Garyounis University Press
Journal of Science and Its Applications
Vol. 2, No. 1, pp 12-21, March 2008

Some Observation on the Age and Growth of *Tilapia zillii* (Gervais, 1848) in Umhfein Lake (Libya)

A. A. Hadi
Biology Department, Faculty of Science, Omar El-Mukhtar University, Tobruk, Libya

ABSTRACT

Age determination and annual increase in both length and weight of *Tilapia zillii* (Gervais, 1848) were investigated. Specimens studied ranged from 15 to 27 cm in total length and aged from one to four years. Age determination and annual increases in both length and weight were made by examination and measurements of scales. A linear relationship between the body length and the anterior radius of scale has been established with an intercept of 5.1683, where the annuli first appeared on the scales in April. The length-weight relationship was estimated by the equation $W = 0.011\ L^{3.2279}$. The condition factor, K for the different size groups ranged between 1.9336 and 2.3646. The maximum growth in length was attained in the first year, while an intensive growth in weight was observed in the fourth year. The theoretical growth in length and weight was accurately described by Von Bertalanffy's model, using the back-calculated lengths. Values of $L\infty = 28.81$ cm, $W\infty = 565.78$ gm, $K = 0.23458$ & $t_0 = -1.73748$ were determined.

Key words: Age; growth; *Tilapia zillii*; length; weight; condition factor; growth performance.

INTRODUCTION

There is a large variety of bony fishes living in the Libyan waters. So far little is known about the biology of these fishes. Fishes belonging to family Cichlidae are moderate in size, living in shallow and vegetative areas (Eccles, 1992). *Tilapia zillii* is one of the most appreciated fish in North Africa. It constitutes an important part of inland fish production especially in the brackish lagoons of Morocco, Senegal River, Egypt and Libya (Teugles & Thys van den Audenaerde, 1991). Age and growth determinations are important in studying longevity, age at first maturity, catchable size and other life history problems in fishes (Lagler, 1966; Ricker, 1971; Lagler, Bardach, Miller, & Passino, 1977). Age and growth determination of *Tilapia zillii* from the Egyptian waters were studied by Botros (1968); El-Zarka, Shaheen, El-Aleem, (1970); Khallaf and El-Nenaei (1987); Latif, Khallaf, El-Nenaei, (1989); Faltas (1995); El-Kashef (2002), from the Nigerian waters by Basu and Kalu (1999), and from the French waters by Panfili and Tomas (2001). Due to its economic importance and its common presence at the sample site, *Tilapia zillii* was selected for investigation. This work aimed to study some biological aspects of *Tilapia zillii* in the Libyan waters, in order to manage and improve its fishery on a legitimate base.

EXPERIMENTAL

Materials and Methods:

Random samples comprising a total of 270 specimens of *Tilapia zillii* in the size range of 15-27 cm and weighing 71-441 gm were collected from the commercial catches of Umhfein Lake (Umalruzam city). It is an enclosed brackish Lake situated on the eastern coast of Libya. The samples were taken to the laboratory as soon as collected and the total length (cm) as well as total and gutted weight (gm) of each fish in the samples was recorded. Scales were taken from just behind the pectoral fins below the lateral line. Scale examination and measurements were carried out under a binocular microscope. After the determination of time of annulus formation, the age determination, growth was calculated by the back calculation method (Ricker, 1971). The Von Bertalanffy growth function was used to describe the fish growth (Daget & Le Guen, 1975; Merona, 1983; Gulland, 1983):

$$L_t = L\infty\ [1- e^{-k(t-t_0)}]$$

with L_t , total length at age t; $L\infty$, asymptotic maximum length; k, growth rate; t_0, hypothetical age corresponding to null length.

