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Age, growth and fishery biology of cichlid spp. in Abu-Zaabal Lakes, Egypt

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ABSTRACT

The present investigation aimed to study species composition, condition factor, growth and feeding habits of *Orechromis niloticus* (Linnaeus, 1758), *Orechromis aureus* (Steindachner, 1864), *Tilapia zillii* (Gervais, 1848) and *Sarotherdon galilaeus* (Linnaeus, 1758) in Abu- Zaabal Lakes, Egypt. The abundance of different species was seasonally fluctuated. It was found that *O. aureus* is the most common species constituting about 50.0%, followed by *S. galilaeus,* while *O. niloticus* ranked as the 3rd species in the total catch. The highest value of the exponent "b" of length-weight relationship and condition factor "K" was recorded for *T. zillii* and the lowest for *O. aureus*. The valve of (K) was inversely related to the size of *O. aureus* and *O. niloticus*, and tends to be fairly constant in *T. zillii* and *S. galilaeus*. All cichlid species attained their highest growth rates in length during the first year of life, after which a gradual decline was noticed with further increase in age. *O. niloticus* had the highest growth rate than the other three species. The parameters of Von Bertalanffy growth model were estimated as $L_{\infty} =$ 34.59, 45.23, 39.88 and 30.65 cm while, k = 0.1336, 0.074, 0.0873 and 0.1692 y^{-1} and t_o = - 2.09; - 2.49; - 2.01 and - 0.75 year for *O. niloticus*, *O. aureus*, *T. zillii* and *S. galilaeus*, respectively. Gut analysis of *O. aureus, T. zillii and S. galilaeus* revealed that the major food items were detritus, diatoms, green algae, animal derivatives, sand particles and rotifers.

Key words: Abu- Zaabal Lakes, *O. niloticus, O. aureus, T. zillii, S. galilaeus,* age, growth, feeding habits.

INTRODUCTION

Abu – Zaabal lakes consist of three man-made ponds (A, B and C), inland closed basins, formed by the fracture and extract the Basalt rocks. The depths are ranged between 6 – 25m, 1 – 7 m and 1 – 5 m for the ponds A, B and C, respectively. The ponds receive their water from the ground and seepage water. They lie at 35 Km northeast of Cairo (Fig.1). They cover an area of 608.050×10^3 m^2, and occupy the area between Latitudes 30° 16.62̀ and 30° 17.58̀ N & Longitudes 31° 20.90̀ and 31° 21.69̀ E (Abd – Ellah, 2003; Abdo, 2005).

The natural fishery resources in Egypt are declining, so there is a need to considerably increase seafood production through safe and high-quality fishery products to bridge the widening gap between demand and supply (EL-Gawady, 2002).Thus, much attention must be given to develop the fishery of Abu-Zaabal Lakes. Several studies have been carried out on these lakes and lights were thrown on morphometry and bathymetry (Abd-Ellah, 2003), physico-chemical characteristics (Abdo, 2005), pathological conditions of *Tilapia zillii* (El-Mansy, 2005), phytoplankton composition (Mohamed, 2005), metals accumulation in fish organs (Mohamed and Gad, 2005), microbiological status (Rabeh and Azab, 2006), zooplankton community (El-Basset and Taylor, 2007),biological, histological and quality aspects of fish (Ibrahim *et al.* 2008), reproductive biology of *O.niloticus*, (Shalloof and Salama, 2008) and feeding habits of *O.niloticus* (Shalloof and Khalifa, 2009).

Fig. (1). Map of northern Egypt showing the location of Abu – Zaabal lakes area (arrow).

The objective of study was to provide and update information on the growth and feeding habits needed by cichlid species to flourish in these newly formed mining lakes.

MATERIALS AND METHODS

Because the commercial fishing in Abu-Zaabal Lakes was sharply declined, experimental fishing gears with the same feature of that of commercial ones were used for sampling, Fish samples were seasonally collected from the three Abu-Zaabal lakes during the period from March 2008 to February 2009. The total length and total weight of the collected fish were measured to the nearest cm and g, respectively. Data about gutted weight, gonad weight and liver weight; sex and stage of maturity were also obtained.

