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Some Ecological Aspects of *Oreochromis niloticus* and *Heterotis niloticus* from Ona Lake, Asaba, Nigeria

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Abstract: Some ecological aspects of *Oreochromis niloticus* and *Heterotis niloticus* at Ona Lake was investigated using age and morphological characters. The study was necessitated to provide information that will enhance management and conservation of the two species and provide future comparisons between populations of the same species. A total of 200 samples comprising one hundred from each species were used. After catch, samples were taken to the laboratory where they were identified, sexed, length and weight determined and age estimated. Data were analyzed using both descriptive and inferential statistics. The oldest male and female specimens of *O. niloticus* were less than two years old. However, three year classes were observed for *H. niloticus*. Fish in their first growing year dominated the stock as they accounted for 88% and 76% for *O. niloticus* and *H. niloticus* respectively. Relationship between total length and weight of each of the species showed that growth in length increased as weight increases but the rate of increase in body length was not proportionate to increased body weight. Condition factor values of both species at the lake indicated that they were in good condition.

Key words: Aging · Scales · Allometry · Condition · Ona Lake

INTRODUCTION

The study of the dynamics of exploited fish populations is mainly based on knowledge of biological processes, such as reproduction, growth, maturity and mortality. However, age and growth parameters of fishes constitute essential data to control the dynamic of ichthyologic populations; they give an important indication on the fisheries management and on the level of their exploitation [1]. Aging is most often done by counting rings in hard part of the fish body, such as ear-bones (otoliths) or scales. The chemical composition and thereby the transparency of the addition depends (among other things) on the amount of food available and it is therefore seasonal. In the temperate latitudes, the differences in deposits made in the winter and in the summer can be detected as one year-ring, composed of a summer and a winter part and can be distinguished from the next. Moreover, temperate fish species usually spawn once a year in a relatively short time-span, which makes it easy to distinguish year-classes or cohorts [2].

In tropical fish species, material is added daily to hard parts, which can be distinguished as daily growth rings. However, the lack of a strong seasonality makes the distinction of seasonal rings and therefore also of year-rings problematic for many tropical species. Furthermore, the same absence of strong seasons results in less distinct spawning periods for most species. Many tropical species spawn at least twice per year and often over long periods. Fortunately, due to periodic changes in winds (monsoons) and shifts in oceanographic conditions (upwelling) in many tropical areas, a certain level of seasonality can still be detected. This seasonality may be reflected on the spawning patterns and growth of tropical fish species albeit less pronounced and much more difficult to detect than in temperate waters [2].

In African fishes, the endogenous factor action in the formation of annuli on the fish bony pieces, the spatial and temporal fluctuations of ecological conditions like the climatic, trophic and physiochemical conditions, diseases, population density and

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temperatures can also be decisive factors as stress sources leading to the formation of growth stopping lines in the hard pieces of fish [3]. Fagade [4]; Saliu [5]; Whenu and Fagade [6] and others have found complete growth rings on hard parts in some tropical species. Scales are the easiest to collect and process therefore its use for age determination and aging process prevents sacrificing the specimens as against the method used in otoliths [6].

Biometric data such as Length-Weight Relationship (LWR) is a veritable tool in fisheries management. According to Pitcher and Hart [7] it has both applied and basic uses in the practical assessment of fish stocks. Furthermore, length and weight data are useful standard results of fish sampling programs [8]. In fish, size is generally more biologically relevant than age, mainly because several ecological and physiological factors are more size-dependent than age-dependent. Consequently, variability in size has important implications for diverse aspects of fisheries science and population dynamics [9]. Length-weight regressions allow the estimation of the average by establishing a mathematical relationship between the relative well-being of the fish population.

