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Use of Eye Lens Diameter as Age Indicator of Nile Tilapia (*Oreochromis niloticus*) *a*nd Red Belly Tilapia (*Tilapia zillii*)

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ABSTRACT
Samples for this study were collected from the upper River Benue consisting of 104 Redbelly tilapia, *Tilapia zillii* (Gervais, 1848) and 120 *Oreochromis niloticus* (Linnaeus, 1758). Eye (ocular) lens diameter was analysed in the two species to determine the possibility of using the data for age determination. The relationship between age and mean eye lens diameter was (Eye lens diameter, mm=0. 623 e $^{0.276\ (age)}$, (r^2=0. 007, s.e = ±0. 13mm, F=9. 72, Durbin Watson=0. 737). In *Oreochromis niloticus* the average lens diameter showed the same trend as in *Tilapia zillii*. The relationship between age and mean eye lens diameter was (Eye lens diameter, mm=0. 795 e $^{0.172\ (age),}$ (r^2=0. 05, s.e =±0. 11mm, F=8. 91, Durbin Watson=0. 961). The result indicated that this technique could not be adopted for determining the age of these species when they are very young (one year or less). This method cannot differentiate *Tilapia zillii* of one year and below because there was significant overlap between the average lens diameters for age group of one year and below. This technique is not useful for samples that are of age one year or less, however, it may prove useful in older samples. Further study in older fish samples with a wider length range is therefore recommended.

Key words: Age determinations, ocular lens, scales, cichlids, River Benue

INTRODUCTION

Age determination is an important step in the process of studying growth in fish species. Fish can be aged using a number of structures which can produce the periodic growth increment, including scales, vertebrae, fin rays, cleithra, opercula and otoliths (Campana, 2001). The method involves the counting of the scale or otolith annuli and usually requires the measurement of a large number of samples (Fletcher, 1991). The ability to determine the age of fish is an important tool in fishery studies. A consistent system for designating age is necessary regardless of the method by which the age is determined. Two important consideration when selecting a structure for aging a sample are whether the structure yields accurate estimates of fish age and whether the structure can be obtained without killing the specimens (Brenden *et al.*, 2006).

The prevalence of impact of inaccurate age determination of the accuracy of population dynamics studies cannot be overstated (Morrison *et al*., 1998). There are many instances in which ageing in fish has contributed to serious overexploitation of a fish species population. The problem often encountered is that of fish age underestimation leading to overestimation of growth and mortality rate (Van den Broek, 1983). Error in ageing fish can be of two forms: error that affects accuracy or closeness of the age estimate of the true value and error that affects precision, or reproducibility of repeated measurements on a given structure (Kalish *et al*., 1995). Measuring the ocular lens has been a common technique for estimating the age of mammals and birds (Lord, 1958; Friend, 1967), as well as the use of eye lens weight (Burlet *et al*., 2010) and insoluble eye lens protein (Janova *et al*., 2007). Studies have concluded that the eye lens diameter can be used to estimate the age of fishes (Al-Hassan *et al*., 1991, 1992: Al Hassan and Al-Sayab, 1994). Age determination using scales or otolith annuli is laborious, complicated and require varied and considerable effort to prepare each specimen. Even then the readings could be subject to systematic and random errors in interpretation and require independent validation. To reduce or avoid such a complicated procedure, therefore, other alternative

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methods of ageing fish such as the use of eye lens diameter are being studied. This study was therefore undertaken to determine the possibility of using eye lens diameter data in order to determine the age of Nile tilapia, *Oreochromis niloticus* and red belly tilapia, *Tilapia zillii.*

MATERIALS AND METHODS

The samples of *Oreochromis niloticus* (Linnaeus, 1758) and *Tilapia zillii* (Gervais, 1848) were randomly collected from fishermen at the Upper River Benue. The river has its origin in the Adamawa Mountains in central Cameroun and has a total length of about 1400 km and almost entirely navigable during the summer months; it is a major tributary of the River Niger into which it discharges in Nigeria. The Upper River Benue is an important transportation route in the region through which it flows. It arises in the Adamawa plateau of Northern Cameroon, from where it flows west, through the town of Garoua and Lagdo Reservoir, into Nigeria south of The Mandara Mountains, and through Jimeta-Yola, Ibi and Makurdi before meeting the Niger at Lokoja. Large tributaries are River Gongola and Mayo Kebbi which connects it with Logone River (part of Lake Chad system) during floods. Other tributaries are Rivers Taraba and Katsina- Ala (Van de Knaap, 1994).

The method of Conides and Al-Hassan (2000) was adopted for this study. The ocular lens diameter is the greatest distance across the cornea of eyeball, found by lightly probing the eye surface to depress the relatively pliant cornea. The eye lens was removed and dried at room temperature before measurement. Both lenses from each specimen were measured. The needle-point dividers were used to measure eye lens diameter, which was read to the nearest 0.1mm by laying the extended divider on the Copper Clipper millimetre ruler (80mm high quality Brass ruler). Eye lens diameter of smaller fish was measured with an ocular micrometre mounted in an eyepiece of the dissecting microscope.

