SINAI Journal of Applied Sciences 10 (2) 2021 161-174

Available online at www.sinjas.journals.ekb.eg

SCREENED BY iThenticate Professional Plagiarism Prevention

SINAI Journal of Applied Sciences

Print ISSN 2314-6079
Online ISSN 2682-3527

ARU-EGYPT SJAS Trust Science | It Creates

SOME BIOLOGICAL ASPECTS OF GOLDEN GREY MULLET, *Liza aurata* (Risso, 1810) FROM BARDAWIL LAGOON, EGYPT

Tamer, M. Marizek[1*], G.D.I. Hassanen[1], M.S. Ahmed[2] and A.A.O. El-Aiatt[3]

1. Dept. Fish and Aquaculture, Fac. Environ. Agric. Sci., Arish Univ., Egypt.
2. Fac. Aquac. and Marine Fisheries, Arish Univ., Egypt.
3. National Inst. Oceanography and Fisheries (NIOF), ElTouloul Branch, North Sinai, Egypt

ARTICLE INFO

Article history:
Received: 07/05/2021
Revised: 25/05/2021
Accepted: 04/07/2021
Available online: 04/07/2021

Keywords:
Length-Weight relationship,
Golden Grey mullets,
Growth,
Bardawil lagoon

Check for updates

ABSTRACT

The present study presents biological aspects of golden grey mullet, *Liza aurata* (risso, 1810) from Bardawil lagoon, Egypt. A total of 1329 specimen's individuals of *Liza aurata* were collected from different landing sites of Bardawil Lagoon in the period from May 2017 to February 2018. Length-weight relationship, condition factor, age composition, and fish growth were studied. The length and weight ranged from 12.2 to 33.6 (cm) and 13.8 to 340 (g) respectively. The Length-Weight relationship (LWR) was determined according to the power regression model. The length-weight relation of *Liza aurata* in Bardawil Lagoon was found as W= 0.0071 $L^{3.053}$ (r^2 = 0.9756). The highest value of condition factor of the studied species was recorded in May and declined to lowest level in November. Growth and mortality were evaluated based on age estimation from scale readings of total 605 individuals. The Von Bartalanffy growth function to be Lt = 38.51 [1-e-0.2421(t+1.4222)] and Wt = 491.96 [1-e -0.2421(t+1.4222)] $^{3.053}$. The total (Z) and natural (M) mortality rates were found to be 0.8865 and 0.3543 $years^{-1}$ respectively. The estimated exploitation rate was found to be E = 0.60 indicating that the current fishing pressure on *L. aurata* suffers from overfishing in the area of study.

INTRODUCTION

Bardawil Lagoon (North Sinai, Egypt) plays an essential role in the fish production in Egypt, where it produces very economically important species of fishes such as sea bass, sea bream, common sole, grey mullet, eel, meager and white grouper (**Abdel-Hakim *et al.*, 2010**). The total production of golden grey mullet, *Liza aurata* (Risso, 1810) in Bardawil Lagoon retched to about 170 tons during the fishing season 2017 (Administration Bardawil lagoon). Golden grey mullet, *Liza aurata* (**Risso, 1810**), is one of the species of the family Mugilidae that constitutes the target of fishery exploitation of Bardawil Lagoon. The golden grey mullet, *Liza aurata*, is a pelagic coastal species which usually lives in inshore waters, entering Lagoons and estuaries. It rarely enters freshwater and prefers a muddy bottom (**Jardas, 1996**). Mullet's catch is composed mainly from *Mugil cephalus, L. ramada* and *L. aurata,* while both *Chelon labrosus* and *L. saliens* are found in very small amounts and recorded under the "others" group (**Mehanna *et al.*, 2019**). Although the mullets in Bardawil Lagoon contribute greatly to the economy of Egypt, very limited studies concerning their dynamics and management are available (**Ismail., 1973; Mehanna, 2006**). The study of length-weight relationship (LWR) of fish is important in fisheries biology and population dynamics where many stock assessment models require the use of LWR parameters (**Jamabo *et al.*, 2009**). The

*** Corresponding author: E-mail address:** attiamr@yahoo.com
https://doi.org/10.21608/sinjas.2021.75617.1020

length and weight of fish is among the important morphometric characters, they can be used for the purpose of taxonomy and ultimately in fish stock assessment (**Goel *et al*., 2011**). The actual relationship between length and weight may depart from the cubic value 3 and this may be due environmental condition in which the animal lives and also due to the physiological condition of the animal (**Ighwela *et al*., 2011**). Weight-length relationships (WLR) are used for estimating the weight corresponding to a given length of fish (**Tesch, 1971**). The aim of the present study is to describe the data on some biological parameters of golden grey mullet from Bardawil Lagoon, located North Sinai Egypt, that could be useful for managing of this important species.

MATERIALS AND METHODS

Sampling Site

Bardawil Lagoon (Fig.1) lies in the north of Sinai, southern east the Mediterranean Sea. It located between 31°03′N to 31°14′N and between 32°40′E to 33°30′E. The Lagoon is shallow with a maximum depth of 6.5 m in its western arm, a minimum depth of 0.3 m, and an average depth of 1.21 m (**Zaghloul *et al*., 2018**).

Sampling and Measurements

Monthly random samples of golden grey mullet, *Liza aurata* (Risso, 1810) (Fig. 2) were collected from the commercial catch in different landing sites of Bardawil Lagoon from May 2017 to February 2018. In the laboratory, total fish length and total weight of 1329 specimens were measured to the nearest 0.1 cm and 0.1 g, respectively.

The relationship between length and weight was described according to the power regression model: $W= a L^{b}$ **(Ricker, 1975**), where: W is the total weight (g), and L is the total length (cm), a and b are constants. The condition factor (K) was calculated monthly by formula $K= ((100W)/ L^3)$ (**Hile, 1936**), where: W is the body weight (g) and L is total length (cm).

