INTERNATIONAL JOURNAL OF BIOASSAYS
ISSN: 2278-778X
CODEN: IJBNHY
ORIGINAL RESEARCH ARTICLE
OPEN ACCESS

Age and growth pattern of the thin-lipped mullet *Liza Ramada* in the Eastern coast of Libya.

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Received: April 18, 2016; **Revised**: April 28, 2016; **Accepted**: May 21, 2016

Abstract: Age and growth characteristics of the thin-lipped Grey Mullet (*Liza ramada*) were investigated in Eastern coast of Libya. Aging was done by two methods: counting annuli on scales and by length frequency distribution, a total of 218 scales were studied for age determination, in addition of 334 fishes specimen for length frequency distribution reading. Four age groups were determined from scale reading, and five age groups from length frequency distribution methods, the parameters of the Von Bertalanffy growth equation for both sex of all individuals were estimated at 35.4 cm, 0.187 per year, -1.14 years and 2.4, for male were estimated at 35.7 cm, 0.17 per year, -1.367 and 2.3, for female were 38.6 cm, 0.156 per year, -1.383 and 2.4, for $L\infty$, k and t_0, and φ', respectively.

Key words: Grey Mullet, Eastern Libya; length frequency; Von Bertalanffy.

Introduction

The Libyan coast extending to nearly about 1970 km (Lambouef, *et al*., 2000), with high fishes diversity, reached 153 fish species, 56 order and 14 classes, differ in fishing methods, according to the habitats (Lambouef and Reynolds, 1994 and Gorgy, *et al*,.1972). The total production of fisheries about 50000 tons. The thin-lipped grey mullet (*Liza ramada*) is one of the most appreciated fish in Mediterranean Sea (Nelson, 1994). It constitutes an important part of inland fish production, especially in the brackish water of the eastern part of Libya coast. The fish species *L. ramada* presents amount number of the total fish production in Eastern coast (Rafalia and El-Mor 2014). *L.ramada* the principal species contributing to fish production; however, due to its economic importance and its common presence at all the sample sites, *L. ramada*, was selected for investigation. Individual species develop a different morphological pattern of growth a result of interaction between genotype and environment (Minos, *et al* 1994). The age and growth pattern study serve in measure the fish response to ecosystem, help to detect endangered species (population viability analysis, PVA), able the decision maker to manage the fisheries (sustainable yield), and to understand ecosystem dynamics and ecological processes.

Materials and Methods

The study area is located on the east coast of Libyan Mediterranean Sea. It includes all coast of Benghazi and the area around it which is located between 32°36'N and 20°03' (Al-Hassan and Silini, 1999) figure 1.

Aging of *L. ramada* was done by two methods: counting annuli on scales according to Hile, 1941, and by length frequency distribution according to Peterson, 1892. The dry scales taken from the 218 fishes were washed by tap water and then placed in hydrogen peroxide (H_2O_2) for one day to remove surface tissues, then placed between two slides and examined under the low power of the microscope. For aging by length frequency distribution total lengths of 334*L. ramada* were measured. Then the frequency distribution of these lengths was drawn. Every peak on the curve resembles one age group (Figure 2).

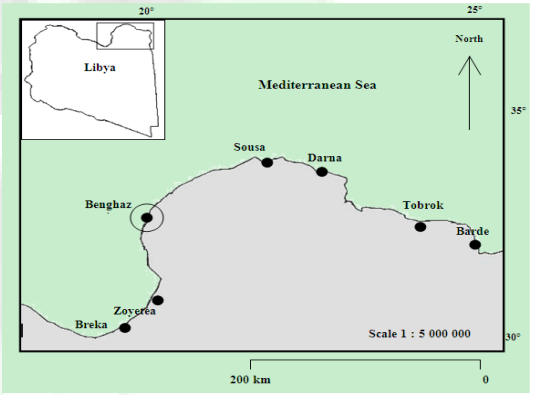

Figure 1: The study area of Eastern coast of Libya.

The lengths at different ages were back calculated using Lee, s formula (1920) as follows:

$$Ln = [(Sn / S) * (L - a)] + a$$

Where Ln is the calculated length in cm., L is the total length in cm, Sn is the scale radius from the nucleus to the annual mark (in micrometer division), S is the total scale radius in micrometer division from the nucleus to the anterior edge of the scale and a is the intercept on the Y axis in the length scale relationship. The back calculated lengths were used to estimate the growth parameters of the Von Bertalanffy growth model (1938) by fitting the Ford (1933) and Walford (1946) plot.

$$Lt = L\infty \{1-exp [-k (t-t_0)]\}$$

Where: Lt, is the length at time t., $L\infty$, is the asymptotic length, that is the mean length of individuals of a given stock if they were left to grow

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indefinitely. K, is growth constant.t, is the age of the fish at "Lt" length.t^0, is the age of fish at length zero. The growth performance index (φ') was calculated followed Munro's.$\varphi' = \log(k) + 2\log(L\infty)$ = where: φ' = the growth performance index. K = the growth rate. $L\infty$ = asymptotic length.

