Age, growth and mortality of the cichlid fish *Oreochromis niloticus* (L.) from the River Nile at Beni Suef Governorate, Egypt.

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ABSTRACT

Monthly samples of *Oreochromis niloticus* from the River Nile at Beni Suef were collected during the period from January 2009 to December 2010. The Von Bertalanffy growth function parameters were: L_∞ = 48.14 cm, K = 0.147 $\mathbf{yr^{-1}}$, and $\mathbf{t_0}$ = 0.2237 year. The total mortality coefficient (Z) was calculated as 0.9654 $\mathbf{yr^{-1}}$, the natural computed mortality coefficient (M) was 0.4010 yr^{-1} with fishing mortality (F) estimated as 0.5643 $\mathbf{yr^{-1}}$ and exploitation ratio (E) calculated as 0.5819. This high exploitation ratio shows that the stock of *Oreochromis niloticus* from the River Nile at Beni Suef is overexploited.

Keywords: Cichlid, *Oreochromis niloticus,* Egypt, fisheries, mortality.

INTRODUCTION

The cichlid fishes are the most common and economically important components of the tropical fresh and brackish waters. The studied species, *Oreochromis niloticus,* which is abundantin in all Egyptian inland waters is tasty and inexpensive. It constitutes most of the commercial catch from the River Nile at Beni Suef Governorate.

Many authors paid their attention for the biological and fishery studies of tilapia species from different water bodies all over the world especially in Egypt. From these studies are those of Moreau *et al*. (1986); Bayoumi and Khalil (1988); Abdel-Aziz *et al*. (1990); Yamaguchi *et al*. (1990); El-Haweet (1991); Getabu (1992); El-Shazly (1993); Abd-Alla (1995); Shenouda *et al*. (1995); Gomez-Marquez (1998); Abd-Alla and Talaat (2000); Khalifa *et al*. (2000); Akel (2005); Akel and Moharram (2007); and El-Ganainy and Hassan (2008). The present study is the first trial to have a complete biological study on this important tilapia species from the main River Nile at Beni Suef Governorate.

MATERIALS AND METHODS

A sum of 1405 specimens of *Oreochromis niloticus* were collected in a random way from the commercial catches of the main landing site on the River Nile at Beni Suef during the period from January 2009 to December 2010. After recording the date of capture, the following measurements were taken for each fresh specimen: total length; total weight; and sex. Some scales were collected from underneath the right pectoral fin of each specimen and kept in special envelops for further investigation. The scales were then dipped in 5% neutral Formalin solution, washed in distilled water and pressed in between two glass slides. The scales were then examined under a compound Nikon light microscope with an eye piece micrometer. The total scale radius "R" and the radius of each annulus "r" were measured to the nearest 0.01 micrometer divisions (m.d.).

The water temperature was measured from four different localities on the River Nile at Beni Suef in all months of the years 2009 and 2010 using a mercuric thermometer.

The length-weight relationship for both sexes combined of *Oreochromis niloticus* were computed by the least squares and the geometric regression methods using the Microsoft Office Excell 2007 program. This program also calculates the composite "K" and relative "$\mathbf{K_n}$" coefficients of condition.

For the back calculation of body length at the end of each year of life, the equation of Lee (1920) was used. These results should be incorporated in the Von Bertalanffy (1938) mathematical model of growth. The constants of the Von Bertalanffy equation (the asymptotic length "$\mathbf{L}_\infty$" and the growth coefficient "K") were calculated by using three different fitting methods (Ford,1933-Walford,1946; Gulland and Holt, 1959; and Chapman, 1960). The empirical equation of Pauly (1979) was used to estimate the hypothetical age ($\mathbf{t_0}$) of the fish, which is the age at zero length. The reliability of these growth parameters was tested using the Munro's phi prime index ($\emptyset$) computed from the equation derived by Pauly and Munro (1984):