Foe aging, scales were detached from 605 individuals of *Liza aurata*, cleaned and investigated under microscope. The growth rings on the scales were counted to determine age group. The equation that describes the length at all ages is as follows equation (**Lee, 1920),** $[L_n = ((L-a)(S_n/S) + a)]$ where: L_n: is the length of fish at age "n", S_n: is a magnified scales radius to "n" annulus. S: is a magnified total Scales radius, L: is a fish length at capture and (a) constant derived from the relationship between total Scales radius and fish length at capture.

The **von Bertalanffy models, 1934** and **1938**, ($L_t= L_\infty (1- e^{-k(t - t_0)})$ was used to describe growth in size, where L_t is the length at age t, L_∞ the asymptotic length, K the body growth coefficient and defines the growth rate towards L_∞ and t_0 the hypothetical age at which a fish would have zero length. The values of L_∞, K and t_0 were estimated by plotting L_t vs L_{t+1} (**Ford, 1933 and Walford, 1946**). The growth performance index (Ǿ) described by **Pauly and Munro (1984)** was calculated using the relationship Ǿ = Log K + 2 Log L_∞ and Ǿ = Log K + 2/3 Log W_∞.

Total mortality (z) can be computed using six methods 1- **(Beverton and Holt, 1957)** based on age data , where $Z= 1/(\bar{t} - t)$ where $\bar{t}$ is the age that corresponds to the average length of the fish in the samples, from the age of two years to the largest fish in the sample, t is the age of the most frequent fish catches; **2- (Beverton and Holt, 1957)** based on length data since $Z=K((L_\infty-\bar{L_c})/(\bar{L_c} - L_c))$ Where L_c is the length of the first capture , $\bar{L_c}$ is the average fish length ranges from 50% to the longest fish in the sample; **3-(Beverton and Holt's, 1957)** based on length data where $Z=K*(L_\infty-L')/(L'-L_r)$ where L′ is the average

Fig. 1. Bardawil Lagoon

Fig. 2. Golden grey mullet, *Liza aurata*, from Bardawil Lagoon

fish length of samples and L_r is the smallest length in samples. 4-**(Chapman and Robson, 1960)** where $Z=-L_n$ S whereS=(A/(B+A-1), [$A=N_1+2N_2+3N_3$ and $B = N_0 + N_1 + N_2 + N_3$ where N_o is the number of fish in ageI, N_1 is the number of fish is age II, N_2 is the number of fish is age III and N_3 is the number of fish is age IV; 5- Estimation of Z from a linearized catch curve based on age composition data as Z=-b and 6- The Powell- Wetherall method (**Powell, 1979**) discussed in-(**Wetherall *et al.*, 1987) as** Z=1-k.

The natural mortality (M) were obtained by using six methods **1-**(**Alverson and Carney, 1975)** where $M = 3 * K / [\exp(t_{max} * 0.38 * K) - 1]$ 2- **Hewitt and Hoenig (2005)** where $M=4.22/t_{max}$), where t_{max} is the maximum age of the fish in the sample 3-**Jensen (1996**) since M=1.5k. **4- Ursin, (1967)** where $M= \bar{W}^{(-1/3)}$ where $\bar{W}$ is the average weight of the samples; 5- Estimation of M by **(Jennings *et al*. 2001**) where $M= 3/T_{max}$ and 6- **Pauly (1980**) where log M = [-0.0066 – 0.279 log L + 0.6543 log K + 0.4634 log T] where "T" is the annual average water temperature. Maximum age of the fish (t_{max}) = 3/K, while fishing mortality (F) = Z - M. The exploitation rate (E) was calculated as follows: E = F / Z) **(Gulland, 1971)**. Length at first capture (L_c) was calculated from the plot of the probability of capture against size.

RESULTS AND DISCUSSION

Length Frequency Distribution

The length frequency distribution of 1329 specimens of *L. aurata,* which caught from Bardawil Lagoon during period from May 2017 to February 2018 were ranged from 12.2 to 33.6 cm (Fig. 3). This figure shows that, the most frequent length group was 19-19.9 cm and the lowest number was recorded in the length group 31-31.9 cm.

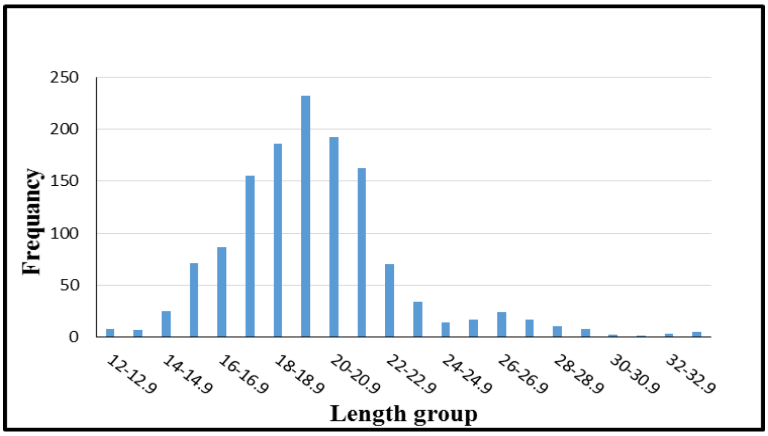

Fig. 3. Length frequency distribution of *L. aurata* in Bardawil Lagoon, 2017

Length-Weight Relationship

Length–weight relationship for fish used to provide information on the condition of fish, their isometric or allometric growth, in the analysis of ontogenic changes, to compare life histories of fish species between regions as well as other aspects of fish population dynamics. Also, length-weight relationship is useful for the conversion of growth-in-length equations to growth-in-weight, for use in stock assessment models and to estimate stock biomass from limited sample sizes **(Binohlan and Pauly, 1998 and Ecoutin *et al.*, 2005).**

The length-weight relationship of *L. aurata* from Bardawil Lagoon (Fig. 4) was estimated from specimens ranging in their total length from 12.2 to 33.6 (cm) and in their total weight from 13.8 to 340 (g). The relationship from the sexes combined was calculated from the following formula: $W = 0.0071L^{3.053}$ ($r^2 = 0.9756$).

