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Age, growth and mortality of the Gilthead Seabream, *Sparus aurata* (Family: Sparidae) in Bardawill lagoon, North Sinai, Egypt

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ABSTRACT

Age, growth, and mortality of the Gilthead Seabream, *Sparus aurata* were studied from a small-scaled fishery of Bardawil lagoon, (North Sinai, Egypt).499 specimens of *Sparus aurata* varied from 9.7 to 29 cm with weights ranging between 16.6 and 325.3 g. were collected from October to April during fishing season 2020-2021. The relationship between length and weight was $W= 0.0239\ L^{2.8357}$ (R^2 = 0.9677) Age was determined by otoliths and age groups 0 to 5 years were observed. Growths in length and weight at the end of each year were calculated. The growth parameters of von Bertalanffy equation were calculated as (L_∞ = 39.38, K = 0.1615 year-1, t_0 = -2.31 $year^{-1}$ and W_∞= 798.5). Growth performance index was 2.40 for length and 1.14 for weight. Mortality rates were 0.794 $year^{-1}$; 0.23 $year^{-1}$ and 0.56 $year^{-1}$ for total, natural and fishing mortality, respectively. The currently exploitation rate (E) = 0.71.

Key words: Bardawil lagoon, gilthead seabream (*Sparus aurata*), Length &Weight relationship, Age, growth, and mortality

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INTRODUCTION

The gilthead seabream (*Sparus aurata* Linnaeus, 1758) is a perciform fish, belonging to the family Sparidae and to the genus Sparus. It inhabits the Atlantic coasts of Europe, Mediterranean and Black sea (rare). the Sparids fishes found predominantly and widespread throughout the Mediterranean Sea and Eastern Atlantic coast **(FAO,**

2005). It is one of the most intensively cultured species in fish farms in Mediterranean countriesdue to the quality of its meat **(Faggio *et al*., 2014).** it is one of the most important marine fish in fishery and aquaculture (especially in the Mediterranean area). The species is found in both marine and brackish water environments such as coastal lagoons and estuarine areas, in particular during the initial stages of its life cycle **(Moretti *et al*., 1999)**.

Gilthead Sea bream is commercially fished and farmed especially in Europe **(FAO, 2005 and Heather *et al*., 2018)**. Since, it is one of the most expensive; it is targeted for intensive fishing. Gilthead Sea bream, *Sparus aurata* mainly exploited in Bardawil lagoon by trammel and gillnets as well as hand line technique and is commonly shed in by catch of trawl fisheries **(Salem, 2011).**

Age, growth rates and other population biology of *Sparus aurata* have studied in several Mediterranean countries such as Croatia **(Kraljevic and Duleic, 1997)**; Algeria **(Chaoui, *et al*., 2006)**; Egypt **(Salem, 2010; Mehanna, 2007; Salem, 2011; Zaher *et al*., 2015)**.

Length-weight relationship (LWR) and condition factor are important to study the biology of a fish. It is one of the important morphometric characters that can be used for taxonomy and ultimately in fish stock assessment. This relationship might change over seasons or even days **(De Giosa *et al*., 2014)**. It is argued that b may change during different time periods illustrating the fullness of stomach, general condition of appetite and gonads stages **(Zaher *et al*., 2015)**.

Age and growth is a vital component for understanding the ecology and life history of any fish species. Knowledge of the individual growth rates and age is required to determine the success and degree of establishment as well as to predict the fish's impact on other fauna. Age and growth rate information can be used to compare dynamics among water bodies, years, and fish sizes; describe trends over time; examine total mortality rates; and determine the general status of a population. Age is one parameter necessary to assess population dynamics and the state of exploited resources **(Allain and Lorance, 2000)**.

The current work is the first attempt to assess *Sparus aurata* stock in Bardawil lagoon by identifies age groups estimate growth rate and growth parameters, estimate mortality and utilization rates, and aims to develop an appropriate management plan to maintain this.

MATERIALS AND METHODS

1. Study area:

Bardawil lagoon **(Fig. 1)** is an important source of local and economic fishes in North Sinai, and it 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, sole, grey mullet, eel, meager and white grouper **(GAFRD, 2012)**.