RESULTS AND DISCUSSION

Length-weight Relationship:

The length-weight relationship of *Tilapia zillii* was computed for specimens ranging between 15 and 27 cm in total length. The data have been analyzed using the formula $W = aL^b$ (Le Cren, 1951; Weatherly, 1976), where W= fish weight in gram, L= fish length in cm, a= the weight of unit fish length & b= the relative growth index of length and weight. The length-weight relationship for the combined sexes was given by the following equation:

$$\text{Log } W = -1.9586 + 3.2279 \text{ Log } L \quad \text{or} \quad W = 0.011\ L^{3.2279}$$

$$(r = 0.9956)$$

The parabolic curve drawn between total length and total weight is depicted in Fig. 1 which indicated high degree of correlation among both measures. According to Hile (1936) and Martin (1949), the values of the exponent "n" usually range between 2.5 and 4.0, but according to Allen (1951) the value of "n" remains constant at 3 for ideal fish. A perusal of length-weight relationship, worked for *Tilapia zillii* from Umhfein Lake, showed the value of "n" as 3.2279, thus not satisfying the cube law. It may be said that the weight of the fish in Umhfein Lake increases in proportion slightly higher than the cube of its length.

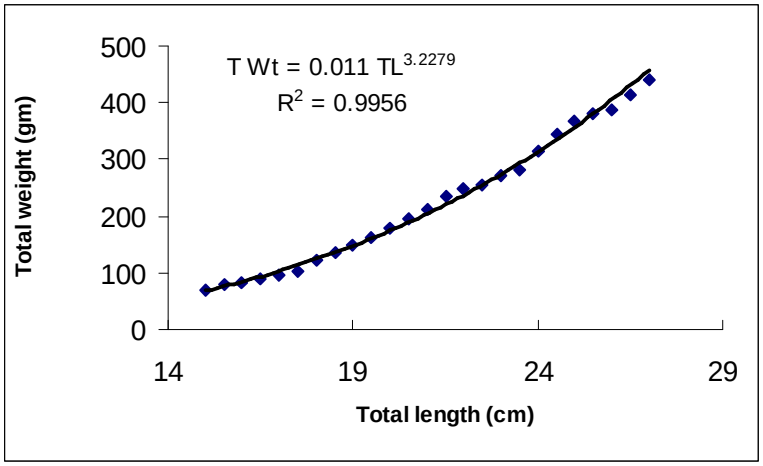

Fig. 1. Length-weight relationship of *Tilapia zillii.*

The length-weight relationship is one of the fundamental parameters in the field of fishery management. It is known that the weight of a fish increases as a function of length. In the present work, the value of the exponent "n" was found to be 3.2279 for *Tilapia zillii* . This does not agree with McAndrew & Majumdar (1983) who stated that the value of the exponent "n" was found to be 2.7430 for *Tilapia zillii* in Hippopotamus pond (Burkina Faso). Basu & Kalu (1999) recorded 2.9696 for the exponent "n" in Lake Alau (North Nigeria), while (King, 1996) recorded value of 3.2100 for the same exponent in New Calabar River (Nigeria), who is in agreement with the present study.

The Condition Factor (k):

Data for condition factor which is considered as direct and quantitative measure of form or well being of fishes regardless of the actual length-weight relationship were derived from sampling records. On these bases "K" indicates the suitability for a species. The formula applied for the calculation of this factor is derived from Hile (1936):

$$K = W \times 100 / L^3$$

Where K = the condition factor, W = the mean observed weight (g), L = mean actual length (cm).

The mean values of the condition factor for the total length between 15 and 27 cm ranged between 1.9336 and 2.3646 as shown in Table 1. It can be seen, that the K values for the combined data dropped at 17 cm, followed by an increase up to 21.5 cm. The values again declined at 23.5 cm, then increased from 26 cm onwards the K values gradually increased. This may be attributed to sexual maturation and active spawning of the larger fish (El-Agami, 1988).

Table 1. The observed and calculated weights, as well as condition factor of *Tilapia zillii* according to length.