Hile (1936) have demonstrated that, the value of (b) remains constant at (3) for ideal fish. In the present study the value of (b) was 3.053, which not significantly different from (3) indicating isometric growth. It may be said that the weight of *L. aurata* from Bardawil Lagoon increases in proportion slightly higher than the cube of length. Table 1 shows different results from the previous studies, moreover, these differences in results may be due to feeding intensity, environmental conditions, gonad maturation and other factors. The value of (b) agree with (**Kraljević *et al.*, 2011; Hotos and Katselis, 2011; Hotos, 2019**) but disagree with (**Ilkyaz *et al.*, 2006; Fazli *et al.*, 2008; Khayyami *et al.*, 2014; Mehanna, 2006)**. Our results are not consistent with **Mehanna (2006)** in the same erea. This may be due to the fact that the total production of Lake Bardawil in 2006 was higher than in the year of study, since total production amounted to 4704 tons in 2006 (**GAFRD, 2013**), while total production was 3718.5 tons year of study (Administration Bardawil lagoon).

Condition Factor (Kc)

In the present study the monthly average condition factor of golden grey mullet was highest in May and declined to the lowest level in November (Fig. 5). This may be concerned with the spawning period of the studied species. **Ghadirnejad (1996)** reported that**,** the spawning season of golden grey mullet starts in November and continues until January. The previous author mentioned that a substantial increase in condition factor to a maximum around September, due to the developing eggs for the spawning season. The spawning of golden grey mullet starts in September and continues until (November and December) in Iranian waters of the Caspian Sea (**Ghadirnejad, 1996; Fazli, *et al.*, 2008**).

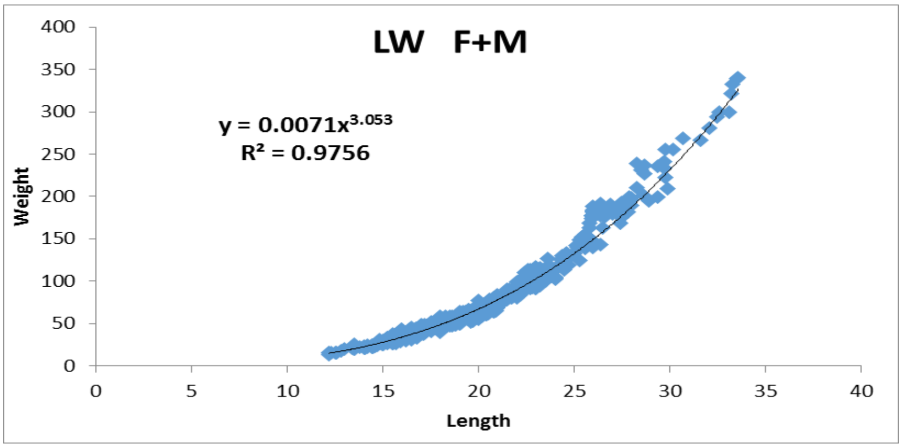

Fig. 4. Length-weight relationship of *L. aurata* in Bardawil Lagoon, 2017

Table 1. Relationship between Length and weight of *L. aurata* from different regions

Sex	L-W relationship	Author	Area
Combined sexes	$W = 0.0071L^{3.053}$	present study	Bardawil Lagoon
Females	$W = 0.006L^{3.114}$		
Males	$W = 0.0058L^{3.130}$		
Combined sexes	$W= 0.0062 L^{3.069}$	**Kraljević *et al.*, 2011**	Adriatic Sea
Combined sexes	$W = 0.0057L^{3.13}$	**Hotos and Katselis, 2011**	Gulf of Patraikos
Combined sexes	$W= 0.0054TL^{3.15}$	**Hotos, 2019**	Lagoon of Klisova-Messolonghi
Combined sexes	$W= 0.0107L^{3.006}$	**Fazli *et al.*, 2008**	Caspian Sea
Females	$W= 0.1152L^{2.9426}$		
Males	$W= 0.1278L^{2.7856}$		
Combined sexes	$W = 0.0086 L^{2.9356}$	**Mehanna, 2006**	Bardawil Lagoon
Combined sexes	$W= 0.0111L^{2.9299}$	**Ilkyaz *et al.*, 2006**	Homa Lagoon
Combined sexes	$W= 0.0081L^{2.942}$	**Khayyami *et al.*, 2014**	Mazandaran
Combined sexes	$W= 0.009L^{2.9219}$		Guilan
Combined sexes	$W= 0.0072L^{2.9701}$		Golestan

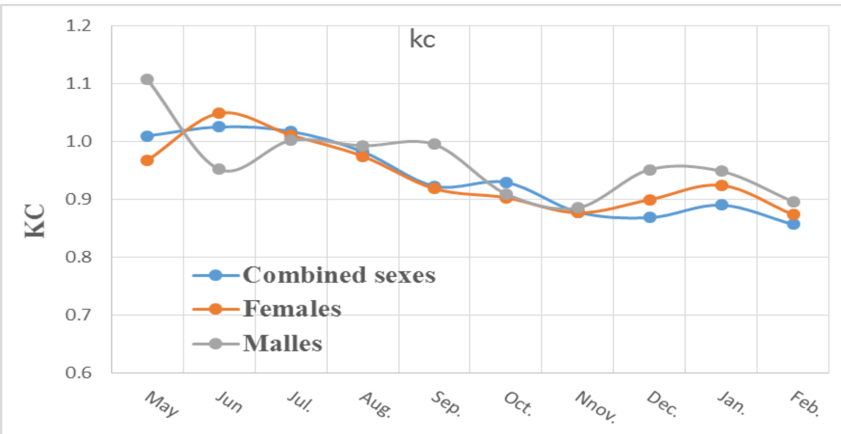

Fig. 5. Monthly variation in (K_c) for males, females and combined sexes of *L. aurata* in Bardawil Lagoon, 2017