$$\emptyset = \mathbf{log_{10}} K + 2\, \mathbf{log_{10}}\, \mathbf{L}_\infty$$

The survival rate "S", the instantaneous total mortality coefficient "Z" and the annual mortality coefficient "A" of *Oreochromis niloticus* were estimated using four different methods (Heinke,1913; Jackson,1939; Chapman and Robson,1960; and coded mean age). The instantaneous rate of natural mortality coefficient "M" was estimated from the empirical equation of Pauly (1980) using the mean annual water temperature of the River Nile at Beni Suef as measured in the present study (Table 1) being 21.5 ℃ . The instantaneous rate of fishing mortality "F" was calculated as F = Z-M. The exploitation ratio "E" was calculated as the fraction of death caused by fishing E= F/Z.

Table 1: Mean Monthly and annual water temperature in (℃) recorded from four different localities on the River Nile at Beni Suef .

Month	**Year 2009**				**Year 2010**			
	Loc.1	**Loc.2**	**Loc.3**	**Loc.4**	**Loc.1**	**Loc.2**	**Loc.3**	**Loc.4**
January	14.9	15.4	15.1	15.4	15.6	15.5	15.8	15.5
February	14.8	14.5	14.0	13.8	17.3	16.8	16.9	17.0
March	16.7	16.7	16.8	16.3	19.4	19.6	19.5	19.5
April	19.4	19.6	19.7	20.7	21.1	20.9	20.8	21.0
May	22.3	21.6	21.9	21.8	22.2	21.8	22.4	22.2
June	22.6	21.9	22.7	22.5	24.5	24.8	24.7	24.6
July	26.8	26.2	26.7	26.5	29.5	30.2	31.3	29.8
August	27.4	27.5	27.2	27.7	27.6	28.0	27.8	27.5
September	25.8	25.5	25.6	25.6	25.8	26.0	25.7	25.8
October	24.8	25.1	25.0	24.7	24.6	24.5	24.7	24.6
November	21.3	21.1	20.9	21.0	20.3	19.7	19.7	19.9
December	17.1	17.5	17.6	17.2	15.4	15.3	14.9	15.1
Mean annual temp	21.1℃				21.9 ℃			
Mean total annual temp	21.5 ℃							

RESULTS AND DISCUSSION

A) Time of annulus formation:

The time of the annulus formation of *Oreochromis niloticus* was estimated as the time of the least distance from the last annulus to the scale margin for a certain age group. Table (2) shows the mean distance from the last annulus to the scale margin at different months for age group (I) of *Oreochromis niloticus.* From this table it is expected that the least increment occurred during February (0.429 m.d.). However, this result did not reflect the actual time of annulus formation. It is well known that *Oreochromis niloticus* in the River Nile has two main spawning periods, the first being in April and the second being in September. As it is clear from Table (2), the differences between the results obtained for all months were not clearly significant, except in June, which may reflect more than two spawning periods. So, it is expected that the water temperature is the only factor affecting the annulus formation.

Table 2: Mean distance from the last annulus to the scale margin at different months for age group (I) of *Oreochromis niloticus.*

Month of capture	Number of ishes	Mean distance from the last annulus to scale margin in (m.d.) for age group (III)
January	22	0.586
February	37	0.429
March	35	0.483
April	31	0.590
May	46	0.490
June	41	1.035
July	79	0.518
August	46	0.548
September	48	0.563
October	35	0.601
November	44	0.431
December	35	0.503

B) Growth in length:

Body length- scale radius relationship:

The total body length and scale radius relationship of *Oreochromis niloticus* is graphically represented by the scattered diagram in Fig. (1). It is represented by a straight line not passing through the origin. Thus the constants "a" and "b" of the straight line were calculated using the least squares method. This relationship is expressed by the following equation:

$$L = -0.6772 + 0.2351\ R$$

With a high correlation coefficient of 0.961.