Total length (cm)	Observed weight (gm)	Calculated weight (gm)	Condition factor (K)
15	71	68.82	2.1037
15.5	79	76.50	2.1214
16	84	84.76	2.0508
16.5	91	93.61	2.0258
17	95	103.08	1.9336
17.5	104	113.19	1.9405
18	121	123.96	2.0748
18.5	137	135.42	2.1637
19	148	147.60	2.1577
19.5	163	160.51	2.1983
20	179	174.17	2.2375
20.5	196	188.63	2.2751
21	212	203.88	2.2892
21.5	235	219.97	2.3646
22	247	236.92	2.3197
22.5	256	254.74	2.2475
23	273	273.47	2.2438
23.5	283	293.13	2.1806
24	315	313.74	2.2786
24.5	346	335.34	2.3528
25	366	357.93	2.3424
25.5	381	381.56	2.2978
26	389	406.24	2.2132
26.5	415	432.01	2.2300
27	441	458.87	2.2405

The K value (condition factor) for the different size group in the present study ranged between 1.9336 and 2.3646 with a mean value of about 2.1953. Le-Cren (1951) stated that the larger the ratio of K, the better is the condition of the fish. In the present study the values of K are relatively higher for large fishes than for small ones. This may attributed to sexual maturation and active spawning of the larger fish.

Age and Growth:

The scales of *Tilapia zillii* are cycloid moderate, more or less rectangular in shape. The assumption used for identifying annuli on the scales is that a true annulus can be traced completely around the scale and generally exhibits crossing over in the posterior portion of the lateral fields (Blackburn, 1950 , 1951).

Time of Annulus Formation:

The distance on the scale (in micrometer division) from the last annulus to the scale margin was measured in the scales of each sampled fish. This represents the increment of scale growth from the time of last annulus formation. The collected scale samples were shown to deposit an annual mark on the periphery during the second half of March. In April,

the collected scales samples almost possessed annual rings. This reveals that the annulus is formed during early spring.

Body Scale Relationship:

Graphical representation of the body scale data for combined sexes (Fig. 2) indicated that the scale radii grew in direct proportion to that of the total length. A test of the relation between both variables was found to be linear. The regression L = 5.1683 + 3.8094 S was fitted by the least squares (where "L" is the total length in cm and "S" is the scale radius in micrometer division). The straight line represents the scale radius values as calculated from the above mentioned formula, the fitness of the line to represent the body scale relation is indicated from the close quality of the calculated and observed values.

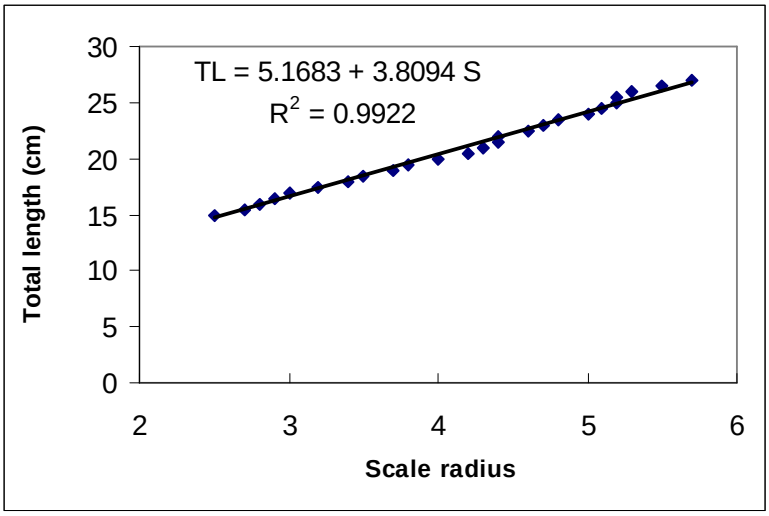

Fig . 2. Relation between average length (L) and scale radius (S) of *Tilapia zillii.*

The scales, which are simply collected, are the most widely used of all methods in age and growth studies (Walburg & Nelson 1966; Hashem, 1972; Kheir 1983). In the present study, scales were used for age determination of *Tilapia zillii* because the annual rings on the scales are clear and easy to count under the microscope.