Age and Growth

Age distribution of 605 *L. aurata* samples from Bardawil Lagoon ranged from 0 to 4 years based on results of the fish scales reading (Fig. 6). The age group 1 was a dominant group and composed 41.7% of the whole age distribution. The group 1 was followed by the age group 0 (25.3%), group 2 (17.7%), group 3 (11.4%). The age group 4 was representing with low percentage in the population (4.0%) (Fig. 6). Also, minimum, maximum and mean lengths of different age groups of *L. aurata* in Bardawil Lagoon during 2017 (Table 2) showed overlapping in lengths between all recorded age groups.

Back-Calculations in Length and Weight

The back-calculated lengths recorded in this study were 17.8, 21.81, 25.1 and 28.16 (cm) for age groups 1, 2, 3, and 4 years, respectively (Fig. 7). The results showed that the highest increment in length occurred at the first year of life 17.08 (cm) and then declined rapidly thereafter till reached 3.06 (cm) at age of group 4. The increments in weight were 41.14, 45.63, 46.36, and 56.08 (g) for age groups 1, 2, 3 and 4 years respectively (Fig. 8). The back calculated weight was 41.14, 86.78, 133.14, and 189.22 (g) for age groups 1, 2, 3 and 4 years, respectively.

Table 3 shows a lot of variation in the values of the growth parameters of *L. aurata* different areas. These differences may be attributed to the difference in biological characters of the studied species in those areas or to the possible false age estimation. In some studies, the younger age groups were not collected (**Kraljević and Dulčić, 1996**) and others the fish older than two or three years were not recorded (**Drake *et al*., 1984**).

Hotos (2019) reported that the lower annual average temperature in the northern latitudes as compared to the southern ones, affect the characteristics of growth of this fish, promoting the creation of the first annulus at a comparatively smaller size.

Mathematical Models of Growth

The parameters of Von Bertalanffy growth were calculated as $L\infty = 38.51$ (cm), $K = 0.2421$ year $^{-1}$ and $t_0 = -1.4222$. The data obtained equations were $L_t = 38.51$ $[1 – e^{-0.2421(t+1.4222)}]$ for length, and $W_t = 491.96$ $[1–e^{–0.2421\ (t+4222)}]^{3.053}$ for weight. The value of L_∞=38.51 (cm) are good agreement with (**Kraljevic and Dulcic, 1996)** from Mirna Bay (North Adriatic) as $L\infty = 39.8$ (cm). **Fehri-Bedoui and Gharbi (2005**) reported that $L\infty = 39.7$ (cm) in Tunisian coasts and (**Kraljević et *al*., 2011**) mention that L_∞ = 40.0 (cm) in Mirna estuary (northern Adriatic Sea. In contrast recorded L_∞ in the present study less than that reported by (**Albertini-Berhaut, 1978**), since $L_\infty = 45$ (cm) in Gulf of Marseilles, **Modrušan *et al.* (1988**) estimated $L_\infty = 51$ (cm) in Krka estuary-middle Adriatic, **Arruda *et al*. (1991**) estimated $L_\infty = 68.5$ (cm) in Ria de Aveiro – Atlantic. Also, the value of $L\infty$ in this study was higher than that recorded by **Andaloro, (1983**) since $L_\infty = 24.3$ (cm) in Marsala Lagoon and that reported by **Mehanna (2006**) since $L_\infty = 33.8$ (cm) in Bardawil Lagoon.

Growth Performance Index (Ǿ)

Growth performance index (Ǿ) had been used since it is the best index for expressing the fish growth (**Pauly and Munro (1984)**). It is computed according to the latter authors depending on the Von-Bertalanffy growth parameters ($L\infty$ & K) as follows: Ǿ = Log K + 2Log $L\infty$ It was found that the growth performance of *L. aurata* in the present study = 2.55. These results agree with the results in N. Adriatic since Ǿ = 2.52 **(Kraljević and Dulčić, 1996),** but lower than the results from Italy, Ǿ= 2.99 **(Konides *et al*., 1992**) Φ′ value In the Lagoon of Klisova-Messolonghi in 2.82 (**Hotos, 2019**). **Mehanna (2006**) reported that the values of growth performance

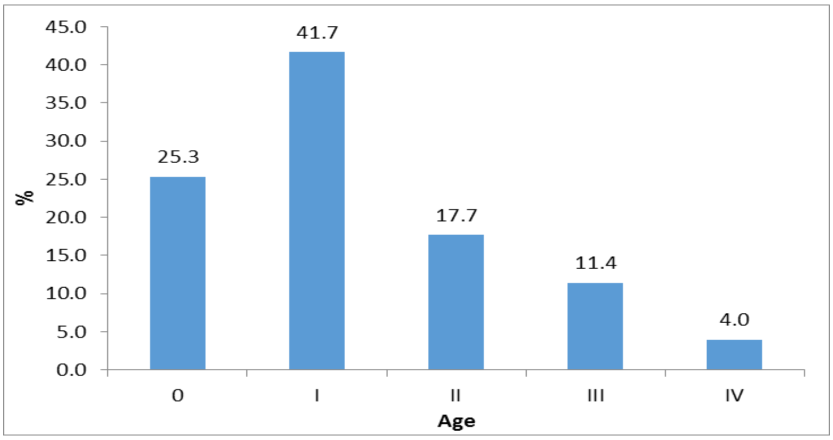

Fig. 6. Age distribution of *L.aurata* in Bardawil Lagoon, 2017

Table 2. Minimum, maximum and mean lengths from different age groups of *L. aurata* in Bardawil Lagoon, 2017