Back calculation of body length at the end of each year of life:

As the body length-scale radius relationship of *Oreochromis niloticus* was found to be linear and does not pass through the origin, therefore the following equation was adopted in back-calculation:

$$\mathbf{L_n = \frac{(L-a)\,r_n}{R} + a} \qquad \text{Lee (1920)}$$

where ($\mathbf{L_n}$) is the fish length at the time of formation of the $n^{\underline{th}}$ annulus, (L) is the fish length at capture , ($\mathbf{r_n}$) is the radius 0f the $n^{\underline{th}}$ annulus, (R) is the total scale radius and (a) is the intercept of the regression line with the Y axis in the body length-scale radius relationship.

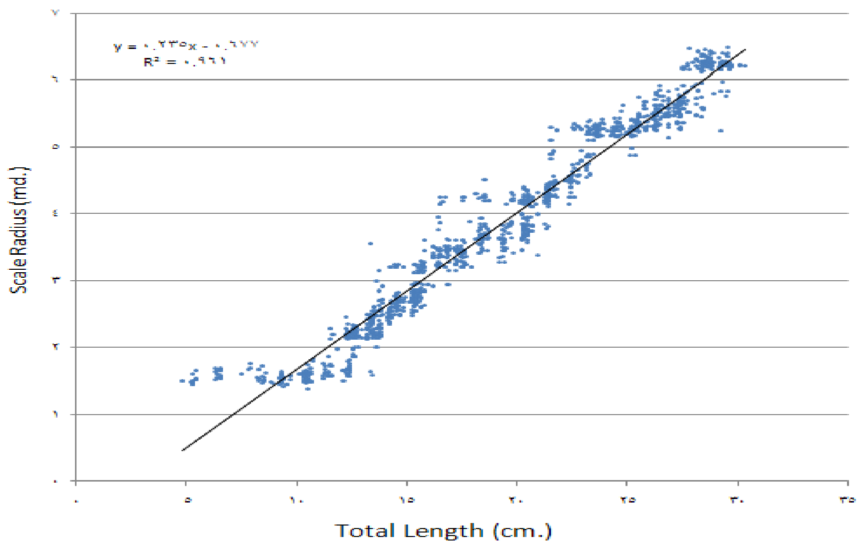

Fig. 1: Total length – scale radius relationship of *Oreochromis niloticus* on normal coordinates (the straight line represents the calculated values and the dots represent the observed ones).

Table (3) shows the mean back-calculated lengths at the end of the different years of life, while Table (4) shows the length increments. From Table (3) it is obvious that the growth in length is more rapid in earlier age groups. The highest estimated length increment was attained at the first year of life (16.13 cm.), which differs from that obtained by El-Ganainy and Hassan (2008) which was (11.07 cm).

Table 3: Mean back calculated total lengths in (cm.) at the end of different years of life of *Oreochromis niloticus.*

Age group in years	Frequency	Mean calculated total lengths (cm.) at the end of each year of life			
		1	2	3	4
I	499	16.13			
II	237	16.27	21.32		
III	109	15.88	21.13	25.01	
IV	2	17.80	23.84	25.64	28.50

Table 4: Calculated lengths (cm.) and length increments of *Oreochromis niloticus* at the end of different years of life.

Years of life	Frequency	Calculated length (cm.)	Length increment (cm.)
I	499	16.13	2.67
II	237	21.32	5.19
III	109	25.01	3.69
IV	2	28.50	3.43

In the present study, scales show that there are four age groups for *Oreochromis niloticus*, which differs from that of El-Ganainy and Hassan (2008), in this study of length frequency distribution, there are five age groups. These differences are expected as the water condition in Beni Suef seems to be more suitable for cichlids than the water in Timsah Lake.