For age determination, the scales were examined using a measuring scale projector "LEITZ T. p. 300" connected to digital micrometer spindle. Growth rate was computed by the method of Lee (1920).

Length-weight relationship was calculated by the following equation: $W = a L^{b}$, where W is the total weight in g, L, is the total length in cm, a & b are constants.

Condition factor (K) was estimated as: $K = 100\times W / L^3$, where W is the total weight in g and L is the total length in cm.

The Von Bertalanffy growth parameters, L_{∞}, k and t_o were estimated. The asymptotic length (L_∞) and the growth rate (k) were calculated using Walford (1946) method. The time at which the growth's theoretically nil (t_o) was calculated by plotting L_t against L_{t+1}.

The fish stomach contents were analyzed, and the seasonal data were grouped. Analysis was done using frequency of occurrence method as described by Hyslop (1980). In above method, the occurrence of food items was expressed as percentage of the total number of stomach containing food.

RESULTS

1- Catch per unit effort: collected samples showed a sharp decrease of catch per unit effort during summer (about 5.5 Kg per boat per day) comparable to spring season (about 35Kg per boat per day). Sharp decreases then occur during autumn and rise again during winter season.

2- Species composition: The fish catch from Abu – Zaabal lakes was represented by four tilapia species namely; *Oreochromis niloticus, Oreochromis aureus, Tilapia zillii* and *Sarotheredon galilaeus.* In addition the catch included specimens of *Clarias gariepinus*. The pooled data (by number) revealed that *O. aureus* was the most common species constituting about 50.0%, followed by *S. galilaeus* (22.0%) , whereas *O. niloticus* representeds about (15.3%) and *T. zillii* represented 9.0% of the total catch. The least frequent species was *C. gariepinus* (5.3 %). Species composition according to weight also ranked *O. aureus* as the 1st species (about 38.4% of the total catch), whereas *C. gariepinus* is the 2nd species, while *T. zillii* was the lowerst one (Fig. 2).

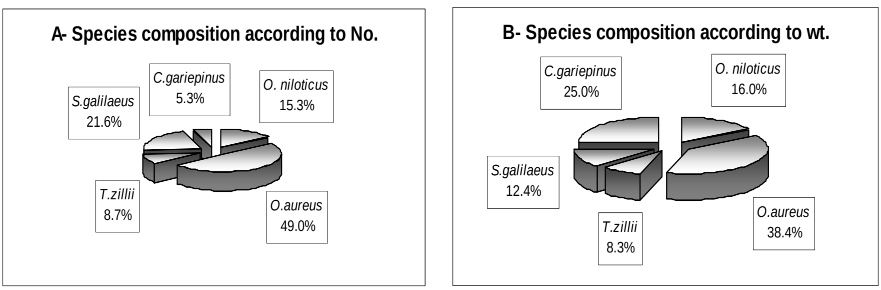
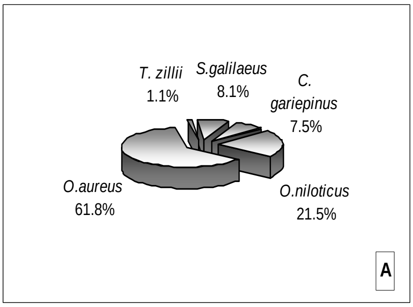
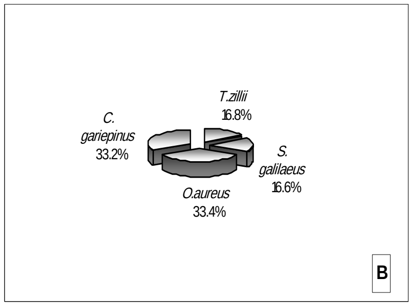
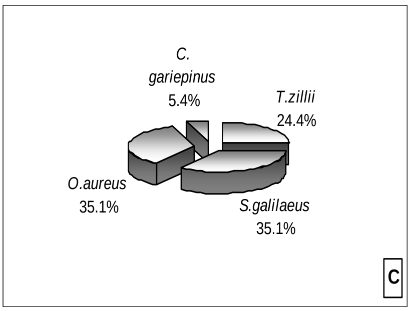


Fig. (2): Species composition of different species (pooled data) in Abu-Zaabal Lakes; A, according to number and B, according to weight during March 2008- February 2009.