AGE	Number of Samples	Minimum Length (cm)	Maximum Length (cm)	Mean Length (cm)
0	153	14	18.6	16.71
1	252	17.6	21	19.5
2	107	20.2	28	22.7
3	69	20.8	29.9	25.6
4	24	22	33.6	28.8
Total	605			

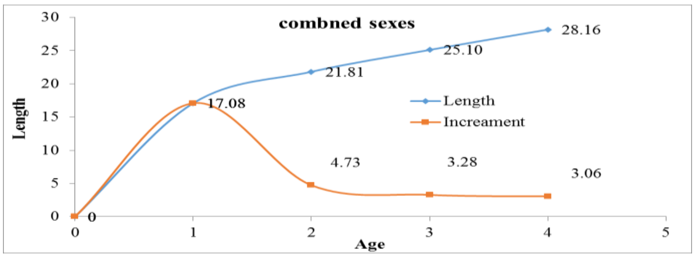

Fig. 7. Increment in length of *L.aurata* in Bardawil Lagoon, 2017

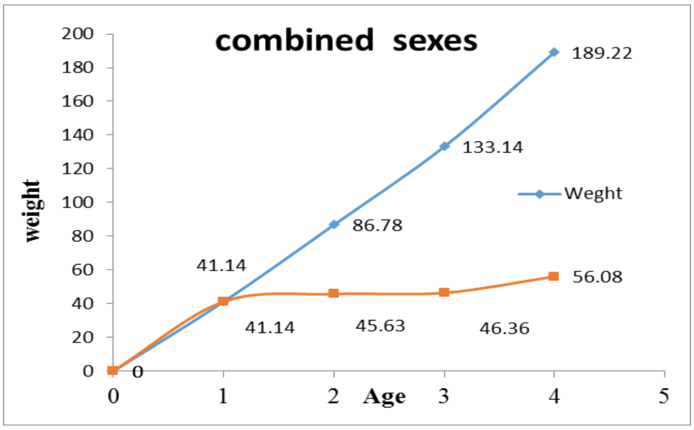

Fig. 8. Increment in weight of *L.aurata* in Bardawil Lagoon, 2017

Table 3. Lengths (cm) at different ages of *L. aurata* from different areas

L_1	L_2	L_3	L_4	L_5	L_6	L_7	L8	Area	Authors
18.2	25.2	30.7	34.66	40.1	42.76	47.06	53.75	Messolonghi Lagoon	**Hotos, 2019**
18.51	24.59	29.88	33.24	39.67	41.95	46.24	53.51	Klisova Lagoon	**Hotos and Katselis 2011**
10.9	19.7	27.2	31.4	35.8	39.9	43.9		France	**Thong, 1969**
9.6	20.9	26.2	31.3	34.5	38.3			France	**Farrugio and Quignard, 1981**
15.0	24.0							Lake Borollus,	**Hashem *et al.*, 1973**
17.9	24.9	28.5						Bitter Lakes	**Mehanna, 2004**
18.8	25.6	29.3						Bardawil Lagoon	**Mehanna, 2006**
10.5	16.5	21.9	26.8					Portugal	**Arruda *et al*.,1991**
17.08	21.81	25.1	28.16					Bardawil Lagoon	Present study

index Φ of L *aurata* were 2.84 in Bardawel Lagoon and the Φ values obtained were consistent with other estimates. It was found that Φ = 2.66 for *L. ramada* at Burullus lake, 2.91 at Wadi El-Raiyan lakes and 2.98 at Lake Timsah and was 2.82 at Bitter Lakes).

Mortality

In the present study, the annual rates of total, natural, fishing mortality and exploitation rate of *L. aurata* were 0.8865, 0.3543, 0.5322 and 0.6 respectively. These results are not consistent with that obtained by various authors and in different locations.

Mehanna (2006) reported that the total mortality coefficient Z, the natural mortality coefficient M, the fishing mortality coefficient F and Exploitation rate E were estimated as 1.36, 0.22, 1.14 and 0.84 year respectively for *L. aurata* in Bardawilll Lagoon. **(Konides *et al*., 1992)** estimated all the above measurements in the Ionian Sea are Z= 0.85, M = 0.21, F=0. 64 and E= 0.75, while (**Kraljević and Dulčić 1996**) in the N. Adriatic Sea found Z= 1.12, M= 0.44, F= 0.68 and E= 0.61 in the N. Adriatic Sea. Also our results were greater than obtained from the Lagoon of Klisova-Messolonghi (W. Greece) , since the total (Z) and natural (M) mortality rate was found to be 0.54 and 0.33 years^{-1} respectively (**Hotos 2019**). **Gulland (1971)** suggested that the optimum exploitation rate for any fish stock is about 0.5 at F=M and more recently, **Pauly (1987**) proposed a lower optimum F that equal to 0.4 M. **Patterson (1992**) reported that an exploitation rate of about 0.4 is safe for the stock. The L_c value in the present study was estimated as 19.5 cm (Fig. 9) corresponding to an age of 1.49 year. The results showed that the stocks of *L. aurata* at Bardawil Lagoon were overexploited. For the management purpose, the current exploitation rate must be reduced from 0.60 to 0.4 (54%). **(Abdallah *et al*., (2013**) mentioned that to maintain a sufficient spawning biomass, the length at first capture should be raised from 19.5 to about 23.73 cm for *L. aurata*.