Ona Lake is a natural freshwater body in Delta State, Southern Nigeria with abundant species composition. Ekelemu [10] have identified fifty two (52) species of fish in this lake and noted that *Oreochromis niloticus* and *Heterotis niloticus*, among other species are permanent and dominant. Like most natural waters, this Lake has been undergoing steady exploitation over the years. Despite the fact that *Oreochromis niloticus* and *Heterotis niloticus* constitute the bulk of the landings from this natural lake, detailed study of the age (scale reading), length-weight relationship and condition of these dominant species have not been studied. This is however necessary in other to enhance the management and conservation of these species. It will also allow for future comparisons between populations of the same species. In view of the above, this study was carried out to examine the age composition, determine the length-weight relationship and condition factor as well as provide information on the sex ratio and size frequency of *Oreochromis niloticus* and *Heterotis niloticus* at Ona Lake.

MATERIALS AND METHODS

Description of Study Area: Ona Lake is a tropical freshwater lake, west of the Niger River. The lake derives its source from a spring called "Utho". It is about 8km from Asaba, Oshimili North Local Government Area of Delta State, Nigeria (Figure 1). It lies on latitude 6°43'E and longitude 6°11'N of the equator and covers a surface area of 52 hectares [11]. The lake has a length of 2,250 km [10].

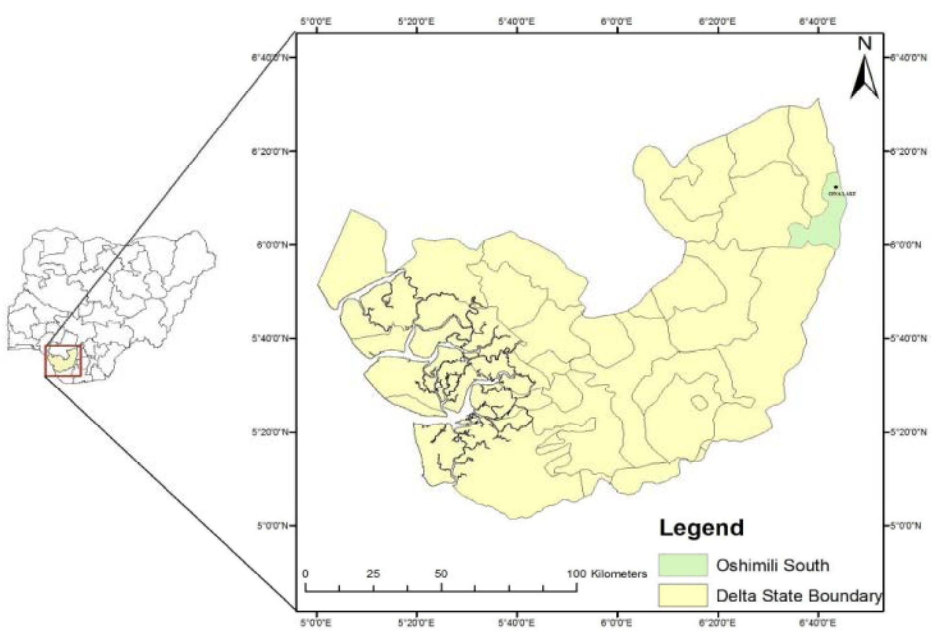

Fig. 1: Map of Nigeria and Delta State showing the study area

Collection of Samples: A total of 200 fish comprising 100 from each species were collected with the help of fishers-folk operating on the lake. Bottom-set and surface-set gill nets, long lines and FAD (Fish Aggregation Devices) were used for sampling between January and July, 2012. Samples collected were washed, packed in iced plastic buckets and transported to the laboratory. Samples were thereafter sorted, identified, sexed; measurements were taken and age estimated using the following morphometric features: fins and fin ray counts (spines and soft rays), scales, lateral lines, nostrils, mouth, colour pattern and body shape as described by FAO [12] and Idodo-Umeh [13].

Morphometric Measurements: Total and Standard lengths of fish species were measured to the nearest 0.1cm using a measuring board, while the weight of the fish were measured to the nearest 0.1g using the overhead loading triple beam balance (OHAUS Model, USA).

Sex Determination: The two (2) fish species which were monomorphic (individuals of each sex were similar both in coloration and body structure) were determined by a process commonly called "venting" and inspection of the gonads according to Balarin [14] and Lagler *et al.* [15].