Regarding to the seasonal fluctuation in species distribution, the frequency of different species varied from season to another. *O. niloticus* constituted 21.5 and 12.62% of the total catch during spring and winter, respectively, while it was not represented completely in the catch during summer and autumn seasons. *O. aureus* was nearly the most frequent species during the four seasons. *S. galilaeus* was more represented during autumn and winter (36.0 and 29.44% respectively). *T. zillii* was highly represented during autumn and summer seasons, constituting about 24.4 and 16.8%, respectively (Fig. 3).







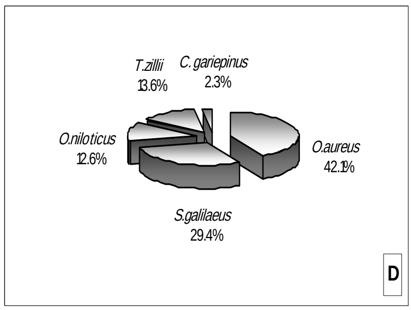


Fig. (3): Species composition of different species in Abu-Zaabal Lakes during spring (A), summer (B), autumn (C) and winter (D) season.

3- Length-weight relationship and condition factor: The total length of the fish sample in this investigation ranged from 12.0-22.0; 11.0- 19.0; 12.0-18.0; 9.0-17.0 and 26.0- 46.0cm for *O. niloticus, O. aureus, T. zillii, S.galilaeus* and *C.gariepinus*, respectively .Table 1 and Figure 4 show the equation parameters of length – weight relationship. The highest value of "b" was recorded for *T. zillii* (b= 3.1474) and the lowest one was recorded for *O.aureus* and *C.gariepinus* (b=2.1084 and 2.3734, respectively).

Table (1): The values of the constants (a and b) of length-weight relationship and the relative condition factors (K± SD) of different species in Abu-Zaabal lakes.

Species	a	b	r	K ± SD
O. niloticus	0.0894	2.4034	0.9790	1.7056 ± 0.2983
O. aureus	0.1791	2.1084	0.9833	1.6610 ± 0.2743
T. zillii	0.0193	3.1474	0.9856	2.2966 ± 0.2266
S. galilaeus	0.0337	2.7588	0.9781	1.8394 ± 0.1838
C. gariepinus	0.0785	2.3734	0.9740	1.1380 ± 0.1267