Fig. 1. Map of Bardawil lagoon

2. Sampling

Monthly, random samples of Gilthead sea bream, *Sparus aurata* were collected from the landing site at the Bardawil lagoon. Were collected from October to April during fishing seasons 2020-2021. The total length of 499 individuals of *S. aurata* from the tip of the snout to the end of the caudal fin was measured to nearest centimeter, total weight to the nearest 0.1 gram. Otoliths were removed, of 221 individuals cleaned and stored dry in labeled vials.

3. Data analysis:

By reading otoliths, the age was determined. Lengths by age were back-calculated using **Lee's (1920)** equation: Ln = (Sn/S) L, where: Ln = is length of fish at age "n ", Sn = is magnified otolith radius to "n "annulus, S = is magnified total otolith radius, L = is fish length at capture.

Length-weight relationship was computed using the formula of **Le Cren (1951)** ($W = a L^b$, where: a and b are constants whose values were estimated by the least square method).

Theoretical growth in length and weight was obtained by fitting the von Bertalanffy growth model, using the **(Ford, 1933; Walford, 1946)** method:

$L_t = L_\infty [(1 – e –k (t – t_0)]$, Where: L_t = the length at age t, L_∞ = the asymptotic length at t_∞, K = growth coefficient and t_0 = age at which the length is theoretically nil.

The calculation of constants of the Von Bertalanffy growth model by Ford – Walford method can be derived as follows: K = - Ln the slope = - Ln b, L_∞ = intercept / 1 – slope = a / 1 – b

$t_0 = t + 1 / k Ln (L_\infty - L_t)\backslash L_\infty$

The growth performance index (φ) was estimated as: $\varphi = \log K + 2 \log L_\infty$ **(Pauly and Munro, 1984)** where: K and L_∞ are parameters of von Bertalanffy.

Estimation of total mortality (Z) from a linearized catch curve based on age composition data Z= -b, Natural mortality coefficient (M): **Ursin formula (1967)**: M=W′-(1/3) Where: W′: is average weight of fish in the catch. Fishing mortality (F): It' was calculated as F=Z-M. Exploitation rate (E): was calculated after **(Gulland, 1971)** where E = F/Z.

RESULTS AND DISCUSSION

The length – weight relationship measurements of Sea bream, *S. aurata* collected from Bardawil lagoon.499 specimens of *S. aurata* varied from 9.7 to 29 cm with weights ranging between 16.6 and 325.3 g. were collected from October to April during fishing season 2020-2021. The equation thus derived in respect of length-weight relationship is as: Pooled: $W = 0.0239\ L^{2.8357}$ ($R^2 = 0.9677$) shown in **(fig. 2)**.

Table 1. Length frequency distribution of combined sexes of *S. aurata* (♂♀) collected from Bardawil lagoon.

Length group (cm)	Frq.	Obs.L	Obs.W
9-9.9	1	9.7	16.6
10-10.9	5	10.5	20.9
11-11.9	9	11.4	24.7
12-12.9	21	12.4	31.9
13-13.9	17	13.4	37.3
14-14.9	30	14.5	47.3
15-15.9	55	15.5	56.0
16-16.9	124	16.4	66.4
17-17.9	98	17.4	75.5
18-18.9	52	18.3	97.6
19-19.9	22	19.2	101.3
20-20.9	21	20.2	119.1
21-21.9	14	21.4	151.5
22-22.9	10	22.3	171.2
23-23.9	6	23.3	188.8
24-24.9	3	24.2	207.2
25-25.9	4	25.1	215.1
26-26.9	3	26.2	254.2
27-27.9	1	27.5	283.4
28-28.9	1	28.5	317.2
29-29.9	2	29.0	325.3
	499		

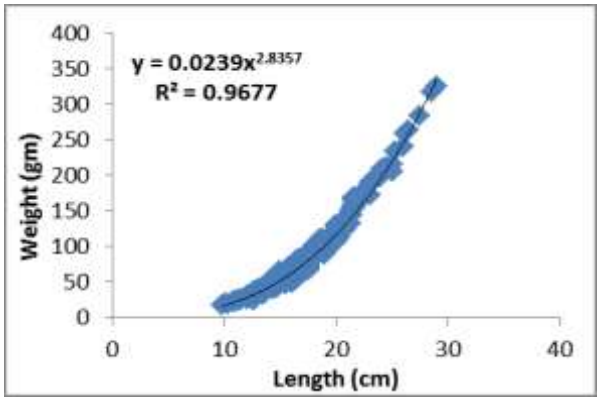

Fig. 2. Length-weight relationship of *S. aurata* (♂♀) collected from Bardawil lagoon during fishing season 20120-2021

The length & weight relationship equation for *S. aurata* showed a negative allometric in which b= 2.8357.These result agree with **Mourad, *et al*. (2008)** who found that, the value of (b) in the Gulf of Tunis exhibit negative allomatric growth (b=2.76). Also it agree with both **Salem (2010) and Mehanna *et al*. (2014)** they resulted that, the value of (b) in Bardawil lagoon, north Sinai, Egypt was 2.759 and 2.7984 respectively.