Growth in Length:

Depending on the linear relationship between the total fish length and the scale radius, the method of Lea (1938) for calculation of growth was computed by the following formula:

$$L_n = S_n / S (L + 5.1683) + 5.1683$$

Where L_n = the calculated length at the end of nth years, L = total length at capture, S_n = scale radius to (n) annulus, S = total scale radius and a = the correction fraction (5.1683). The mean calculated lengths and the increments for the successive age groups are shown in Table 2 and Fig. 3. There is a distinct overlapping in the lengths of the successive age groups, i.e. a fish of a particular length might belong to two or three age-groups. The highest growth takes place in the first year of life, after which the annual increment gradually and progressively decrease with further increase in age.

Table 2. The average and calculated lengths (cm) at different years of life of *Tilapia zillii.*

Age group	no. of fish	Mean back calculated length at the end of each year (cm)			
		L1	L2	L3	L4
I	66	11.38			
II	74	11.21	15.32		
III	69	11.67	14.92	17.48	
IV	61	11.95	15.70	18.42	20.35
Total aver. Length	270	11.69	15.33	18.01	20.35
Average Annual increment		11.69	3.64	2.68	2.34
% annual increment		57.445	17.887	13.170	11.499

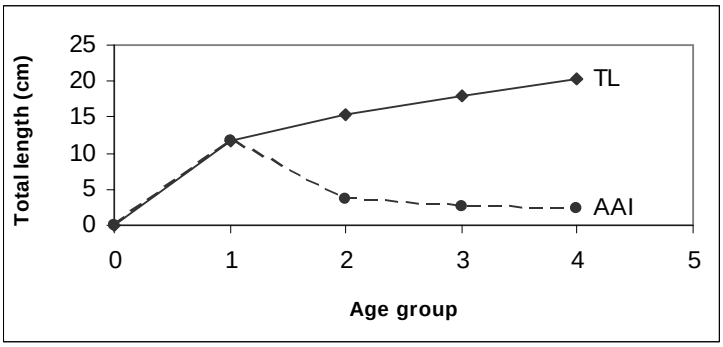

Fig. 3. Growth in length and annual increments in length of *Tilapia zillii.*

Growth in Weight:

The calculated growth in weight at the end of each year of life was estimated by applying the corresponding length-weight equation to the calculated lengths at each year of life. The annual increments and percentage increase in weight during successive years in relation to the weight reached at the end of life span are presented in Table 3.

Table 3. The average calculated weights (gm) at different years of life of *Tilapia zillii.*

Age group	no.of fish	Mean back calculated weight at the end of each year (gm)			
		W1	W2	W3	W4
I	66	28.22			
II	74	26.88	73.67		
III	69	30.60	67.64	112.77	
IV	61	33.04	79.73	133.54	184.21
Total aver. Weight	270	30.77	73.82	124.18	184.21
Average Annual increment		30.77	43.05	50.36	60.03
% annual increment		16.70	23.37	27.34	32.59

The calculated weights at the end of each year of life and annual growth increments (Fig.4) indicate that the growth is very slow in the first year of life, and then increases in successive years of life. The greatest weight increments were attained in the fifth year.