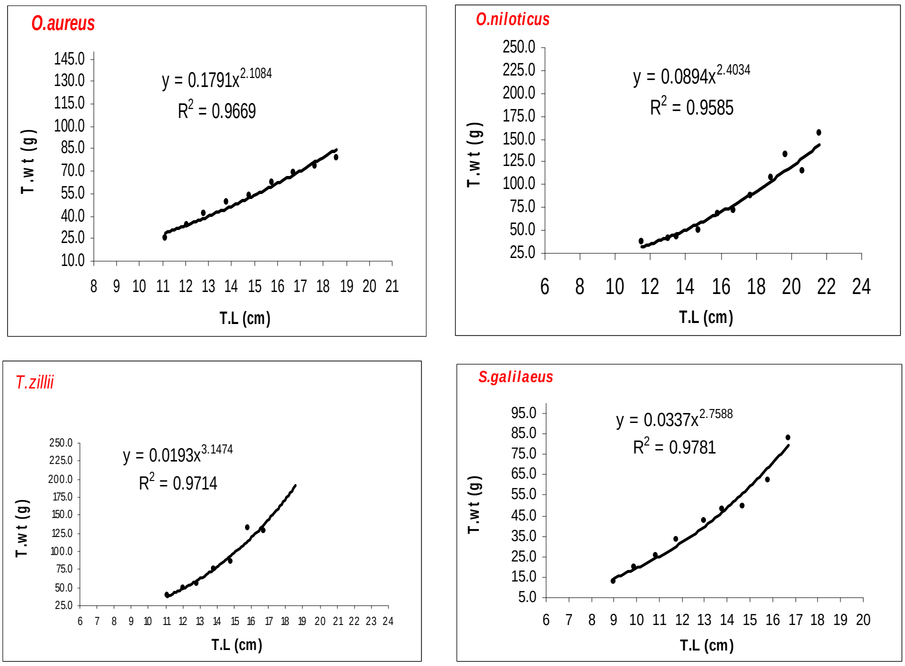


Fig. (4): Length-weight relationship of different cichlid species at Abu-Zaabal Lake during the period of investigation.

Also, the highest condition factor (K) was recorded for *T. zillii* (K = 2.2966), whereas the lowest one was recorded for *C. gariepinus* and *O. aureus* (K= 1.1380and 1.6610 respectively).The values of condition factor of *O. aureus*, *O. niloticus* and *C. gariepinus* were inversely related to the size of fish and tend to be fairly constant in small fish of *T. zillii* and *S. galilaeus* (Fig. 5) .The largest fish, *C. gariepinus* (26- 46 cm) recorded the lowest mean value of condition factor (1.1380).

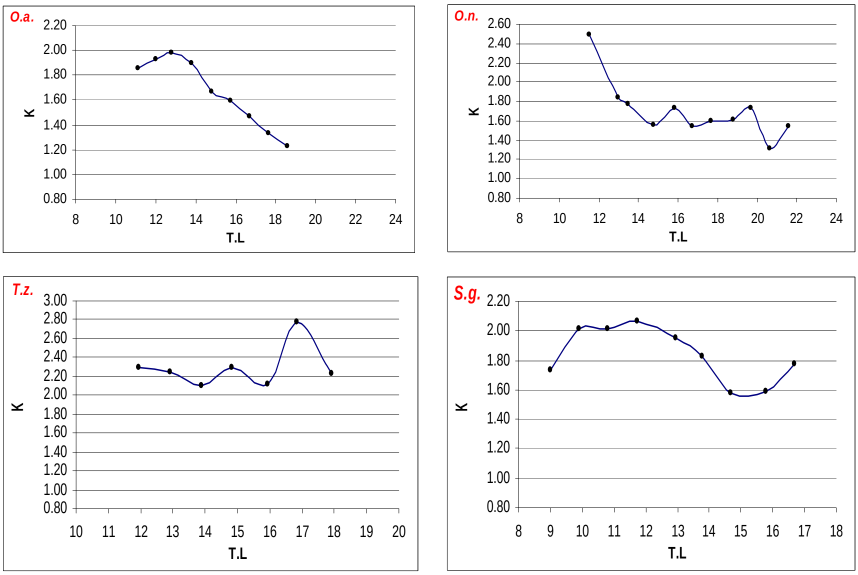


Fig. (5): Mean condition factor-mean total length relation of. *O.aureus* (*O. a*), *O. niloticus* (*O. n.*), *T. zillii* (*T. z.*) and *S. galileus* (*S. g.*) at Abu- Zaabal Lakes during the period of study

4- Age determination: In the present study, scales were used for age determination for cichlid species. The total body length (T.L.)-scale radius (Sr) of the four studied cichlids were found to be linear and could be represented by the equations in Figure 6.The recorded ages in the present study ranged from 1-4 years for *O.niloticus*,1- 3 years for *O. aureus* and *T. zillii* and O- 3 years for *S. galilaeus*.