On other hand, this result disagrees with that of **Wassef (1978)** who found that, the value of (b) in Mediterranean Sea water, positive allometric growth (b>3) b= 3.2216. **ChaOui *et al*. (2006)** estimated the length-weight relationship for S. aurata in Mellah lagoon (north-eastern Algeria) where the value of (b) was 3.06. Also, **Hadj-Taieb *et al*. (2013)** the relationship equation showed a positive allometric in which b= 3.0799 in Tunisia. **(Ozaydin and Taskavak, 2006)** in Spain the value of b=3.164.

The relationship between body length and weight can be change with many condition factors as season, sex, quality and quantity of food, maturity stage and techniques of sampling **(Le Cren, 1951)**.

The age composition of *S. aurata* in Bardawil lagoon during season 2020 -2021 was determined by the annual rings of otolith of 221specimens. Five age groups plus age group zero were observed with percentage of fishes of each age group are shown in **Table (2)**.

These tables show that age group I is dominate in sexes combined and contributing 37.9 %, Frequencies of fish age group V are low 1.1% for sexes combined from *S. aurata* in Bardawil lagoon. **Table (2)** also clear that the frequency of fishes increases gradually from age – group 0 ((less than one year) to reach its maximum in age-group I for combined sexes and then decreases with increase of age.

Table 2. Age composition of *S. aurata* collected from Bardawil lagoon during season, 2020-2021

Age group	**Sexes combined**	
	number	**%**
age0	97	36.1
age1	102	37.9
age2	10	3.7
age3	5	1.9
age4	4	1.5
age5	3	1.1
SUM	221	

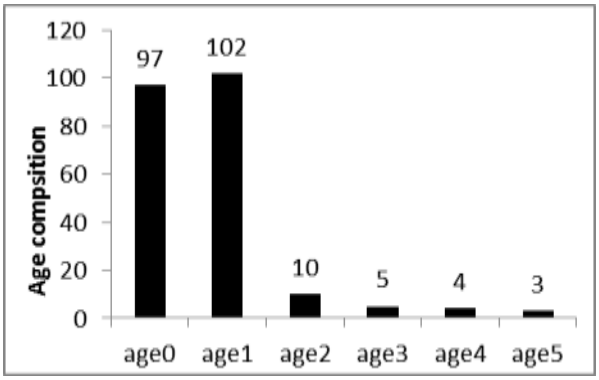

Fig. 3. Age composition of combined sexes of *S. aurata* collected from Bardawil lagoon during season, 2020-2021

This result disagrees with **Khalifa (1995)** he estimated age (6 years) for *S. aurata* in Bardawil Lagoon. On other hand, this result

disagrees with **Al-Zahaby *et al.* (2018)** who found that, the catch of *S. aurata* is composed of four age groups plus age group zero.

The average back-calculated lengths of *S. aurata* are given in **Table (3)** as were 16.31, 19.77, 22.62, 25.20 and 27.28 cm and increment in length of age as were 16.31, 3.46, 2.85, 2.59 and 2.08 for the 1st, 2nd, 3rd ,4th and 5year of life, respectively. The highest annual increment occurred during the first year of life, while a noticeable decrease was observed in the second year, reaching to minimal value during the Fifth year of life **(Fig. 4).**

Table 3. Back – calculation length at the end of different life years of, combined *S. aurata* collected from Bardawil lagoon

Age	No. of fish	Observed length (cm)	Observed weight (gm.)	Average back calculated lengths at the end of each year (cm)				
				I	II	III	IV	V
Males (♂)								
0	97	13.6	42.2					
I	102	17.5	83.8	**16.31**				
II	10	20.9	141.0	17.99	**19.77**			
III	5	23.4	193.8	19.91	21.50	**22.62**		
IV	4	25.9	242.1	21.19	22.89	24.20	**25.20**	
V	3	28.3	308.6	22.04	23.72	25.08	26.34	**27.28**
			Increment	**16.31**	**3.46**	**2.85**	**2.59**	**2.08**