Age Determination: Growth marks on scales were used for age determination in the fish sample. The scales were taken from the same location on all the fish species [16]. They were removed from the region beneath the dorsal fin and above the lateral line. Scales from *Heterotis niloticus* were carefully removed with a pair of forceps while those of *Oreochromis niloticus* were scraped from the fish with a sharp knife. Samples of Six (6) scales were extracted from each of the specimen as suggested by Whenu and Fagade [6]. They were cleaned in diluted aqueous ammonia solution, rinsed and then dried. The dried scales were mounted on microscope slides and the growth marks read. Scales that were curled after drying were bound tightly between two slides with cello tape before mounting them on the microscope [16].

Length-Weight Relationship, Condition Factor and Grouping: This was computed from the formula described by Bagenal and Tesch [16] and Pauly [17]: The value of constants *a* and the slope *b* was estimated from the *ln* transforms values of length and weight *i.e.* $ln\ W = lna + b\ ln\ L$, the least square linear regression. The condition factor (*K*) also known as ponderal index or the Fulton's coefficient was computed for different ages, sexes and species using the formula described by Bagenal and Tesch [16]. The body shape/weight of fish species was determined using Smith [18].

Statistical Analysis: Simple descriptive statistics such as mean, range and standard deviation were used to relate information on morphometric parameters examined during the study. Correlation analyses were executed to measure the magnitude and direction of the association between the variables for each of the two fish species. Linear regression was also performed to assess the models fit. Male and female mean *K* values were subjected to T-test, to note if significant differences occurred between them for each of the fish species. Condition factor for both species were also pooled and significant differences (P=0.05) among them tested while deviations of the sex-ratio from the expected 1:1 were determined using the Chi-square test.

RESULTS

Age Composition and Morphometric Measurements: The sample size, minimum and maximum length and weight of *Oreochromis niloticus* and *Heterotis niloticus* at Ona Lake are presented in Table 1. Apart from *O. niloticus* which had two year classes, three year classes were identified for *H. niloticus*. In *O. niloticus* two distinct year classes (0 and 1) were observed at the study area (Table 1). Fish with age grade 0 dominated the stock as it accounted for 88% of the total. The frequency distribution of length *O. niloticus* and *H. niloticus* for both sexes is shown in Figures 2 and 3. Both sexes were adequately represented in all the size classes except for class 25.0-30.0 where males accounted for 90% of the size category. Also, more male fish were recorded than females, though Chi-square test revealed no significant difference (x^2 0.506, df =1, p=0.776) between the frequencies of male and female in the Lake. Specimens measuring 20.0-25.0cm were the most abundant and constituted 34% of the total catch. Despite, the fact that the mean weight for male and female fish species did not differ significantly (p>0.05) average weight of males were higher than females. For *H. niloticus*, Females represented 53% of the population. Fish in their second growing year made up of 15% while those in their third growing year accounted for only 9%. There was intersexual variation in the total weight of *H. niloticus* though not statistically significant (p>0.05).

Table 1: Total length and weight at age for *O. niloticus* and *H. niloticus* at Ona Lake

				Length (cm)			Weight (g)		
Species	Age	Sex	N	Min-Max (cm)	Mean ± S.D	S.E	Min-Max (g)	Mean ± S.D	S.E
O. niloticus	0	M	42	7.8-21	17.32±4.64	0.72	11.3-160.61	135.45±80.73	12.46
		F	46	7.7-23.6	17.62±4.48	0.66	11-224	136.46±73.57	10.85
	1	M	10	25-27.5	26.54±1.04	0.33	369-418	394.2±18.79	5.94
		F	2	24.9-25.9	25.3±0.57	0.4	368-371	369.5±2.12	1.5
H. niloticus	0	M	40	26.1-43.1	31.72 ± 5.29	0.83	269-740	418.58 ±179.63	28.40
		F	36	26.4-44.2	32.3 ± 5.02	0.84	268-750	443.5 ± 174.3	29.04
	1	M	5	43.4-45.5	44.94±0.93	0.42	745-843	795.4±44.07	19.70
		F	10	40.1-46.0	44.67±1.69	0.53	701-841	802.9±44.4	14.04
	2	M	2	70.0-80.0	75.00 ± 7.07	5.00	3216-4251	3733.5 ±731.86	517.5
		F	7	68.9-81.2	71.99-4.27	1.61	3140-4591	3439.86±515.54	194.86