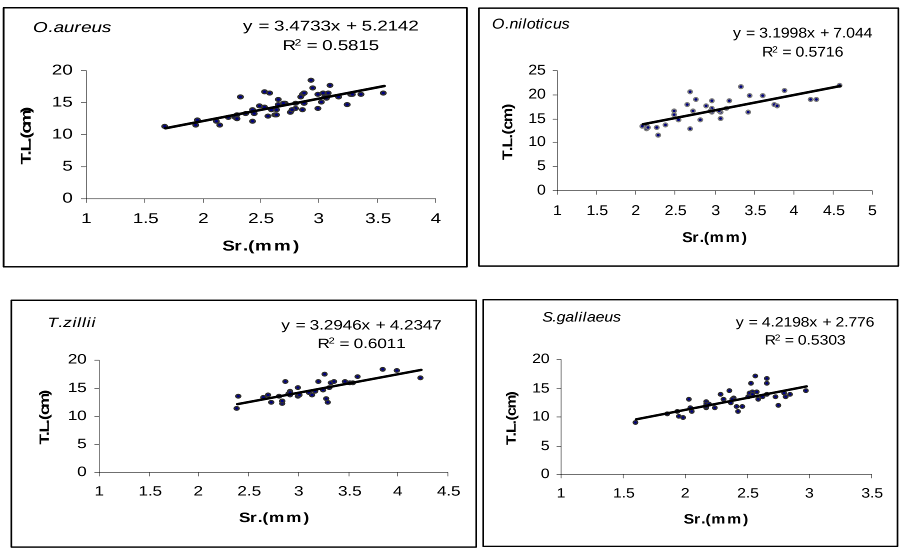


Fig. (6): Total length (T.L) - Scale radius (Sr) relationships of four cichlid species in Abu-Zaabal Lakes.

Back- calculation and growth in length: Tables (2–5) showed the back-calculation of lengths at the end of each year of life for the four studied species. It was noticed that, each of them attained its highest growth rates in length during the first year of life, after which a gradual decrease was noticed with further increase in age. It is clear that *O. niloticus* has the highest growth than the other three species. The parameters of Von Bertalanffy growth parameters were estimated as L_{∞} = 34.59; 45.23; 39.88 and 30.65 cm & k= 0.1336; 0.074; 0.0873 and 0.1692 y^{-1} & t_o= - 2.09; - 2.49; - 2.01 and - 0.75 year for *O. niloticus*, *O. aureus*, *T. zillii* and *S. galilaeus*, respectively.

Table (2): Back- calculated lengths at the end of each year of life of *O.niloticus* at Abu-Zaabal Lakes during the period of investigation.

Age	Length at capture	Back- calculated lengths at the end of each year of life			
		L_1	L_2	L_3	L_4
I	12.84	10.79	--	--	--
II	16.43	11.83	14.74	--	--
III	18.10	11.67	14.31	16.56	--
IV	20.65	12.31	14.78	17.50	19.25
	Mean	11.65	14.61	17.03	19.25
	Increment	11.65	2.96	2.42	2.22
	% increment	60.52	15.38	12.57	11.53

Table (3): Back- calculated lengths at the end of each year of life of *O.aureus* at Abu-Zaabal Lakes during the period of investigation.

Age	Length at capture	Back- calculated lengths at the end of each year of life		
		L_1	L_2	L_3
I	12.60	11.20	--	--
II	14.09	9.84	12.27	--
III	15.69	9.82	13.41	15.09
Mean		10.29	12.84	15.09
Increment		10.29	2.55	2.27
% increment		68.19	16.90	14.91

Table (4): Back- calculated lengths at the end of each year of life of *T.zillii* at Abu-Zaabal Lakes during the period of investigation.

Age	Length at capture	Back- calculated lengths at the end of each year of life		
		L_1	L_2	L_3
I	11.95	9.51	--	--
II	14.04	9.04	11.57	--
III	16.21	9.07	12.07	14.12
Mean		9.21	11.80	14.12
Increment		9.21	2.59	2.32
% increment		65.23	18.34	16.43

Table (5): Back- calculated lengths at the end of each year of life of *S.galilaeus* at Abu-Zaabal Lakes during the period of investigation.