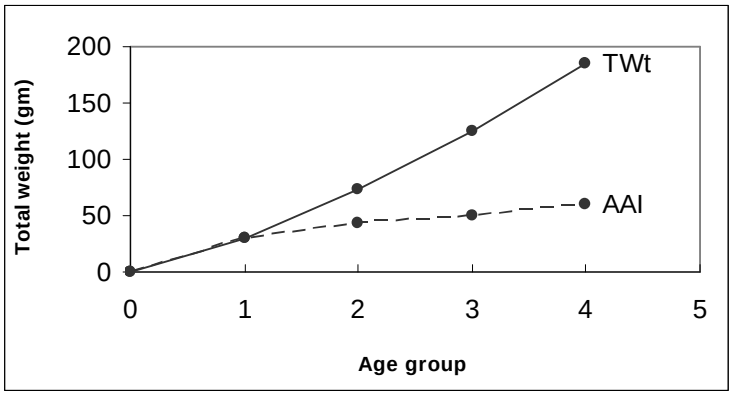

Fig. 4. Growth in weight and annual increments in weight of *Tilapia zillii.*

Growth in length and weight of *Tilapia zillii* in Umhfein Lake was lower than in some other sites, such as in Southern California by Hauser (1975) who stated that *Tilapia zillii* recorded growth in length-weight of 25.7-31.5 cm /380-709 gm for the second year. Ujjania, Sharma, Jain, (1997) recorded growth in length-weight for the same species in the first year 26.44 cm/330 gm, in the second year 32.39 cm/625 gm and in the third year 38.85 cm/1075 gm in Lake Jaisamand (India). It is concluded that the rapid growth observed is an example of the growth potential of this species when released into an environment with a long growing season, abundant food and little competition (Hauser, 1975). In the present study, the greatest length increments were attained in the first year, while the greatest weight increments were attained in the fourth year of life. Therefore, on the basis of the increase in weight it could be economically important to protect the fish in Umhfein Lake till their third year of life, when they have reached a total body length of about 18 cm, and weight of about 124 g, which is a good marketable size.

Theoretical Growth in Length:

The parameters of Von Bertalanffy growth equations proved to be most useful in studies of fish population dynamics and the particular assessment of the status of exploited stock and the effect of fisheries regulation (Tomlinson & Aramson, 1961). The study of the theoretical growth in length of *Tilapia zillii* was estimated using the Von Bertalanffy equation and the straight line models. The constants of the Von Bertalanffy recorded the values of $L\infty$ (the maximum size the fish can attain) = 28.81 cm, k (growth coefficient) = 0.23458 & t_0 (hypothetical age which the fish would have been of zero size) = - 1.73748. The equation of Von Bertalanffy for growth in length of *Tilapia zillii* was estimated as follows:

$$L_t = 28.81\ [1- e^{-0.23458\ (t + 1.73748)}]$$

Mean back calculated lengths at different ages of *Tilapia zillii* were estimated by Von Bertalanffy method. Agreement between theoretical and calculated value is clear (Table 4).

Theoretical growth in weight:

The Von Bertalanffy's equation for growth in weight for *Tilapia zillii* was predicted as follows:

$$W_t = 565.78\ [1- e^{-0.23458\ (t + 1.73748)}]^{3.2279}$$

Table 4 shows that the back-calculated and the theoretical values of weight agree closely.

Table 4. The mean back calculated lengths & weights at different ages of *Tilapia zillii* obtained by vertebral method and those predicted from Von Bertalanffy's equation.

Age group	Back calculated from vertebral method		Predicted from Von Bertalanffy	
	Length (cm)	Weight (g)	Length (cm)	Weight (g)
I	11.69	30.77	13.65	50.76
II	15.33	73.82	16.82	99.59
III	18.01	124.18	19.33	156.03
IV	20.35	184.21	21.31	213.76

Growth performance index (Φ):

Growth performance index (Φ) had been used since it is the best index for expressing the fish growth (Moreau, Bambino, & Pauly, 1986). It is computed according to the latter authors depending on the Von Bertalanffy growth parameters ($L\infty$ & K) as follows:

$$\Phi = \text{Log } K + 2 \text{ Log } L\infty$$

It was found that the growth performance of *Tilapia zillii* is 2.2894.

Parameters of the Von Bertalanffy growth function were calculated for *Tilapia zillii*, where the maximum length reported in Umhfein Lake was 28.81 cm at four years old. This is not in agreement of that recorded by Booth & Merron (1996) ($L\infty$ = 21.52 cm standard length) in Okavango Delta (Botswana) for the same family fish. The largest size of *Tilapia zillii* reported was 40 at 7 years old (Van Oijen, 1995). This is markedly higher than for Umhfein Lake. This is a remarkable difference of growth in favour of the Cichlidae living in closed conditions.