Based on the result, it can be concluded that the studied species suffers from overfishing due to some illegal practices such as matching the size of the mesh gears and also there is a miss of information on the extent of the state of the catch.

Also, the destructive fishing gears should be banned meanwhile; the technological development and biological effect of several fishing methods operating inside the Lagoon should also be taken into account when analyzing the impact of the fishery on the different fish stocks.

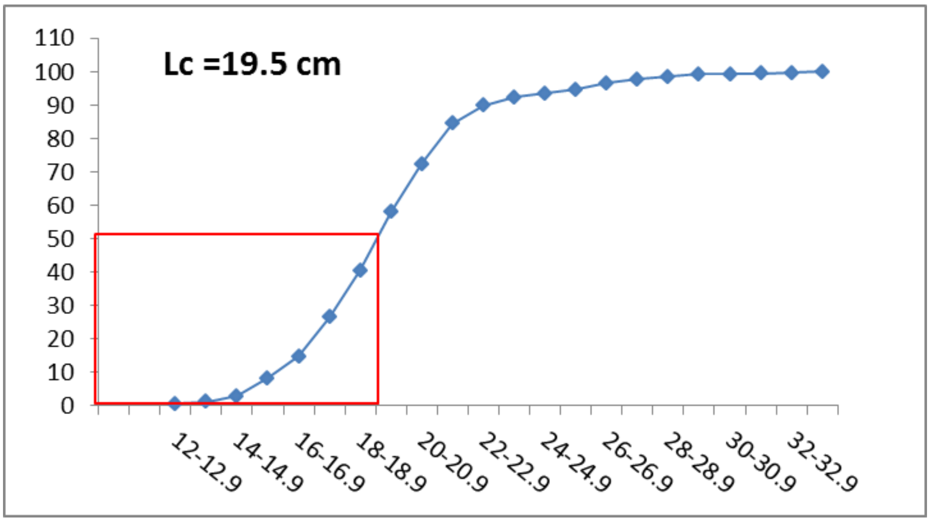

Fig .9. L_c of combined sexes of *L. aurata* in Bardawil Lagoon during 2017

REFERENCES

Abdallah, C.; Ghorbel, M. and Jarboui, O. (2013). Reproductive biology of the Golden grey mullet *Liza aurata* (Risso, 1810), in the Gulf of Gabes (central Mediterranean, Tunisia). Medit. Mar. Sci., 14/2, pp 409-415.

Abdel-Hakim, N.F.; Mehanna, S.F.; Eisa, I. A. (2010). Length weight relationship, condition factor and stomach contents of the European sea bass, *Dicentrarchus labrax* at Bardawil Lagoon, North Sinai Egypt. Proceeding of the Global Fisheries and Aquaculture Research Conference, Egypt, 1-14.

Albertini-Berhaut, J. (1978). Croissance linéaire et pondérale de *Mugil auratus* comparée a celle de *Mugil capito*. (Linear growth and weight of *Mugil auratus* in comparison with those of *Mugil capito*). Cybium 4: 51-60.

Alverson, D.L. and Carney, M.J. (1975). A graphic review of the growth and decay of population cohorts. Journal du Conseil International pour l' Exploration de la Mer 36:133–143

Andaloro, F. (1983). Contribution on the knowledge of the age and growth of the Marsala Lagoon golden mullet, *Liza aurata* (Risso, 1810). Rapp. Comm. int. Mer Médit. 28: 81-82.

Arruda, L. M.; Azevedo, J. N. and Neto, A.I. (1991). Age and growth of the grey mullet (piisces, Mugilidae) n Ria de Aveiro (Portugal). Sci. Mar., 55: 497-504.

Beverton, M.A. and Holt, S.J. (1957). On the dynamics of exploited fish populations, U.K. Ministry of Agriculture and Fisheries: Fisheries Investigation Series, 2: 533.

Binohlan, C. and Pauly, D. (1998). The length-weight table, in: R. Froese, D. Pauly (Eds.). Fishbase 1998: Concepts, design and data sources. ICLARM, Manila. pp: 121-123.

Chapman, D.G. and Robson, D.S. (1960). The analysis of a catch curve. Biomertics, 16(3): 354-368p.

Drake, P.; Arias, A.M. and Rodriguez, R.B. (1984). "Biology of mullets (Osteichthyes, Mugilidae) in the esteros of San Fernando (Cadix). I. Growth in length and weight." Invest. Pesquera, 48: 139-456.

Ecoutin, J.M.; Albaret, J.J. and Trape, S. (2005). Length–weight relationships for fish populations of a relatively undisturbed tropical estuary: The Gambia. Fisheries Res., 72: 347-351.

Farrugio, H. and Quignard, J.P. (1981). Age and growth of grey mullets. In: Oren, O. H. (ed.), Aquacul. grey mullets, 155-184, IBP 26. Cambidge Univ. Press.

Fazli, H.; Ghaninejad, D.; Janbaz, A.A. and Daryanabard, R. (2008). Population ecology parameters and biomass of Golden grey mullet (*Liza aurata*) in Iranian waters of the Caspian Sea. Fisheries Research, 93: 222- 228.

Fehri-Bedoui, R. and Gharbi, H. (2005). Age et croissance de *Liza aurata* (Mugilidae) des côtes tunisiennes. Cybium, 29 (2): 119-126.

Ford, E., (1933). An account of the herring investigation conducted at Ply Mouth. J. Marin. Biol. Ass. U.K., 19: 305-384.

GAFRD, (2013). The General Authority for Fishery Resources Development: Fisheries Statistics Yearbook for 2013. Ministry of Agric. and Land Reclamation, Cairo, Egypt.

Ghadirnejad, H. (1996). Population dynamics grey mullet species (*Liza aurata* and *L. Saliens*) in southern Caspian Sea. Ph.D. University of wales, Swan Sea.207P.