Length-weight relationship:

The total length (cm.) and the total weight (gm.) relationship of *Oreochromis niloticus* can be expressed by the power equation: W = a $\mathbf{L^n}$ (Ricker,1975), where (a and n) are constants computed by the least squares and the geometric regression methods (Table 5). The equations representing this relationship by the two fitting methods are:

$$W = 1.3771 \text{ X } \mathbf{L}^{2.7555} \quad \text{(Least squares method)}$$
$$\text{and } W = 0.0377 \text{ X } \mathbf{L}^{2.7924} \quad \text{(Geometric regression method)}$$

Table 5: The constants of the length-weight relationship of *Oreochromis niloticus* for both sexes combined.

	Least squares method	**Geometric regression method**
a	1.3771	0.0377
n	2.7555	2.7924
	0.9471	0.9516
Average weight in gm. Average length in cm. N	137.80 16.93 1405	

"a and n" : the constants for the length – weight equation.
$W = aL^n$ gm,/cm. ;
R^2 correlation coefficient.
N : Number of fish.

There is a close agreement between the observed and the calculated weights for both sexes combined which is clear in Table (6) and graphically represented in Figs. (2 & 3).

Table 6: Mean observed and calculated weights of *Oreochromis niloticus* for both sexes combined.

Total length in cm.		No. of fishes	Total weight in gm.		
			Observed	Calculated	
Range	Mean		Mean	Least squares	Geometric regression
4-5.9	5.24	14	9.41	4.03	3.85
6-7.9	6.74	21	12.29	8.06	7.78
8-9.9	8.98	39	15.49	17.78	17.31
10-11.9	10.77	90	25.96	29.51	28.75
12-13.9	13.02	199	50.08	48.98	48.84
14-15.9	15.08	189	75.44	74.13	73.61
16-17.9	16.94	121	86.53	102.33	101.85
18-19.9	18.88	100	125.43	138.04	137.86
20-21.9	20.87	171	169.56	181.97	182.38
22-23.9	23.04	104	245.16	239.88	240.40
24-25.9	25.05	99	323.80	302.00	303.65
26-27.9	26.90	132	413.44	363.08	370.49
28-29.9	28.85	123	514.47	446.68	450.46
30-31.9	30.10	2	502.00	501.19	507.10
32-33.9	33.60	1	768.00	676.08	689.43

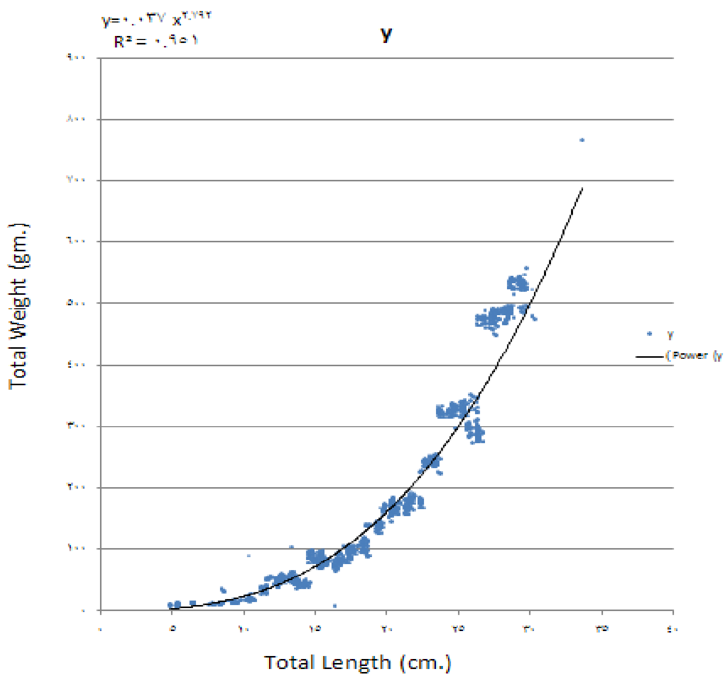

Fig. 2: Length-weight relationship of *Oreochromis niloticus* on normal coordinates. (The smooth curve represents the calculated values and the dots represent the observed ones).