CONCLUSION

The tilapia is one of the most appreciated fish in North Africa. Age and growth determinations are important in studying some biological aspects of fish in the Libyan waters. In conclusion, *Tilapia zillii* must be protected in Umhfein Lake till their third year of life, when they have a good marketable size

REFERENCES

Allen, K. R. (1951). The Horokiwi stream. A study of a trout population. *NewZealand Marine Department Fisheries Bulletin*, 10, 238.

Basu, M., & Kalu, M. (1999). Study and comparison of length-weight relationship and condition factor of Tilapia zillii (Gervais) in Lake Alau and Monguno hatchery, The Borno State, Nigeria.Fourth Indian Fisheries Forum, Kochi, Kerala. (pp. 357-360).

Blackburn, M. (1950). Studies on the age, growth and life history of *Sardinoops neopilchardus* stein of the pilchard, in the southern and western Australia. *Aust.J. Mar. Freshw. Res.*, 1, 221-254.

Blackburn, M., (1951). "Condition rings" on scale of the European pilchard *Sardina pilchardurs* Walbaum. *J. Conserv.*, 18, 181-195.

Booth, A.J., & Merron, G.S. (1996). The age and growth of the greenhead tilapia *Oreochromis macrochir* (Pisces: Cichlidae) from the Okavango Delta, Botswana. *Hydrobiologia*, 321(1), 29-34.

Botros, G.A. (1968). A comparative study on the fecundity of *Tilapia zillii* from Lake Mariut (Egypt). Ocean. Dep. Fac. Sci. Alex. Univ.

Daget, J., & Le Guen, J. (1975). Les criteres chez les poisons. In: Lamotte M and Bourliere F (Eds.), Problemes d'Ecologie. La demographie des populations de vertebres. (pp. 253-291)Masson et Cie, Paris.

Eccles, D.H. (1992). FAO species identification sheets for fishery purposes. Field guide to the freshwater fishes of Tanzania. Prepared and published with the support of the United Nations Development Programme (project URT/87/016). FAO, Rome. 145 p.

El-Agami, A.E. (1988). Age determination and growth studies of *Gerres oyena* (Forskall 775) in the Arabian Gulf waters. *Mahasagar*, 21(1), 23-34.

El-Kashef, M.A. (2002). Fishery biology of some Nile fishes. Ph.D.Thesis, Fac. Sci., Zagazig Univ.

El-Zarka, S., Shaheen, A.H., & El-Aleem, A.A. (1970). Scale characteristics and annulus formation of the cichlid fish *Tilapia nilotica* L. *Bull. Natl. Inst. Oceanogr. Fish.*, 1, 183-192.

Faltas, S.N. (1995). Population dynamics of *Tilapia zillii* (Gervais) in Lake Qarun, Egypt. *Bull. Natl. Inst. Oceanogr. Fish.*, 21, 517-527.

Gulland, J.A. (1983). Fish stock assessment. FAO Wiley ser. Food & Ager., 233 pp.

Hashem, M.T. (1972). The age, growth and maturity of *Labeo niloticus* Forsk. From the Nozha hydrodrome in 1968-1970. *Bull. Natl .Inst. Oceanogr. Fish.*, 2, 83-102.

Hauser, W.J. (1975). An unusually fast growth rate for *Tilapia zillii*. Calif. Fish Game, 61(1), 54-56.

Hile, R. (1936). Age determination of the Cisco *Leucichthys artedi*(Le Sueur) in the lake of the north eastern high bands, Wisconsin. *Bull. U.S. Bur. Fish*, 48, 211-317.

Khallaf, E.A. & El-Nenaei, A.A. (1987). Feeding ecology of *Oreochromis niloticus* (Linnaeus) and *Tilapia zillii* (Gervias) in a Nile canal. *Hydrobiologia*, 146, 57-62.

Kheir, M.T. (1983). Biological studies on *Barbus bynni* and possibilities of its culture in Egyptian Fish Farm Ponds. Msc. Thesis. Fac. Sci., Alex. Univ.