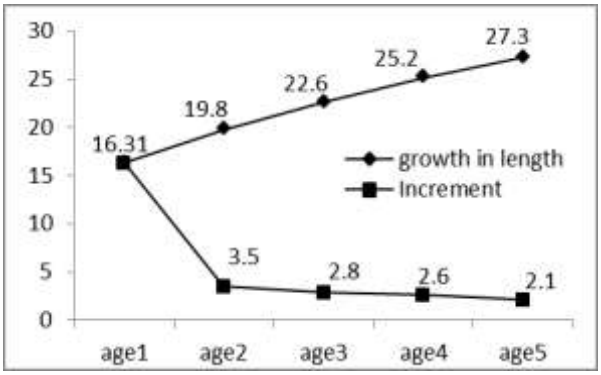

Fig . 4. Growth and annual increment in length (♀♂) of *S. aurata* collected from Bardawil lagoon.

This result disagrees with **Salem (2011)** in Bardawil lagoon, he found that, average back – calculation lengths for *S. aurata* were 23.38, 27.51, 30.21 and 32.15 cm for ages 1st, 2nd, 3rd and 4th years respectively. Also, **Mosbh (2013)** resulted that the back-calculated for *S. aurata* in Bardawil lagoon as 17.74, 23.25, 27.6, 31.44, 32.85 and 34.19cm for ages 1st, 2nd, 3rd , 4th, 5 and 6 years respectively.

Mehanna *et al*. (2014) found that the mean lengths at age were back-calculated for *S. aurata* in Bardawil lagoon as 17.5, 23.5, 27.3 and 30.1 cm TL the 1st, 2nd, 3rd and 4th year of life respectively.

The average back-calculated weight for combined sexes of *S. aurata* are given in **Table (4)** as were 65.49, 113.03, 165.60, 225.21 and 281.97g at the end of first, second, third, fourth and Fifth years of life respectively in fishing season 2020-2021 in Bardawil lagoon**.** The results in these tables showed that the weight increased successively and reached its maximum at group V up to 281.97gm**.**

Table 4. Calculated weight at the end of different years of life (♂♀) *S. aurata* Collected from Bardawil lagoon

Age	No. of fish	Observed length (cm)	back calculated length(cm)	Average back calculated weights at the end of each year (cm)				
				I	II	III	IV	V
Males (♂)								
0	97	13.6	42.2					
I	102	17.5	83.8	**65.49**				
II	10	20.9	141.0	86.51	**113.03**			
III	5	23.4	193.8	115.31	143.40	**165.60**		
IV	4	25.9	242.1	137.66	171.32	200.69	**225.21**	
V	3	28.3	308.6	153.87	189.49	222.06	255.16	**281.97**
			Increment	65.49	47.54	52.57	59.60	56.76

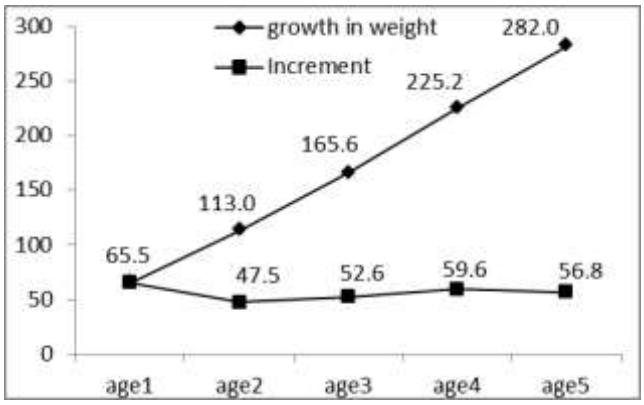

Fig. 5. Calculated weight at the end of different years of life (♀♂) of *S. aurata* collected from Bardawil lagoon.

In this study the growth parameters of von Bertalanffy for gilthead seabream, *Sparus aurata* were as follow; L_∞ = 39.38, K = 0.1615 year$^{-1,}$ t_0 = -2.31 year^{-1} and W_∞= 798.5.