Goel, C.; Barat, A.; Pande, V.; Ali, S. and Kumar, R. (2011). Length weight relationship of snow trout (*Schizothorax richardsonii*) based on linear and nonlinear models from hill stream of Uttarkhand, India. World Journal of Fish and Marine Sciences 3(6): 85-488.

Gulland, J.A. (1971). The Fish Resources of the Oceans. Fishing News Books Ltd., England. 255p.

Hashem, M.T.; El-Maghraby. A.M. and El-Sedafy, H.M. (1973). The grey mullet fishery of Lake Borollus, Bull. Inst. Oceanog. Fish. 3: 29-54.

Hewitt, D.A. and Hoenig, J.M. (2005). Comparison of two approaches for estimating natural mortality based on longevity. Fishery Bulletin, 103: 433-437.

Hile, R. (1936). Age and growth of the Cisco *Leucichthys arted* in the lakes of the northeastern high lands, Wisconsin *Bull. U. S. Bur. Fish* 48: 211-317.

Hotos, J.N. (2019). Natural Growth and Mortality of the Golden Grey Mullet *Liza aurata* (Risso, 1810) In the Lagoon of Klisova-Messolonghi (W. Greece). Academic J. Life Sci., 5(4): 23-31.

Hotos, G.N. and Katselis, G.N. (2011). Age and growth of the golden grey mullet *liza aurata* (actinopterygii: mugiliformes: mugilidae), in the messolonghi-etoliko lagoon and the adjacent gulf of patraikos, western Greece. Acta Ichthyologica Et Piscatoria, 41 (3): 147–157.

Ighwela, K.A.; Ahmed, A.B. and Abol-Munafi, A.B. (2011). Condition factor as an indicator of growth and feeding intensity of Nile tilapia fingerlings (*Oreochromis niloticus*) feed on different levels of maltose. American-Eurasian J. Agric. & Environmental Sci.; 11(4): 559-563.

Ilkyaz, A.T.; Firat, K.; Saka, F. and Tuncay, H. (2006). Age, Growth, and sex ratio of golden grey mullet, *Liza aurata* (Risso, 1810) in Homa Lagoon (‹zmir Bay, Aegean Sea. Turk J. Zool., 30: 279-284.

Ismail, M.Z. (1973). A biological study of the mullet fisheries in Nozha Hydrodrome. M.Sc. Thesis, Alexandria University, Egypt.

Jamabo, N.A.; Chindah, A.C. and Alfred-Ockiya, J.F. (2009). Lengthweight relationship of a mangrove prosobranch *Tympanotonus fuscatus* var fuscatus (Linnaeus, 1758) from the bonny estuary, Niger delta, Nigeria. World J. Agric. Sci.; 5(4): 384-388.

Jardas, I. (1996). Jadranska ihtiofauna (Adriatic ichthyofauna). Školska knjiga, Zagreb, 536 pp.

Jennings, S.; Kaiser, M.J. and Reynolds, J.D. (2001). Marine Fisheries Ecology. Blackwell Science, Oxford, UK. 417 pages.

Jensen, A.L. (1996). Beverton and Holt life history invariants result from optimal trade-off of reproduction and survival. Canadian J. Fisheries and Aquatic Sci.: 53: 820-822.

Khayyami, H.; Movahedinia, A.; Zolgharnein, H. and Salamat, N. (2014). Length-Weight relationship of *Liza aurata* (Risso, 1810), along the southern Caspian Sea. International J. Fisheries and Aquatic Studies, 2(1): 248-252.

Konides, A.; Anastasopoulou, K.; Photis, G.; Koussouris, T. and Diapoulis, A. (1992). Growth of four Mugilidae species in Western Greek lagoons. 27th European marine biology symposium. 7th -11th Sep., Ireland: Trinity College, Univ. Dublin.

Kraljevic, M.; Dulcic, J.; Pallaoro, A. and Matic-Skoko, S. (2011). Age and growth determination of the golden grey mullet, *Liza aurata* (Risso, 1810) from the Adriatic Sea by using scale readings and length frequency analysis. Acta Adriatica, 52(2): 223–234.

Kraljević, M. and Dulčić, J. (1996). "Age, growth and mortality of the golden grey mullet Liza aurata (Risso, 1810) in the eastern Adriatic." Arch. Fish. Mar. Res., 44:69-80.

Lee, R., (1920). A review of the methods of age and growth determination in fishes by means of scales. Fishery investigations, Series 2, Marine fisheries, Greet Britain Minist. Agric., Fisheries and Food, 4 (2).

Mehanna, S.F. (2004). Population dynamics of keeled mullet *Liza carinata* and golden grey mullet *Liza aurata* at the Bitter Lakes, Egypt. J. Aquat. Res., 30 (B): 315-321.

Mehanna, S.F. (2006). Lake Bardawil fisheries: current status and future sight. J. Egyp. Ger. Soc. Zool., 51(D): 91-105.

Mehanna, S.F.; Desouky, M.G. and Makkey, A.F. (2019). Some Targeted Reference Points for Thin Lip Grey Mullet Liza Ramada Management in Bardawil Lagoon, North Sinai, Egypt. Fish Aqua J. 10:263. doi: 10.35248/ 2150- 3508.19.10.263.

Modrusan, Z.; Teskeredzic, E. and Jukic, S. (1988). Biology and ecology of mugilidae species on the Eastern Adriatic coast (Sibenik Bay). In: FAO Fish. Rep. 394, Rome, 159-167.

Patterson, K. (1992). Fisheries for small pelagic species: an empirical approach to management targets. Rev. Fish Biol. Fish., 2 (4): 321–338.

Pauly, D. (1980). On the interrelationships between natural mortality, growth parameters, and mean environmental temperature in 175 fish stocks. J. Cons. Int. Explor. Mer., 39(2): 175-192.