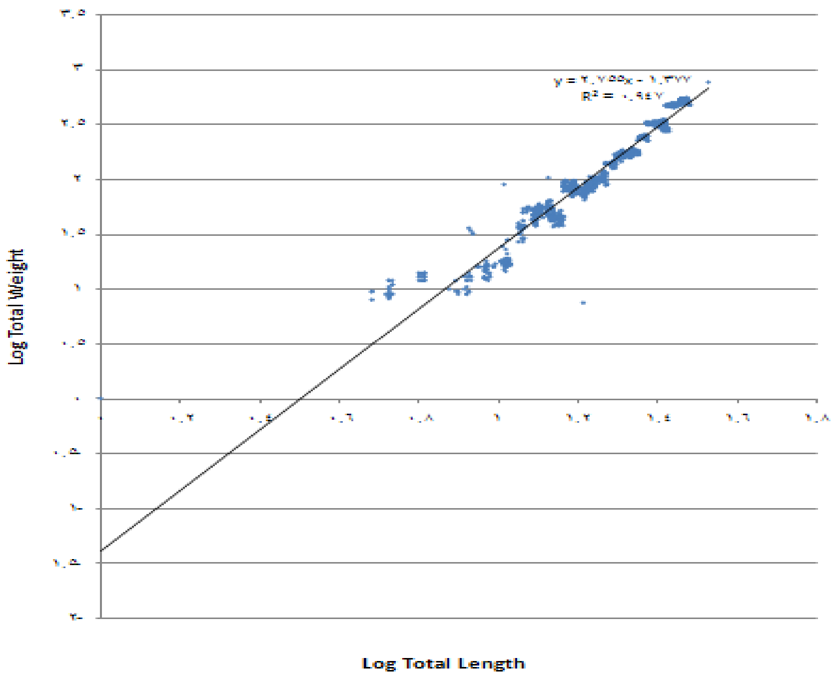

Fig. 3: Total length-total weight relationship of *Oreochromis niloticus* on logarithmic coordinates (The straight line represents the calaulated weights and the dots represent the observed ones).

Coefficient of condition:

The coefficient of condition is the degree of well being of fish in numerical terms. The following methods were used to calculate the coefficient of condition:

i- Fulton's coefficient of condition "K":

$$K = 100\ W/\mathbf{L^3} \qquad \text{(Hile, 1936)}$$

where (W) is the observed weight in gm. And (L) is the length in (cm).

ii- Relative coefficient of condition "$\mathbf{K_n}$":

$$\mathbf{K_n} = W/a\ \mathbf{L^n}$$

$$\textbf{or} \qquad \mathbf{K_n} = W/W` \qquad \text{(Le Cren, 1951)}$$

where (W`) is the calculated weight using the length-weight relationship.

The calculated K and $\mathbf{K_n}$ for both sexes combined of *Oreochromis niloticus* for each 2 cm. length interval are given in Table (7). It shows a general trend towards the decrease in the values of K and $\mathbf{K_n}$ in higher length groups. The average monthly K and $\mathbf{K_n}$ are shown in Table (8) where it shows that the lowest values of K and $\mathbf{K_n}$ were reported during the winter season (November, December, January and February). On the other side, the highest values were recorded during the summer season (April, May, June, July and August) where fishes are more active. This may explain the differences in age groups between the present study and that of El-Ganainy and Hassan (2008), and also explains the highest value of the mean distance from the last annulus to the scale margin being in June.

Table 7: Average composite "k", and relative "kn" coefficients of condition of *Oreochromis niloticus* for the different length groups between 4 and 34 cm. for both sexes combined.