Results

From total of 234 fishes, only 218 scales were studied for age determination (16 scales not availed), in addition of 334 fishes specimen for length frequency distribution reading. Four age groups were determined from scale reading (figure 3, 4,5 and 6), and five age groups from length frequency distribution methods (Figure 2), every peak resembles year group, age from scale were used in this studied, while age from length frequency used for comparison and accuracy.

From Table 1, its appeared that age groups 1, 2, and 3 were more abundant at length groups, 17-20, 20-23, and 23-26cm respectively, from scale reading, and from frequency distribution reading, its appear that age groups 1 and 2 were more abundant at length groups 14-18cm and 18-21 cm, while age groups 3 and 4 were less abundant at length groups, 21-24cm and 24-27 cm.

Table 1: Age composition, length groups, mean length, from scale reading and frequency distribution of *L. ramada* from Eastern coast of Libya 2014-2015.

Age	Length group	Mean length	Fish number	Length group	Mean length	Fish number
	Reading from scale			Reading from length frequency		
1	17-20	18.3	72	14-18	16	144
2	20-23	21.5	56	18-21	19.5	96
3	23-26	25	60	21-24	22.5	51
4	26-29	27	30	24-27	25.5	43
5				27-30	28	
Total			218			334

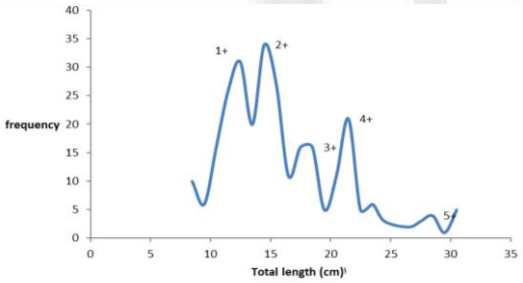

Figure 2. length frequency distribution of *L. ramada* from Eastern coast of Libya2014-2015.

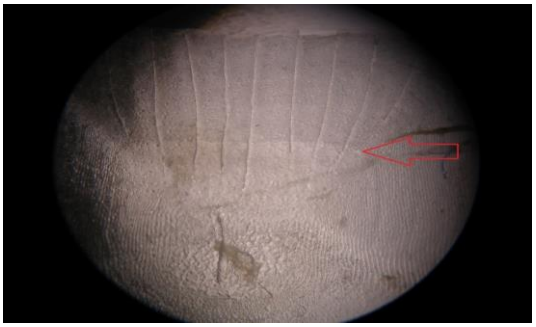

Figure 3: Showed one-year scale reading for *L. ramada* from Eastern coast of Libya 2014-2015.

Figure 4: Showed two years' age group of *L. ramada* from Eastern coast of Libya 2014-2015.

Figure 5: Showed three age groups of *L. ramada* from Eastern coast of Libya 2014-2015.

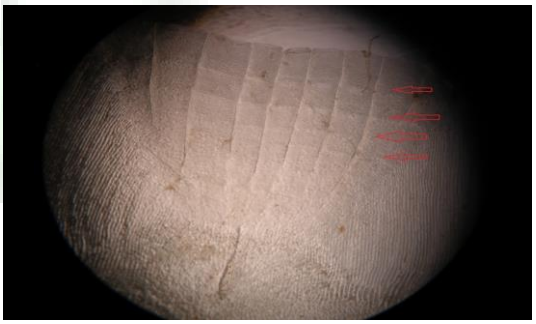

Figure 6: Showed four years' age group of *L. ramada* from Eastern coast of Libya 2014-2015.

From Tables 2,3,4 and figure 7, 8 and 9. The Von Bertalanffy growth equation parameters ($L\infty$, k and t_o), were estimated using for that body back calculated length as a function of age. The results showed that the back calculated length were lower than observed length, and oldest age group estimated was 4 years at observed length 27cm and calculated length 21.8cm (Table 6).

Individuals of specie *L. ramada* from Table 6, for the both sex seem to be grew faster during the first five years of life, attaining approximately 68% (24.17 cm) of their maximum length (35.4 cm), for male at first six years attaining 25.5 cm from maximum length, and for female at seven first years attaining 28.2 cm from maximum length. When we fit the equation of Von Bertalanffy growth Figures 6, 7 and 8, and Table 6, it was appearing that for the both sex, length at zero age equal 6.8 cm, the growth started to be steady at age 9 year and at length 30.9 cm.