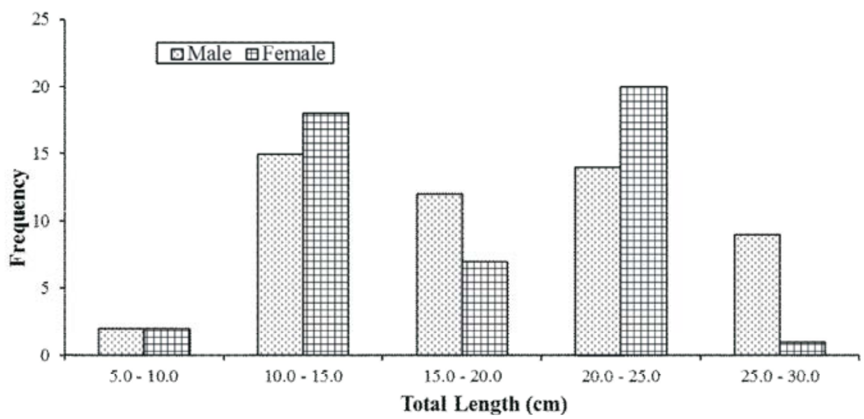

Fig. 1: Frequency distribution of total length of male and female *Oreochromis niloticus* at Ona Lake

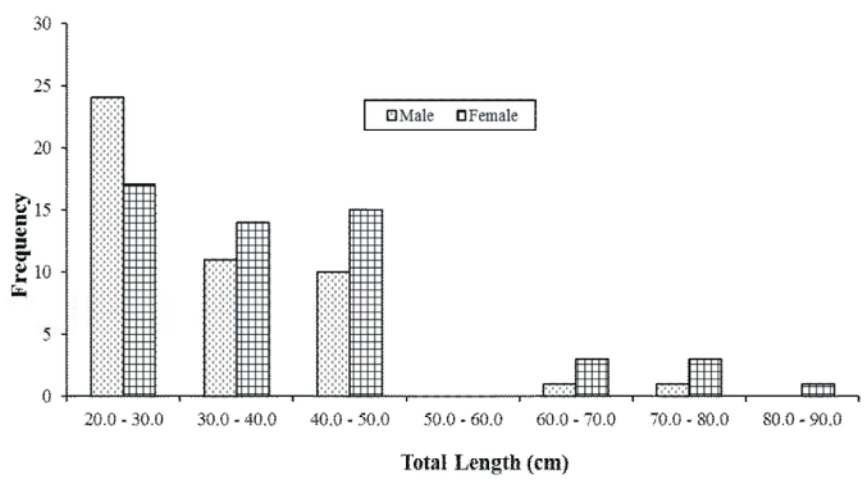

Fig. 2: Frequency distribution of total length of male and female *Heterotis niloticus* at Ona Lake

Fish species in the length group 20.0-30.0 dominated the catch as they contributed 41% to the catch. However, the number of fish caught dropped steadily as length increased. Male specimens dominated the first length group (20.0-30.0) while females were more prominent in the other size classes.

Table 2: Simple Linear Regression

Species	A	b	Equation	R^2
O. niloticus	-1.425	2.183	Log W=-1.425 + 2.183 log L	0.832
H. niloticus	-2.624	2.489	Log W =-2.624 + 2.489 log L	0.909

a and *b*, the parameters of the length-weight relationship; R^2, the coefficient of determination

Table 3: Pearson Correlation Coefficient Matrix for *O. niloticus* at Ona Lake

	Length	Weight	Age
Length	1.00		
	1.00		
Weight	0.91*	1.00	
	0.95*	1.00	
Age	0.56*	0.75*	1.00
	0.91*	0.88*	1.00

Upper Figures: *O. niloticus.* Lower Figures: *H. niloticus** means significant at P<0.05