Age	Length at capture	Back- calculated lengths at the end of each year of life		
		L_1	L_2	L_3
I	11.95	9.51	--	--
II	14.04	9.04	11.57	--
III	16.21	9.07	12.07	14.12
Mean		9.21	11.80	14.12
Increment		9.21	2.59	2.32
% increment		65.23	18.34	16.43

5- Gut analysis: Gut analysis of *O. aureus, T.zillii and S.galilaeus* in Abu-Zaabal Lakes revealed that, the major food items were detritus, diatoms, green algae, animal derivatives, sand particles and rotifers. The ability to exploit different varieties of food makes *O. aureus, T. zillii and S. galilaeus* to be omnivorous. Diatoms were represented mainly by *Navicula* spp., *Cyclotella* spp., *Achnanthes* spp. and *cocconies* spp. Green algae were represented in fish stomachs mostly by *Scenedesmus* spp., *Ankistrodesmus* spp., *Coelastrum* spp., and *Cosmarium* spp., while blue green algae were represented by *Merismopedia* spp, *Oscillatoria* spp., *Anabaena* spp., *Microcystis* spp. and *Coelospharium* spp. whereas rotifers, molluscans (bivalves), cladocerans, ostracods, copepods and animal derivatives constitute the food of animal origin. It was noticed that, phytoplankton was the most common food items (Fig. 7).

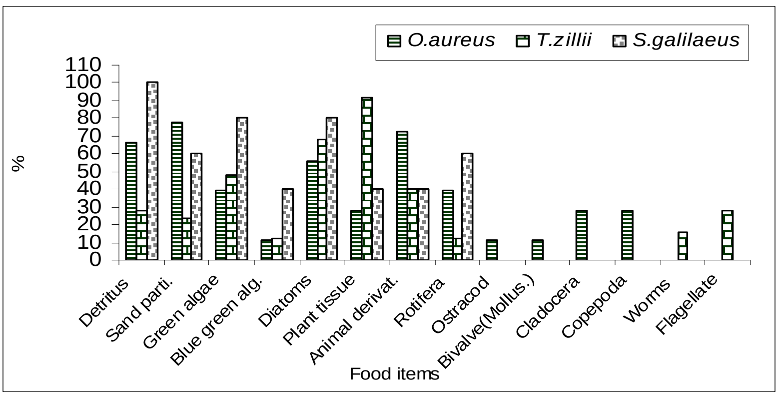


Fig. (7): Percentage of occurrence of different food items of different cichlid species in Abu-Zaabal Lakes.

Remains of higher plant hydrophytes were comparatively greater in *T. zillii* than *O. aureus* and *S. galilaeus* guts, since they occurred in 92.0% of the examined guts of *T. zillii*. In contrast, the organic detritus decreased considerably in *T. zillii* than in guts of the other two species. The food of animal origin was much frequent in stomachs of *O. aureus* than in both *T. zillii* and *S. galilaeus*. Among zooplankton, rotifers occurred in higher number of *O. aureus* and *S. galilaeus* guts (i.e. 40.0 and 60.0% respectively). Examination of the diet of these species showed that, there was high percentage of sand particles in there stomachs comprising about 77.8, 60.0 and 24.0% in the guts of *O. aureus, S. galilaeus* and *T. zillii*, respectively.

DISCUSSION

Since there is a growing consensus that tilapia can become the world' s most important warm water cultured fishes (FAO, 1980), the present study reports on some fisheries biology as growth and abundance of natural diets needed by different cichlid species in these newly formed mining lakes to show the possibility of their usage as a big fish farm.

