoon. Abowei and Davies (2009) [2] attributed growth fluctuations in tropical and sub-tropical fishes to many factors such as environmental changes, food composition changes, competition with the food chain, changes in the physical and chemical properties of aquatic medium. The growth marks observed in this study may also be attributed to high turbidity, low oxygen and reduced feeding intensity during this period as this also coincided with the period of spawning.

The readings on the opercular bones in this research revealed that growth was slowed during certain period of the year and faster at other times. The period of slow growth coincided with the period of flooding which is from July to October in this part of country (Araoye, et al., 2002) [8]. This is also the period of spawning of these species in this area. The flooding of the river brings about changes in the hydrological, chemical and physical characteristics of the water body especially temperatures. Olaosebikan et al., (2006) [24] observed that seasonal changes in temperature and day length were less pronounced in tropical latitudes, therefore, suitable environmental conditions were governed more by the change in rainfall and water level, forming a sequence of wet and dry seasons than by physiological process. From the opercular readings and the back calculations, it was observed that growth rate was rapid during the early years and gradually declined during the preceding years. Araoye et al., (2002) [9] explained that this was a usual phenomenon in some fishes in which wider gaps between the annular marks on the opercular of the fishes in their early years was an indication. This is due to the fact that the younger fishes were more involved in feeding activities than the matured ones which might be more engaged in reproductive activities and territorial protection, hence slowly declining growth curves for most fishes. However in piscivorous fishes such as Lates niloticus and Clarias gariepinus the growth rate could approach a straight line even up to 10 years Araoye et al., (2002) [9].

The highest \( L_\infty \) was 30.05cm in the females while the maximum length of 30.40cm was recorded in a female also. There was not much difference between the \( L_\infty \) and the maximum length of fish obtained indicating that the values obtained were reasonable for the species in the river.

Araoye (1997) [7] computed the \( L_\infty \) of S. schall in Asa Lake from the observed, back calculated, and integrated methods as 50.4cm, 49.5cm and 50.0cm respectively. Abowei and Hart (2009) [4] reported the \( L_\infty \) of S.schall to be 38.7cm, \( S.clarias \) 35.56cm and \( S. membranaceus \) 43.8cm from the Lower Nun River, Niger Delta. Midhat et al., (2012) [27] observed the \( L_\infty \) of 62.74cm, 64.24cm and 63.45cm for males, females and combined sexes respectively in S. schall in Egypt at Gizza. The different asymptotic lengths observed in the different localities even in the same species can only be explained by the different environmental conditions in those areas or high fishing pressure. Spare et al., (1992) [41] reported that growth of fishes differed from species to species and from stock to stock even within the same species as a result of different environmental conditions. Abowei and Hart (2007) [3] attributed the differences in the maximum size of Chrysichthys nigrodigitatus in the Lower Nun River to high fishing pressure, environmental pollution and degradation. King (1991) [21] had shown that the maximum size attained in fishes was generally location specific.

The hypothetical age at which length is zero (\( t_0 \)) were all positive in \( S. schall \) male, female and combined sexes. Gado (1999) [17] reported positive \( t_0 \) values for the fishes of Hadejija N’guru wetlands, North-Eastern Nigeria. Abowei and Hart (2007) [3] also reported positive \( t_0 \) values for the major cichlids and Chrysichthys nigrodigitatus from Umusoserhe Lake and Nun River respectively. Sambo and Haruna (2012) [38] also reported positive \( t_0 \) values for the fishes of Adamu Ibrahim Lake, Kazaure, Jigawa state. These were \( O. niloticus \) 0.12 for males, 0.66 for females; \( S. galilalaeus \) 0.30 for males, 0.86 for females and \( B. bayad \) 0.50 for males, 0.85 for females. Pauly (1983) [34] stated that \( t_0 \) values were usually negative. King (1997) [25] reported that with negative \( t_0 \) values, juveniles tended to grow more quickly than the predicted growth curve for adults, and with positive \( t_0 \) values, juveniles grew more slowly. Schnute and Fournier (1980) [39] stated that \( L_\infty \), \( K \) and \( t_0 \) had no direct biological meaning and that values of \( L_\infty \) in particular were dependant on adequate sampling in the larger length classes.

The growth rate of this species in the river was 0.580, 0.570 and 0.430 in the females, males and combined sexes respectively. This shows that the rate at which the males and females of \( S. schall \) approach \( L_\infty \) is similar.

The growth performance index of fishes (\( \Omega' \)) compares the growth performance of different populations of fish species in the same or different environments. In this study the growth performance indices of the female, male and combined sexes of \( S. schall \) were 2.756, 2.645 and 2.946 respectively. These values are in agreement with most values obtained in tropical fishes. Abowei (2009) [1] reported the growth performance index (\( \Omega' \)) of 2.63 in Hemisynodontis membranaceus from the fresh water reaches of Lower Nun River, Niger Delta. Abowei and Hart (2009) [4] observed the growth performance indices of 2.71 in \( S. schall \), 2.63 in \( S. membranaceus \), and 3.23 in \( S. clarias \) from the Lower Nun River, Niger Delta. Midhat et al., (2012) [27] reported the growth performance indices in length of \( S. schall \) in River Nile at Gizza to be 2.689, 2.692 and 2.709 in the males, females and combined sexes respectively. Ade dolapo (2007) [5] observed the growth performance index of 2.62 and 2.51 in Schilbe mystus in Asejire and Oyan Lakes respectively. Ade dolapo (2007) [5] showed that Phi Prime (\( \Omega' \)) were species specific parameters and gross dissimilarity of \( \Omega' \) values for a number of stocks of the same species or related species are an indicator of unreliability in the accuracy of estimated growth parameters. Thus the similarity of \( \Omega' \) related species in different tropical areas is an indication of the reliability of the computed growth parameters in this study. Bajot and Moreau (1997) [44] stated that the \( \Omega' \) mean values of some important fishes in Africa ranged between 2.32-2.51, which they considered as low. Gatabu (1992) [45] indicated that besides the genetic makeup which determines the growth potential of the species, overfishing, diet type and its utilization could affect the growth performance index of a particular species. Even though the growth performance is a function of \( L_\infty \), increase in \( L_\infty \) leads to increase in growth performance and vice versa.
5. Conclusion
The study of age and growth of Synodontis schall in River Benue at Makurdi showed that opercular bones were a reliable part of the skeleton for the determination of age. The growth rate and the growth performance index were found to be good in the river.

6. Acknowledgment
We are most grateful to the laboratory technicians, Mr. Waya, Joshua, Mrs. Shiriki, Dooshima, Mrs. Tyona Esther, Mr. Adanu, Peter and all the other Laboratory Assistants for their support during the practical. I cannot forget my students who assisted me in the practical, Miss Shima, Judith and Mr. Adi, Peter. We are also grateful to Mr. Iyouden Atoo who used to drive us to the market to purchase the fishes. May God bless you all.

7. References
23. Khan MA, Khan S. Comparison of age estimates from scale, opercula bone, otolith, vertebrae and dorsal fin ray in Labeo rhoheta (Halmilton), Catla catla (Halmilton), and Channa marulius (Halmilton). Fisheries Research, 2009; 100(3):255-259.