Table 4: Condition factor of *O. niloticus* and *H. niloticus* at Ona Lake

Species	Age	Min-Max	Mean ± SD	SE
O. niloticus	0	0.19-9.90	$2.585{\pm}1.43^a$	0.153
	1	1.80-2.44	$2.146{\pm}0.19^a$	0.054
H. niloticus	0	0.87-1.55	$1.270{\pm}0.15^b$	0.017
	1	0.84-1.09	$0.894{\pm}0.06^c$	0.015
	2	0.83-0.99	$0.911{\pm}0.05^c$	0.017

Means with the same superscript letters along the column are not statistically different (p>0.05)

Length-Weight Relationship: The relationship between the logarithmic transformation of length and weight of each of the two fish species (Table 2) can be described by the following equations: *Oreochromis niloticus*: Log W=-1.425 + 2.183 log L, R^2 = 0.832; *Heterotis niloticus*: Log W =-2.624 + 2.489 log L, R^2 = 0.909. Results from the regression model indicated that *H. niloticus* had the highest *b* value and also revealed that fit index or modeling efficiency was highest in *H. niloticus*. The results of the correlation matrix for measurements made on *O. niloticus* and *H. niloticus* is presented in Table 3. There were significant (p<0.05) positive relationship between total length-weight, total length-age and weight-age for the two species. Of all the correlated variables across species, correlation coefficient, *r* between length and weight were the highest. This was closely followed by coefficient between weight and age for *O. niloticus*.

Condition Factor (*K*): Table 4 illustrates the variation in condition among the two different species in relation to age. *Oreochromis niloticus* had the highest mean condition factor and ranged between 0.19 and 9.90 while *Heterotis niloticus* had the lowest mean condition factor with a range of 0.83 to 1.55. Mean condition factor of *O. niloticus* at ages 0 and 1 were 2.585±1.43 and 2.146±0.19 respectively. However, there was no significant difference in values of *K* within the two age groups. The present study revealed that *K* value reduced as the fish grew older. Also, there were significant differences (p<0.05) in values of condition factor across both species. Sexually dimorphic character such as condition factor was higher in males than females of *H. niloticus*. The result however showed that there were no significant variations (p>0.05) in *K* values within the two fish species with respect to sex.

DISCUSSION

Age Composition: The two age groups and three age groups observed in *O. niloticus* and *H. niloticus* respectively reflects the impact that fishing has on the two fish species individual growth and consequently on the population age structure, that do not surpass the near two year age for *O. niloticus* and near three year age for the other species. Gómez-Márquez *et al.* [19] identified three year classes of *Oreochromis niloticus* from a tropical shallow lake in Mexico. The three modes observed in this present study for the length frequency distribution (Petersen method) in *O. niloticus* was an indication that three year groups were present at the Lake. However, in view of the fact that there were more than one spawning per year [20], the first two modes can reasonably be concluded to be in their first growing year while the last mode for their second growing year. There was a clear distinction of length-frequency of *H. niloticus* from one age class to the other. This may be attributable to the observation of Idodo-Umeh [13] who noted that reproduction in *H. niloticus* was stimulated by three major changes in the environment namely: increase in photoperiod, beginning of rainy season and lowering of pH. He further opined that the breeding season is between June and September. Since there is only one spawning per year for *H. niloticus* [13]. Results of length frequency distribution (Petersen method) further confirmed the three age groups obtained from scales reading.

Blake and Blake [21] reported that the growth rings in *Labeo senegalensis* were formed as a result of minimum water temperature and for onset of the rains associated with a limited food supply. Garrod [22] showed that in the mouth breeding *Tilapia esculenta* caught in Lake Victoria, the growth rings were formed in the scales as a result of spawning. The same pattern was reported by Alejo *et al.,* [23] for *O. mossambicus,* [24] for *O. niloticus* from Mexico. Frequency of spawning could be influenced by the abundance and seasonal availability of food and by other environmental factors at different localities [20]. Payne and Collinson [25] observed that food availability and spawning, affected the ring formation on *O. niloticus* scales. Garrod [22] also suggested that growth marks on hard structures in tropical fish were results of factors such as reproductive activity, feeding intensity, salinity and water level.