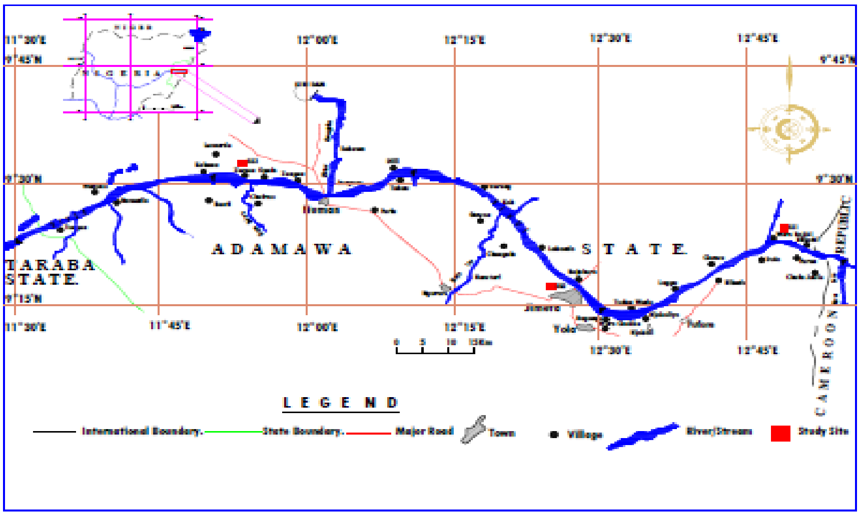


Fig. 1 Map of Upper River Benue Showing Sampling (Study) Sites

Scales for the study were removed from the flanks at the top of the pectoral fins using forceps and scalpel. The scales were then soaked in water for about an hour and then cleaned and rubbed between the thumb and forefinger so as to remove the epithelial tissue from the scale; they were then placed in 20% formalin for about an hour before they were taken out and dried and placed in paper envelopes. Sampled scales were mounted directly from water to the glycerin gelatin mixture which had a suitable refractive index to reveal the annuli as described by Chilton and Beamish (1982). The Dahl Lea linear technique was used for back calculation to verify the ages before being matched to the eye lens (Ricker, 1975). The relationship of eye size (ocular lens diameter) to standard length were presented as scattered plots and Box-whisker graphs (mean, minimum & maximum) of eye lens diameter versus age for both fish species.

RESULTS

The relation of eye lens diameter (as % of standard length) and standard length are presented in Fig. 2 for *Tilapia zillii* and *Oreochromis niloticus* (Fig.3). The results indicated that an increase in size (standard length) did not lead to a corresponding increase in eye size (eye lens diameter), there was no correlation between eye size and age. The fact that the age as revealed by the growth ring (annulus) of the fish examined is not correlated with their eye sizes seems to suggest invalidity of such a study. However, there was indication that at younger age, most of the fish had larger eye size. The eye size decreased with increase in body size in both species as indicated by both scattered grams (Figs. 2 & 3). Box-Whisker graphs indicating the mean, minimum and maximum values are presented for *Tilapia zillii* (Fig.4) and *Oreochromis niloticus* (Fig.5).