In the present study, *O. aureus* was the most common species, constituting about 50.0%, followed by *S. galilaeus,* whereas *O. niloticus* ranked as the 3rd species of the total catch. The least frequent species was *C. gariepinus*. Ibrahim *et al*. (2008) pointed out that *O. niloticus* was the most frequent species in Abu-Zaabal Lakes during 2005-2006. These differences in species composition during 2008- 2009 may be due to the change in salinity and water level of the lakes. El-Mansy (internal report, 2009) reported that, *O. aureus* is the least affected cichlid species by parasites in Abu-Zaabal lakes at the same time of the present study. Oviatt and Nixon (1973) found that, depth, sediment, temperature and wind speed were significant in explaining distribution of fish. Hoff and Ibra (1977) regarded temperature and salinity to be the most important factors affecting the fish fauna diversity. Amarasinghe and Samarakoon (1988) reported that, the differences in the catches of *Etroplus suratensis* and *Tilapia rendalli* were due to their restricted movements, associated with reproductive behavior. Weng (1988) found that seasonal occurrence and habitat preference of most species contribute notably to the varied catches of fish fauna. Regarding to the seasonal difference in species distribution, the frequency of different species was fluctuated from season to another. This may be correlated with variation in salinity, temperature and availability of food.

The length- weight relationship is very important for proper exploitation and management of the population of fish species (Pervin and Mortuza, 2008), and allows prediction of weight from length in yield assessment (Pauly, 1993).In fish, the weight is considered to be a function of length (Weatherley and Gill, 1987). The highest value of "b" was recorded for *T. zillii* (b= 3.1474) and the lowest was recorded for *O. aureus* and *C. gariepinus*(b= 2.1084 and 2.3734, respectively).Hile(1936) and Martin(1949) observed that the value of the regression coefficient "b" usually lies between 2.5 and 4.0 and for ideal fish b= 3. If the fish retains the same shape ,it grows isometrically and length exponent "b" has the value " 3 ",and if a value is significally larger or smaller than " 3", it shows allometric growth (Bagenal and Tesch, 1987). A value less than "3 "shows that fish becomes heavier for its length as it grows (Zafar *et al*., 2003).The highest values of "b" revealed that the length-weight relationships of this species followed the cube law and might be affected by the general condition of appetite and gonadal contents of fish (Pervin and Mortuza, 2008).

Condition factor helps to assess the experimental improvements in an environment for an existing fish and for purpose of new stocking (Zafar *et al*., 2003).It is also a useful index for monitoring of feeding intensity, age, and growth rates in fish (Oni *et al*., 1983). It is strongly influenced by both biotic and abiotic environmental conditions and can be used as an index to asses the status of the aquatic ecosystem in which fish live (Anene, 2005).In the present study, the condition factor of *O. niloticus, O. aureus* and *C. gariepinus* was inversely related to the size of fish and tends to be fairly constant in small fish of *T. zillii* and *S.galilaeus*. The largest fish, *C. gariepinus* recorded the lowest mean condition factor (1.1380 ± 0.1267).Saliu *et al*. (2007) recorded that, the condition factor was inversely related to the fat and protein content and *C.gariepinus* had the highest mean fat and protein than *Sarotherodon melanotheron, Melapterurus electricus, Synodontis clarias* and *Chrysichthys nigrodigitatus.* No evidence that the largest *Salmo salar* had the highest condition factor (Johanson and Jobling, 1989).The fluctuations in relative condition factor may be due to feeding intensity, gravid condition of female or other factor (Shafi and Quddus, 1974).Condition factor of *Catla catla* appears to remain constant with increasing length or weight (Zafar *et al*., 2003). The highest condition in the present study was recorded for *T.zillii* and *S.galilaeus* (2.2966 and 1.8394, respectively). Ibrahim *et al*. (2008) recorded that, the best condition factor (K) was recorded for *T. zillii* (1.94), while the lowest was for *S. galilaeus* (1.74) in Abu Zaabal Lakes during 2005-2006. The condition factor may vary when average weight of the fish is not increasing in direct proportion to the cube of its length (Wooten, 1990).Therefore, when b = 3, K would remain constant .If however, the weight increases more rapidly than the cube of length, K would increase with the increase in length. When the weight increases less than the cube of length, K would tend to decrease with the growth of fish (Javaid and Akram, 1972).