Total length group (cm.)		No. of fishes	Coefficients of condition	
Range	Mean		K	kn
4-5.9	5.24	14	1.58	1.46
6-7.9	6.74	21	1.87	1.67
8-9.9	8.98	39	1.68	1.91
10-11.9	10.77	90	1.90	1.87
12-13.9	13.02	199	1.30	1.64
14-15.9	15.08	189	1.18	1.01
16-17.9	16.94	121	1.77	1.85
18-19.9	18.88	100	1.25	1.90
20-21.9	20.87	171	1.07	1.93
22-23.9	23.04	104	1.19	1.01
24-25.9	25.05	99	1.07	1.07
26-27.9	26.90	132	1.11	1.11
28-29.9	28.85	123	1.14	1.14
30-31.9	30.10	2	1.04	0.99
32-33.9	33.60	1	1.03	1.11

Table 8: Monthly variation in the average composite coefficient of condition "K" and "$\mathbf{K_n}$" for both sexes combined of *Oreochromis niloticus*.

Month	No. of fishes	K	$\mathbf{K_n}$
January	66	1.04	1.00
February	102	1.07	1.00
March	101	1.26	1.07
April	98	1.56	1.23
May	125	1.74	1.98
June	127	1.83	1.71
July	216	1.61	1.82
August	130	1.56	1.74
September	129	1.20	1.04
October	104	1.13	1.02
November	98	1.10	1.01
December	109	1.15	1.04

Growth in weight:

Table (9) shows the estimated weight of *Oreochromis niloticus* at the end of the different years of life which were calculated by applying the length-weight equation for both sexes combined (by the geometric regression method) to the back-calculated lengths of Table (2). Table (10) shows the calculated weights and weight increments in the different years of life. Tables (9 & 10) show that the growth in weight is slower in earlier age groups, and then increased in the following years of life. The highest weight increment was attained at the 4th year (133.06 gm.), while the least increment was attained by the end of the first year (88.83 gm.).

Table 9: Calculated total weights in gm at the end of the different years of life of *Oreochromis niloticus*.

Age in years	Frequency	Calculated total weights (gms,) at the end of each year of life			
		1	2	3	4
I	499	88.83			
II	237	91.00	193.57		
III	109	85.04	188.80	302.30	
IV	2	116.95	264.44	324.04	435.36

Table 10: Calculated weights in gm and weight increments of *Oreochromis niloticus* at the end of the different years of life.

Year of life	Frequency	Weight (gm.)	Weight increment (gm.)
I	499	88.83	88.83
II	237	193.57	104.74
III	109	302.30	108.73
IV	2	435.36	133.06

Mathematical models of growth:

The results of scales and the back-calculation of body lengths at different ages should be incorporated in mathematical models to have a generalized form of growth description Free of errors. From these models are those of Gompertz (1825), the logistic model (Verhulst,1845 and Winsor, 1932) and the most common model of Von Bertalanffy (1938). The linear growth length equation of Von Bertalanffy is:

$$\mathbf{l_t} = \mathbf{L_\infty} \,(1 - \mathbf{e^{-K(t-t_0)}})$$

where ($\mathbf{l_t}$) is the length at age "t", ($\mathbf{L_\infty}$) is the asymptotic length when t → ∞, (K) is a constant and ($\mathbf{t_0}$) is the age at which the length is theoretically nil.

The Von Bertalanffy growth in weight equation was obtained by applying the length-weight equation (W = a$\mathbf{L^n}$) to the growth in length equation as follows:

$$\mathbf{W_t} = \mathbf{W_\infty} \,(1 - \mathbf{e^{-K(t-t_0)}})^{\mathbf{n}}$$

The constants of the Von Bertalanffy equation ($\mathbf{L_\infty}$, K and $\mathbf{t_0}$) were calculated by using Ford (1933)-Walford (1946), Gulland and Holt (1959) and Chapman (1960) fitting methods.

i- Theoretical growth in length:

The Von Bertalanffy model was used to estimate the theoretical growth in length of *Oreochromis niloticus* from Beni Suef. Table (11) shows the constants of the Von Bertalanffy computed by the different methods, as well as the growth performance index (∅). The different Von Bertalanffy theoretical growth in length equations are:

$$\mathbf{l_t} = 48.14\,(1 - \mathbf{e^{-0.147\,(t-0.2237)}}) \qquad \text{Ford-Walford fitting}$$

$$\mathbf{l_t} = 52.33\,(1 - \mathbf{e^{-0.128\,(t-0.1146)}}) \qquad \text{Gulland and Holt fitting}$$

$$\mathbf{l_t} = 48.14\,(1 - \mathbf{e^{-0.147\,(t-0.2237)}}) \qquad \text{Chapman fitting}$$

Table 11: The constants of the Von Bertalanffy equation and the phiprime index of *Oreochromis niloticus* with different fitting methods.

Mehod / Constant	Ford Walford	Gulland and Holt	Chapman
L_∞	**48.14**	**52.33**	**48.14**
K	**0.147**	**0.128**	**0.147**
t_0	**0.2237**	**0.1146**	**0.2237**
Ø	**2.532**	**2.544**	**2.532**

The observed and calculated lengths of *Oreochromis niloticus* using the above equations are given in Table (12). The estimated growth parameters and the growth performance index (Ø) of the studied species compared with those computed in other Egyptian and African lakes are given in Table (13). There is an agreement to some extent between the different results.

Table 12:The observed and calculated lengths of *Oreochromis niloticus* using Von Bertalanffy equation.

Age in years	Mean observed lengths	Calculated length using Von Bertalanffy equation		
		Ford-Wallford method	Gulland and Holt method	Chapman method
I	18.85	16.13	16.16	16.13
II	24.81	20.51	20.51	20.51
III	28.69	24.29	24.33	24.29
IV	31.60	27.55	27.69	27.55

Table 13: The estimated growth parameters of *Oreochromis niloticus* from different localities in different studies.

Locality	L_∞	K	Ø	Author
Lake Nasser	46.2	0.546	3.07	Moreau *et al.* (1986)
Lake Mariout	29.4	0.594	2.71	Moreau *et al.* (1986)
Lake Manzala	29.4	0.294	2.41	Moreau *et al.* (1986)
Nozha Hydrodome	32.6	0.356	2.58	Moreau *et al.* (1986)
High Dam Lake Female	36.9	0.545	2.87	Yamaguchi *et al.* (1990)
High Dam Lake Male	42.8	0.384	2.85	Yamaguchi *et al.* (1990)
Lake Victoria	64.6	0.254	3.025	Getabu (1992)
Mexico	29.19	0.070	---	Gomez-Marquez (1998)
Lake Timsah	28.73	0.46	2.58	El-Ganainy and Hassan (2008)
River Nile Beni Suef	48.14	0.15	2.532	Present study

ii- Theoretical growth in weight:

The growth in weight equations of Von Bertalanffy by the different fitting methods of *Oreochromis niloticus* from Beni Suef are given here:

$W_t = 1881.79\,(1 - e^{-0.147\,(t-0.2237)})^{2.7924}$ Ford-Walford fitting

$W_t = 2375.64\,(1 - e^{-0.128\,(t-0.1146)})^{2.7924}$ Gulland and Holt fitting

$W_t = 1881.79\,(1 - e^{-0.147\,(t-0.2237)})^{2.7924}$ Chapman fitting

C) Mortality:

The survival rate “S”, the instantaneous rate of total mortality coefficient “Z” and the annual rate of mortality coefficient “A” of *Oreochromis niloticus* from Beni Suef were computed using four different methods (Heinke,1913; Jackson,1939; Chapman and Robson, 1960; and coded mean age). Table (14) shows that the four methods give nearly the same values of “S”, “Z” and “A”.