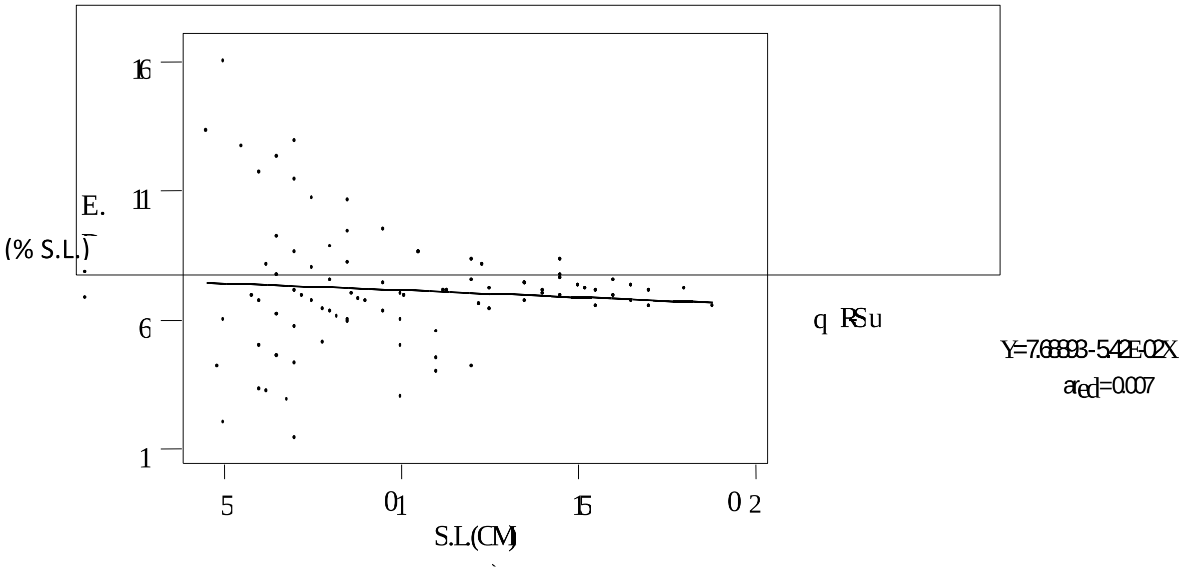
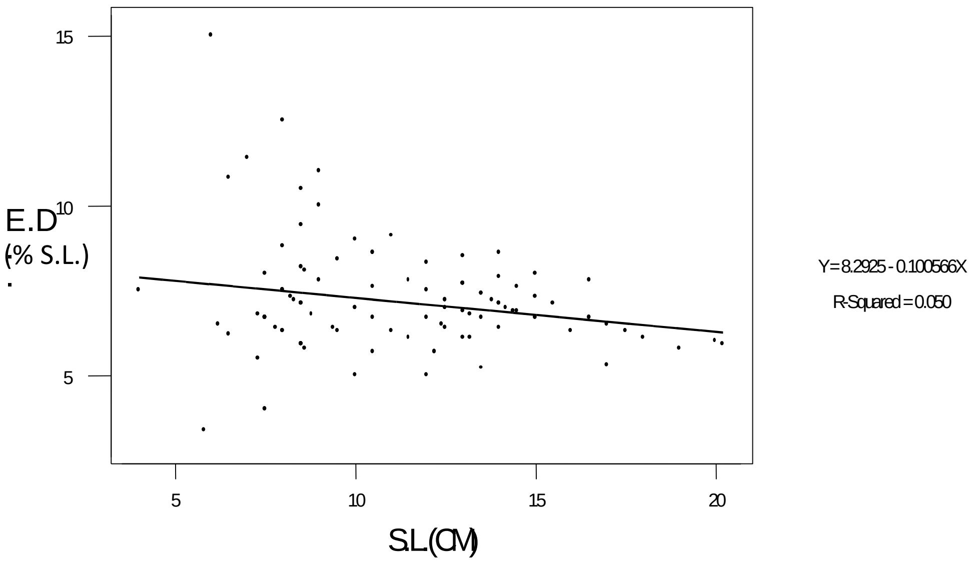


Fig.3. Relation of Eye Diameter (ED) To Standard Length (S.L) of the Nile Tilapia *Oreochromis niloticus*



DISCUSSION

The eye lens diameter values decreased with increase in size (standard length) in both species, though the decrease was more pronounced in *Oreochromis niloticus*. The study revealed that eye lens diameter values in *Tilapia zillii* and *Oreochromis niloticus* can't be used to determine the age of these fish, especially when they are just one-year-old or less because there was a significant overlap between the average lens diameter for age groups of one year or below. This method therefore cannot differentiate *Tilapia zillii* of one year and below (Fig. 4). In *Oreochromis niloticus* the average lens diameter follows the same sequence as in *Tilapia zilli*, and there appears to be a significant overlap for samples that are one year and below (Fig.5). This differs with the of Conides and Al-Hassan (2000) who worked on the eye lens diameter as age indicator of *Lithognatus mormyrus* and *Diplodus vulgaris*. They reported that overlap occurred in samples of *Lithognatus mormyrus* above one year of age, while in *Diplodus vulgaris* overlap occurred in samples above two years. Subsequent phases of this study will focus on samples of more two years.

Using an eye lens diameter for determination of age in young *Tilapia zillii* and *Oreochromis niloticus* of one year or below (as an alternative to other methods such as scales, otolith and ring counts) is not feasible for now as indicated by this study. As pointed out by Mohr (1994), different hard parts are more appropriate for aging different species of fish, thus in Haddock (*Melanogrammus eaglefinus)* age determination is best based on Cleithra and vertebrae, in Cod *(Gadus morhua*) Cleithra and in Herring (*Clupea harengus*) on the vertebra. In Sole (*Solea solea*) on the other hand hard bone structures can't be used. Therefore, further studies on the fish species for more than one year is recommended. The recommended studies should also be based on more than one predictor. This is so because eye lens growth as occur in other body parts used for studying growth in field studies is affected by seasonal variation in many environmental factors such as availability of food resources, photoperiod and response to population density, sex and phase of the population cycle as put forward by Jonava *et al.* (2003) and Burnet *et al.* (2010).

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