King, R.P. (1996). Length-weight relationships and related statistics of 73 populations of fish occurring in inland waters of Nigeria. *Naga ICLARM Q*. 19(3), 49-52.

Lagler, K.F. (1966). *Fresh water fishery biology*. W.M.C. Brown Company, Dubuque, Iowa,

Lagler, K.F., Bardach, G.E., Miller, R.R., & Passino, A.A. (1977). *Ichthyology*. Second edition, John Wiley and Sons, Inc.

Latif, A.F.A., Khallaf, E.S.A., & El-Nenaei, A.A. (1989). Effect of selectivity of trammel nets upon growth and mortality of two tilapia species. . *Bull. Natl .Inst. Oceanogr.Fish.*, 2, 253-260.

Le Cren, E.D. (1951). The length-weight relationship and seasonal cycle in gonad weight and conditions in perch *Perca fluviatilis*, *J. Anim. Ecol*., 20(2), 201-219.

Lea, E. (1938). Amodification of the formula for calculation of the growth of the herring. *Rapp.Cons, Explor. Mer. Copenh.*, 108 (1), 13-22.

Martin, W.R. (1949). The mechanics of environmental control of body form in fished. *Journal of the Marine Biological Association of U.K.*, 29, 185-229.

McAndrew, B.J., & Majumdar, K.C. (1983). Tilapia stock identification using electrophoretic markers. *Aquaculture*, *30*, 249-261.

Merona, B. De. (1983). Modele d'estimationrapide de la croissancedes poissons. Application au poissons d'eau douce d'Afrique. *Rev Hydrobiol Trop*., 16, 103-113.

Moreau, J., Bambino, C., & Pauly, D. (1986). Indices of overall growth performance of 100 Tilapia (Cichlidae) populations: 201-206. In J.L.Maclean, L.B. Dizon & Hosillos, I.V.(Eds.). The first Asian Fish. Forum Asian Fish Soc., Manila, Philippines.

Panfili, J., & Tomas, J. (2001). Validation of age estimation and back-calculation of fish length based on otolith microstructures in tilapias (Pisces, Cichlidae). *Fishery Bulletin* 99(1), 139-150.

Ricker, W.R. (1971). *Methods for assessment of fish production in fresh waters.* I.B.P. Blackwell Scientific Publishers.

Teugels, G.G., & Thys van den Audenaerde, D.F.E. (1991). Tilapia. , 482-508.In: J. Daget,J.-P. Gosse, G.G.Teugels and D.F.E. Thys van den Audenaerde (Eds.) *Check-list of the freshwater fishes of Africa* (CLOFFA).ISNB, Brussels; MRAC, Tervuren; and ORSTOM, Paris.

Tomlison, P. K. & Aramson, N. J. (1961). Fitting a Von Bertalanffy growth curve by least squares. *Calif. Dept. Fish. Bull*., 116, 1-69.

Ujjania, N.C., Sharma, L.L., & Jain, A.K. (1997). *Base line data on age and growth of Tilapia (Oreochromis mossambicus) from Lake Jaisaman,* India. Cent. Inst. Of fish Educ., Fish. Univ. Road, Seven Bungalows, Versova Mumbai, India.

Van Oijen, M.J.P. (1995). Appendix I. Key to Lake Victoria fishes other than haplochromine cichlids. (pp. 209-300). In F. Witte and W.L.T. van Densen (Eds.) *Fish stocks and fisheries of Lake Victoria*. A handbook for field observations. Samara Publishing Limited, Dyfed, Great Britain.

Walburg, C. H., & Nelson, W.R. (1966). Carp. River carpsucker, small mouth Buffalo and Big mouth Buffalo in Lewis and Clark Lake, Missouri River. *Fish. Res. Biologist Research Report*, 69, 1-30.

Weatherly, A.H. (1976). Factors affecting maximization of fish growth. *J. Fish. Res. Bd. Canada*, 33, 1046-1058.