Pauly (1980) suggested the following equation for the estimation of the natural mortality coefficient “M”:

$$\text{Ln } M = -0.0066 - 0.279 \text{ Ln } \mathbf{L}_\infty + 0.6543 \text{ Ln } K + 0.6434 \text{ Ln } T$$

where "$\mathbf{L}_\infty$” and “K” are the constants of the Von Bertalanffy model and “T” is the mean annual water temperature. Table (1) shows that the mean annual water temperature from the River Nile at Beni Suef was recorded to be 21.5 ℃ during the years 2009 and 2010. Then “M” for *Oreochromis niloticus* can be calculated as:

$$\text{Ln } M = 0.0066 - 0.279 \text{ Ln } 48.14 + 0.6543 \text{ Ln } 0.147 + 0.6434 \text{ Ln } 21.5$$

Then M = 0.4010 $\mathbf{year^{-1}}$.

The fishing mortality coefficient “F” of *Oreochromis niloticus* was calculated using the following formula: F = Z – M. Table (14) shows that “F” ranges between 0.4862 and 0.6417 $\mathbf{year^{-1}}$ with a mean of 0.5644 for the four different fitting methods.

Table 14: The survival rates “S”, the instantaneous total mortality coefficients “Z” , the annual mortality rates "A", the instantaneous rate of fishing mortality "F" and the exploitation ratio "E" of *Oreochromis niloticus* by the different fitting methods.

Parameter / Method	“S”	“Z”	“A”	"F" (Z – M)	"E" (F/Z)
Heinke (1913)	0.4109	0.8894	0.5891	0.4884	0.5491
Jackson (1939)	0.4118	0.8872	0.5882	0.4862	0.5480
Chapman & Robson (1960)	0.3527	1.0421	0.6473	0.6411	0.6152
Coded mean age	0.3525	1.0427	0.6475	0.6417	0.6154
Mean	0.3820	0.9654	0.6180	0.5643	0.5819

This fishing mortality coefficient corresponds to an exploitation ratio “E” of: E = F/Z. Table (14) also shows that “E” ranges between 0.5480 and 0.6154 with a mean of 0.5819. Gulland (1971) found that the optimum exploitation ratio of fish $\mathbf{E_{opt.}}$ = 0.5. This indicates that the stocks of *Oreochromis niloticus* from the River Nile at Beni Suef are overexploited and its fishery needs some management regulations (such as reducing the number of Fishing boats and increasing the mesh-size) for improving its production. These results agree with those of El-Ganainy and Hassan (2008) on the same species from Lake Timsah.

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ARABIC SUMMARY

العمر، النمو ومعدلات الوفيات لنوع من أسماك البلطي أوريوكروميس نيلوتيكس من نهر النيل في محافظة بني سويف، مصر

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لقد تمت دراسة المعايير العشائرية لنوع هام من أسماك البلطي وهو أوريوكروميس نيلوتيكس من نهر النيل في محافظة بني سويف وذلك بدراسة القشور لمعرفة المجموعات العمرية المختلفة أثناء فترة الدراسة من يناير ٢٠٠٩ وحتى ديسمبر ٢٠١٠ والتي وصلت أربعة مجموعات عمرية. وقد تم حساب ثوابت معدلات النمو لفونبرتلانفي وكانت على النحو التالي :

L_∞ = 48.14 cm, K = 0.147 $\mathbf{yr^{-1}}$, and $\mathbf{t_0}$ = 0.2234 year.

وقد كانت قيم معدلات الوفيات الكلية (Z) 0.9654 $\mathbf{yr^{-1}}$ ، والطبيعية (M) كانت 0.4010 $\mathbf{yr^{-1}}$ ، وبسبب الصيد (F) كانت 0.5643 $\mathbf{yr^{-1}}$ ، وقيمة معدلات الاستغلال (E) الحالية لهذا النوع من هذه المنطقة كانت 0.5819 وهي قيمة عالية مما يدل على أن هناك صيد جائر. لذلك نوصي بتقليل هذه المعدلات لضمان الحصول على إنتاجية عالية من هذه السمكة الاقتصادية الهامة.