In the present study, all the studied cichlid species attained their highest growth rates in length during the first year of life, after which a gradual decrease was noticed with further increasing in age and *O.niloticus* has the highest growth than the other three species. These results are in accordance with these of Ibrahim *et al*. (2008) and Mahmoud and Mazrouh (2008).

The parameters of Von Bertalanffy growth model were estimated as $L_{\infty =}$ 34.59; 45.23; 39.88 and 30.65 cm & K= 0.1336; 0.074; 0.0873 and 0.1692 y^{-1} & t_o= - 2.09; - 2.49; - 2.01 and - 0.75 year for *O. niloticus*, *O. aureus*, *T. zillii* and *S. galilaeus*, respectively. Mahmoud and Mazrouh (2008), pointed out that L_∞ of the previous studied cichlids in Rosetta branch of the Nile River were 28.5, 26.4; 16.5 and 20.3cm, respectively. This means that the value L_∞ of the studied cichlids in the present study was greater than that recorded in the River Nile. This may be attributed to the difference in size of collected sample and the difference in ecological environment of both habitats.

The study of the food and feeding habits of freshwater fish species is a subject of continuous research because it constitutes the basis for the development of a successful fisheries management programme on fish capture and culture (Oronsaye & Nakpodia, 2005 and Oso *et al.*, 2006).

Analysis of guts of *O. aureus, T. zillii* and *S. galilaeus*(since gut content of *O. niloticus* in Abu-Zaabal Lake was previously studied by Shalloof and Khalifa (2009) revealed that, the major food items were detritus, diatoms, green algae, animal derivatives, sand particles and rotifers . A kind of competition may be occurring between cichlids in this ecosystem. *O.aureus* populations compete with *S.galilaeus* and the competition for food sources between these two cichlid species was demonstrated by Drenner *et al.* (1982) and Vinyard *et al.* (1987). Tissues of higher plant hydrophytes were comparatively greater in *T. zillii* than *O. aureus* and *S. galilaeus* guts, since they occurred in 92.0% of the examined guts of *T. zillii*. According to Fryer and Iles (1972), *T. zillii* has the ability to utilize higher plants as a source of food. This meets the cutting edge of its teeth adapted for such feeding habits. Shalloof and Khalifa (2009) emphasized the importance of plant as a major food resource in the stomach of *O.niloticus.*

Among the zooplankton, rotifers occurred in higher number of *O.aureus* and *S.galilaeus* guts (i.e. 40.0 and 60.0%, respectively). El-Shabrawy *et al.* (2007) mentioned that, rotifers dominated the zooplankton groups forming about 87% of total zooplankton in Abu-Zaabal Lakes, and *Brachionus plicatlis* proved to be the most dominant species.

Examination of the diet of these species showed that, there was high percentage of sand particles in their stomachs comprising about 77.8, 60.0 and 24.0% in *O.aureus, S.galilaeus* and *T.zillii* respectively. Abdo, (2005) pointed out that, the increase in silicate concentration may be related to the nature and chemical composition of the basalt rocks in Abu-Zaabal Lakes. The ability to exploit different varieties of food makes *O. aureus, T.zillii and S.galilaeus* to be omnivorous, and so can be used for culture and rearing in this lake.

In conclusion, results of the present study show that:

1- It can be obtained marketable size of cichlid from Abu- Zaabal Lakes can be used as a big fish farm, for cichlid fish since maximum asymptotic lengths (L_∞) = 34.59; 45.23; 39.88 and 30.65 cm for *O. niloticus ,O. aureus, T. zillii* and *S. galilaeus*, respectively.

2- Sharp decrease in catch per unit effort(Kg /boat), and change in species composition from 2005 to 2009 indicate successive changes in the ecology of the lakes, so studies must be carried out continually to investigate such ecological alternations.

3- Gut analysis of *O. aureus, T. zillii and S. galilaeus* in Abu-Zaabal Lakes revealed that, the major food items were detritus, diatoms, green algae, animal derivatives, sand particles and rotifers. This ability to exploit different varieties of food makes these species omnivorous and so can be used for culture and rearing in this lake.

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