Sex Ratio: In the present study the sex ratio (1:1) for both species indicated that male and females are statistically equal in number. For *O. niloticus,* this was possibly caused by the incidence of fish pairs near to the nest area where females take care of their hatchlings. Fawole and Arawomo [26] reported that for every female there was a male specimen in *Sarotherodon galilaeus*. Babiker and Ibrahim [20] also reported similar result for *O. niloticus*. Similarly, Nilkosky [27] revealed that the sex ratio varies considerably from species to species, but in most of cases it is close to one and may vary from year to year in the same population.

Growth Pattern: The slope of the regression lines of length and weigh t (*b*) showed that the two species were in the light group (*b*< 3) and experienced the same growth pattern as none of the species had isometric or heavy allometric growth pattern. Negative (light) allometric growth was an indication that growth in length increased as weight increases and also the rate of increase in body length was not proportionate to increased body weight [28]. Pervin and Mortuza [29] reported that these values (*b*) usually ranged from 2.5 to 4.0 for many fish species. The value obtained from this study was slightly different from the work of Gómez-Márquez *et al*. [19] who reported that the slope of the regression lines for *Oreochromis niloticus* from a tropical shallow lake in Mexico was 2.469. Of the nine (9) species of fish examined at Ologe Lagoon, Lagos, by Kumolu-Johnson and Ndimele [30], *H. fasciatus* (2.98), *T. zillii* (2.69), *O. niloticus* (2.77), *O. aureus* (2.73), *T. mariae* (2.94), *S. galilaeus* (2.51) and *C. nigrodigitatus* (2.89) showed a negative allometric growth pattern. Many factors such as differences in habitat, fish activities, food habits and seasonal growth rates could contribute to the differences in growth of fish [31]. Other factors such as sex, number of specimens examined, temperature, trophic level and food availability in the community were also important [32]. Mean weight of males were higher than females for *Oreochromis niloticus*. This was attributed to the fact that sexual differences in growth rates became evident after puberty. Mature males were larger than mature females since the latter devote part of their energy to gonadal development while the former devote to somatic development.

Condition Factor: The mean condition value of *O. niloticus* and *H. niloticus* were in agreement with values of most tropical fishes. Whenu and Fagade [6] obtained *K* values of 2.01 for *Brycinus nurse* in Asa reservoir. The *K* values of these fishes at the Lake indicated that they were in a very good condition (*K*>1). Nilkosky [27] reported that the larger the condition factor, the better the condition of the fish. The high values of *K* recorded in this study can be explained by the flexibility in the diet of these species being able to utilize varied diet sources. *K* values of the present study were higher than the range 0.49-1.48 in Andoni River by Nwandiaro and Okorie [33].

The higher mean *K* value observed in the females of *O. niloticus* compared to their male counterparts could be explained by differences in fatness and gonad development of the females. Similar explanations were advanced for higher *K* values in the females of

Sarotherodon melanotheron and *Oreochromis niloticus* by [34]. In contrast, Fagade and Olaniyan [35] reported higher values of condition in males than females of *Ethmalosa fimbriata* in Las Lagoon.

The significant difference observed in *K* value across the two fish species could be attributed to the shape of the fish and fullness of the stomach. Also, the variation in sexual dimorphic character noticed in the present study could be as a result in differences in ontogenetic developmental stages. Gayando and Pauly [36] reported that certain factors such as data pulling, sorting into classes, sex, stages of maturity and state of the stomach often affect the well-being of a fish. The factor of condition factor (*K*) reflects, through its variations, information on the physiological state of the fish in relation to its welfare. From a nutritional point of view, there is the accumulation of fat and gonadal development [37]. Condition factor has also been closely linked with reproductive cycle for fishes in other water bodies [5, 35].

CONCLUSION

Regular folding of scales few minutes after harvest and the characteristic translucent nature in older specimen were major limitations to the use of scales for aging in *H. niloticus*. The present study revealed that each of the two species had different length-weight relationship due to factors such as differences in length and body weight, differences in food availability and other environmental conditions. Studies on the food and feeding habit of these species at the lake should be carried.

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