The parameters of the Von Bertalanffy growth equation for both sex of all individuals were estimated at 35.4 cm, 0.187 per year, -1.14 years and 2.4, for male were estimated at 35.7 cm, 0.17 per year, -1.367 and 2.3, for female were 38.6 cm, 0.156 per year, -1.383 and 2.4, for $L\infty$, k and t_0, and φ', respectively (Table 5). The growth curve fitting the Von Bertalanffy growth equation for both sex samples were $Lt = 35.4(1-e^{(-0.187*(t+1.14))}$, For male: $Lt = 35.7*(1-e^{(-0.17*(t+1.367))}$ and for female: $Lt = 38.6*(1-e^{(-0.156*(t+1.}$

Table 2: Observed and calculated length (Lt) and (Lt+Δt) using the Ford Wal Ford plot, for both sexton estimate $L\infty$, k and t_o of *L. ramada* from Eastern coast of Libya 2014-2015.

Age (year)	Observed Lt (cm)	Observed Lt+Δ	Calculated Lt	Calculated Lt+Δt	-ln(1-L(t)/L∞)
1	18.3	21.5	11.4	15.9	0.3941
2	21.5	25	15.9	17.9	0.6056
3	25	27	17.9	21.8	0.71627
4	27		21.8		0.97354

Table 3: observed and calculated Lt to estimated $L\infty$, k and t_o for male of *L.ramada* from Eastern coast of Libya 2014-2015.

Age (year)	Observed Lt (cm)	Calculated Lt	Calculated Lt+Δt	-ln (1-Lt/L∞
1	17.4	11.6	15.8	0.3929
2	21.1	15.8	17.6	0.5844
3	24.7	17.6	21.4	0.6792
4	26.2	21.4		0.9148

Table 4. observed and calculated Lt to estimated $L\infty$, k and t_o for female of *L. ramada* from Eastern coast of Libya 2014-2015.

Age (year)	Observed Lt (cm)	Calculated Lt	Calculated Lt+Δt	-ln (1-Lt/L∞
1	18.5	11.3	15.6	0.3574
2	22.3	15.6	18.0	0.51775
3	25.2	18.0	21.6	0.62796
4	26.6	21.6		0.82003

Table 5: the values of $L\infty$, k, t_o and growth performance (φ') index for male, female and both sex of *L. ramada* from Eastern coast of Libya 2014-2015.

Categories	L∞ (cm)	K (per year)	t_o (year)	φ'
Male	35.7	0.17	-1.367	2.3
Female	38.6	0.156	-1.383	2.4
Both sex	35.4	0.187	-1.14	2.4

Table 6: Age groups and cross pending length fitting Von Bertalanffy growth equation of *L. ramada* from Eastern coast of Libya2014-2015.

Age	Both sex Lt (cm)	Male Lt (cm)	Female Lt (cm)
0+	6.8	7.4	7.57
1	11.67	11.8	12.11
2	15.72	15.6	15.8
3	19.07	18.7	19.11
4	21.86	21.4	21.9
5	24.17	23.6	24.33
6	26.08	25.5	26.34
7	27.67	27.09	28.16
8	28.94	28.4	29.66
9	30.08	29.6	31.12
10	30.9	30.5	32.06
11	31.74	31.33	33.07
12	32.36	32.02	33.81
14	33.31	33.08	35.09
15	33.66	33.49	35.6
18	34.41	34.4	36.72
20	34.72	34.75	37.22

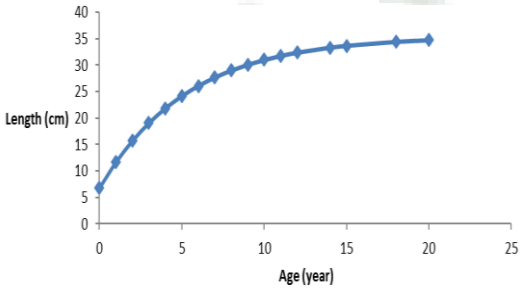

Figure 7. The growth curve of Von Bertalanffy equation for whole samples of *L. ramada* from Eastern coast of Libya 2014-2015.

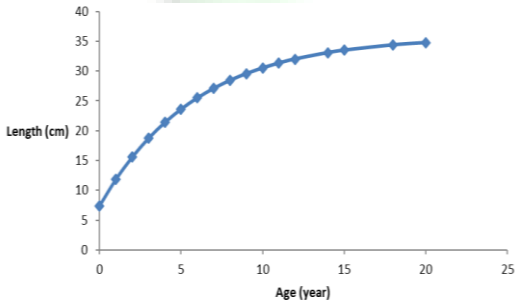

Figure 8. The growth curve of Von Bertalanffy equation for male of *L. ramada* from Eastern coast of Libya 2014-.2015

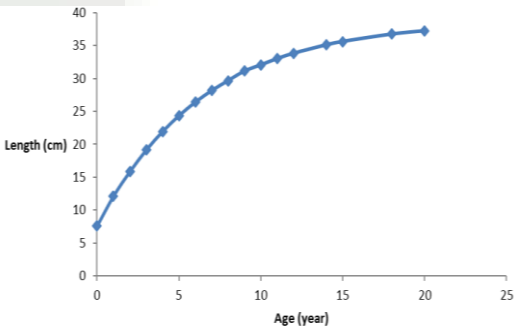

Figure 9. The growth curve for Von Bertalanffy for female of *L. ramada* from Eastern coast Libya 2014-2015.