Pauly, D. (1987). A review of the ELEFAN system for analysis of length-frequency data in fish and aquatic invertebrate. ICLARM Conf. Proa, 13:7-34.

Pauly, D. and Munro, J.L. (1984). Once more on the comparison of growth in fish and invertebrates. Fishbyte, 2(1): 21

Powell, D.G. (1979). Estimation of mortality and growth parameters from the length frequency of a catch. Rapp.P.-v.Réun.CIEM, 175:167-169.

Ricker, W.E. (1975). Computation and Interpretation of Biological Statistics of Fish Populations. Bulletin of the Fisheries Research Board of Canada, Bulletin 191, Information Canada, Ottawa.

Tesch, W. (1971). Age and growth. In: Ricker WE (eds), Methods for assessment of fish production in fresh waters. Edn 2, International Biological Program, Oxford and Edinburgh, 97-130.

Thong, L.H. (1969). "Contribution a I'' etude de la biologie des Mugilides (Poissons, Teleosteens) des cotes du massif armoricain." Trav. Fac. Sci. Rennes, Oceanogr. Biol., 2: 55-136.

Ursin, E. (1967). A mathematical model of some aspects of fish growth, respiration and mortality. J. Fish. Res. Bd. Can., 24: 2355-2453.

Von Bertalanffy, L. (1934). Undersuchungen uber die Geselzlichkeit des wachstums. 1. Allgemeine Grundlag der theorie. Wilherm Rouse. Arch. Entumech. Org., 131: 613-653.

Von Bertalanffy, L., (1938). A quantitative theory of organic growth (Inquiries on growth laws. II). Human Biology, 10(2): 181–213. Von Bertalanffy, L., 1938. A quantitative theory of organic growth (Inquiries on growth laws. II). Human Biology, 10(2): 181–213.

Walford, L.A., (1946). A new graphical method of describing the growth of animals. Biol. Bull. Mar. Biol., 90 (2): 141-147.

Wetherall, J.A.; Polovina, J.J. and Ralston, S. (1987). Estimating growth and mortality in steady-state fish stocks from length-frequency data. In: Length-based References 131 methodss in fisheries research (eds D. Pauly and G.R. Morgan). ICLARM Conf. Proc., 13: 53-74.

Zaghloul, F.A.; El Aiatt, A.A.; Hussien, N.R. (2018). Recent variability in the plankton structure of a natural hypersaline lagoon; Bardawil Lagoon in northern Sinai, Egypt. Asian J. Adv. Basic. Sci., 6(1): 58-68.

الملخص العربي

بعض الجوانب البيولوجية لأسماك الدهبان (*Liza aurata*) من بحيرة البردويل، مصر

تامر محمد مريزق[1]، جابر دسوقي إبراهيم[1]، محمد سالم أحمد[2]، عطية على عمر العياط[3]

1. قسم الثروة السمكية والأحياء المائية، كلية العلوم الزراعية البيئية، جامعة العريش، مصر.
2. كلية الاستزراع المائي والمصايد البحرية، جامعة العريش، مصر.
3. المعهد القومي لعلوم البحار والمصايد NIOF، فرع التلول، شمال سيناء، مصر.

تمت دراسة بعض الجوانب البيولوجية لأسماك الدهبان ببحيرة البردويل وذلك خلال الفترة من مايو 2017 إلى فبراير 2018 حيث تم جمع عدد 1329 عينة من مواقع الانزال المختلفة ودراسة العلاقة بين الطول والوزن، معامل الحالة، معدلات النمو ومعدلات النفوق. تراوحت اطوال العينات بين (12.2 إلى 33.6 سم)، الاوزان بين (13.8 إلى 340 جم). كانت العلاقة بين الطول والوزن مثالية وممثلة بالمعادلة ($W = 0.0071 * L^{3.053}$). تم تحديد العمر عن طريق قراءة القشور حيث كانت الفئات العمرية من 0 إلى 4 سنوات. تم حساب النمو في الطول والوزن في نهاية كل عام على أنها 17.08 و21.81 و25.1 و28.16 سم للسنة الأولى والثانية والثالثة والرابعة على التوالي. تم حساب معاملات النمو لمعادلة فون برتالانفي ($L\infty = 38.51$ سم، $K = 0.2421$ و$t_0 = -1.4222$). وتم حساب معدل أداء النمو ($\varphi' = 2.555$). كانت معدلات الوفيات 0.8865، 0.3543 و0.5322 للوفيات الكلية والطبيعية ونفوق الصيد على التوالي. سجل معدل الاستغلال الحالي $E = 0.60$. بلغ الطول عند بداية الصيد 19.5 (Lc) سم عند عمر (1.49 سنة). وتم استنتاج ان هناك العديد من المشاكل التي تواجه ادارة بحيرة البردويل من اهمها الصيد الجائر للعديد من انواع الاسماك، استخدام بعض حرف الصيد اغير القانونية، النقص الشديد في المعلومات عن حالة المصيد من الناحية البيولوجية والايكولوجية. لذا يجب وضع خطة تنمية شاملة لتطوير بحيرة البردويل للحفاظ على المخزونات السمكية وايضا الحث على استخدام حرف الصيد المطابقة للمواصفات القانونية ومعاقبة مستخدمي حرف الصيد غير القانونية.

الكلمات الاسترشادية: علاقة الطول بالوزن، الدهبان، النمو، بحيرة البردويل.

المحكمـــــون:

1- أ.د. محمـد محمـد السـيد المـر أستاذ بيولوجيا الأسماك والمصايد، كلية الزراعة، جامعة قناة السويس، مصر.

2- أ.د. كاريمان أحمد شوقي شالوف أستاذ بيولوجيا الأسماك، المعهد القومي لعلوم المحيطات ومصايد الأسماك، مصر.