Discussion

We used two methods on this study to determine the age groups of species *L. ramada*, scale methods and length frequency distribution methods for accuracy and comparison between the results. Thomson, 1997, recognized that in this species and family of *L. ramada*, scale reading is the most used method for age determination, especially due to the difficulty of otolith interpretation (Degens, *et al.*, 1969). The scales used in age determination were ctenoids shape (Crosetti and Cataudella, 1994). Zisman, (1981), stated that all scales present in *L. ramada* specimens above 25mm in total length are ctenoids.

The age of 4 years at total length (TL) was 31.5 cm at the maximum weight was 303.4g, we found in the present study, vary to the known longevity of the species, estimated to 10 years (Thomson 1990). The maximum known total length(TL) is 70.0 cm and the maximum weight is 2900.0 g (Thomson 1990). In this study, age groups determined were 1,2,3 and 4 with mean length 18.3mm, 215mm, 250mm 270mm respectively, compared with age groups and length of Almeida, *et al.*, 1995. From Portugal fisheries, he determined 116.9 mm, 145,6mm, 166,4mm and 196.3mm, for age 1, 2, 3, and 4, respectively, the two results showed slightly different, these may be return to location of data collection also time different of sample studied. Minos *et al*, 1995 and Elawad, 2013). Pointed that the differences in ages estimated could results from the fact that the body zone considered by the authors is not always the same or simply because sample composition used different from one author to another.

Parameters of the Von Bertalanffy growth function were calculated for the species *L. ramada* populations in Eastern coast around Benghazi coast to evaluating the fisheries and condition status of the species study (Von Bertalanffy, 1930) , the parameters of growth for both sex were $L\infty$ = 35.4 cm, k = 0.187 , t_o = -1.14, for male were, 35.7cm, 0.17 per year and -1.367 year for female 38.6cm, 0.136 per year and -1.367.Thomson 1990, mentioned that the average K value for this species is 0.15 per year and varies between 0.11 and 0.45 per year, which is in accordance to the findings of our study, which the average of k in this studied was 0.164 per year. When we compared our results in growth with results from different location, we see disagreement and agreement. Farrugio and Quignard (1974) in Lake Tunis (Tunisia) of the Mediterranean mullet populations, they stated that the $L\infty$ 31.8 cm, k 0.45 and t_o -0.21, Arruda *et al.,* (1991) in Ria de Aveiro lagoon (north- western Portugal), they mentioned $L\infty$ 65.8cm, k 0.08 and t_o -0.60, and Sinovcic and Algeria (1986) in River krka (Adriatic Sea), they recognized the growth parameters of *L. ramada* $L\infty$ 40 cm, k 0.75 and t_o -0.09.

From the comparison above we see that rate growth of this species in Mediterranean sea was high than those in Europe (k in Libya coast and in Tunisia were 0.187 and 0.45 respectively) in Europe (Portugal) was 0.08, these meaning this species attained the maximum length faster than in Europe, while in Adriatic sea, we see the k value was high than in Mediterranean sea (0.75 per year in Adriatic sea compare with 0.187 in Libya coast and 0.45 in Tunisia coast), that meaning this species *L. ramada* attained the maximum length faster in Adriatic sea than maximum length in Mediterranean sea. Also Pauly and Munro (1984) have indicated a method to compare the growth performance of various stocks by computing the Phi index (φ'). The obtained results indicated that the values of growth performance index of *L. ramada* in Eastern coast of Libya was 2.4 compare with 3.00 Mehanna (2006) from Bardawil lake in Egypt. Based on the calculated growth performance index, the growth rate of *L. ramada*in Lake Bardawil is slightly higher than that in Eastern coast of Libya.

This variation in the results due to many reasons, may be due to different in environment factors which almost effected in growth also may be due to availability on food and location of the studied. Kraiem, *et al.*, 2001 and Benetti and Fagundes, 1991), attributed the variation in growth rate return to different in environmental conditions.

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Cite this article as:
Manal M. Khalifa, Ramadan A. S. Ali, Abdalla N. Elawad, Mohammad El. ElMor. Age and growth pattern of the thin-lipped mullet *Liza Ramada* in the Eastern coast of Libya. *International Journal of Bioassays* 5.6 (2016): 4620-4624.

Source of support: Nil
Conflict of interest: None Declared