. **Kraljevi and Dul (1997)** determined the Von Bertlanffy parameters for *S. aurata* in northern Adriatic, where L_∞= 59.8 cm; K= 0.15 year^{-1}; t_0= -1.71 year^{-1} and W_∞= 5554 g. **Tharwat *et al.* (1998)** mentioned that, In the Bardawil Lagoon The growth parameters of von Bertalanffy for *S. aurata* L_∞= 38.5 cm, K = 0.297 year^{-1}, t_o= -1.085 year^{-1} and W_∞= 796.3. In Bardawil lagoon **Mehanna *et al.* (2014)** growth parameters where found as L_∞, K and W_∞ was 35.5 cm, 0.4 per year and 531g respectively. While, **Al-Zahaby *et al.* (2018)** resulted that, K = 0.370 year-1, L_∞= 39.17cm, t_o= -0.650 year^{-1} and W_∞ = 898 gm. **Mcllwain *et al.* (2005)** mentioned that the differences in growth parameters were due to age, sex, maturity and sampling period for the same species.

The obtained results indicated that the growth performance index of *S.aurata* was 2.40 for length and 1.14 for weight. **Mehanna *et al.* (2014)** estimated (φ) for the same species in Bardawil lagoon was computed as 2.7.while **Salem (2010) and Salem (2011)** where they recorded that, that the growth performance index of *S.aurata* in Bardawil lagoon 6.33, 6.22 respectively. Thus, it could be reported that the environmental condition of Bardawil lagoon is retreat for the growth of *S.aurata* under study.

Such differences may be attributed partially from the different techniques used, but more likely reflect slight environmental differences such as food availability, Salinity and temperature **(El -Ganainy and Ahmed, 2002)**.

The total mortality (Z) was calculated for *S.aurata a* was 0.794 year^{-1} **(Fig. 6)**, the natural mortality coefficient (M) was 0.23 year^{-1}, fishing mortality (F) was 0.56 and Exploitation rate (E) was 0.71.

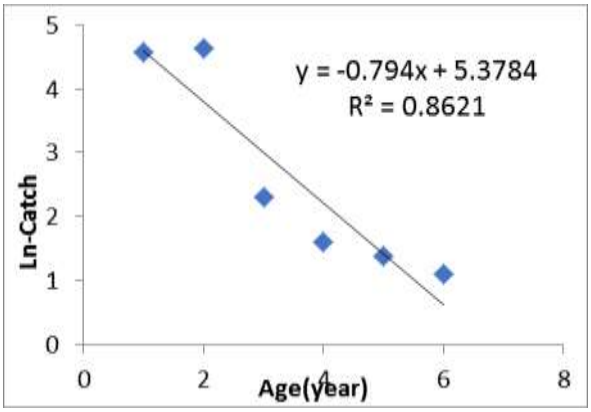

Fig. 6. (Z) from a linearized catch of combined sexes of *S. aurata* in Bardawil lagoon.

The present results disagree with the results obtained by **Salem (2011)** the total mortality coefficient Z for the same species in Bardawil lagoon was 1.02 year^{-1}, natural mortality was 0.21 year^{-1}, while the fishing mortality was 0.81 year^{-1}.

The value of exploitation ratio (E): According to **Gulland (1971)** when the exploitation ratio is more than 0.5, this means overexploitation of the fish population. The value of exploitation ratio (E) for gilthead seabream in the Bardawil Lagoon was 0.71. This means that the *S. aurata* population in the Bardawil Lagoon suffers from overfishing. This is in consistence with results of **Tharwat *et al.* (1998)**, estimated the total exploitation ratio (E = 0.57); **Salman (2011)** found that, the exploitation rate (E) in the Bardawil lagoon, Egypt E= 79.43 %. And **Al-Zahaby (2018)** pointed out, the exploitation rate for the same species (E) = 0.637.

REFERENCES

Allain, V. and Lorance, P., 2000. Age estimation and growth of some deep sea fish from the northeast Atlantic ocean. Cybium, 24(3), 7-16.

Al-Zahaby, A.S.; El-drawany, M.A.; Mahmoud, H.H. and Abdalla, M.A.F., 2018. Some biological aspects and population dynamics of the gilthead sea bream from Bardawil lagoon, Sinai, Egypt. Egyptian Journal of Aquatic Biology. Vol. 22(5): 295-308.

Chaoui, L., Hichem kara, M. and J. Quignnard, 2006. Growth and reproduction of the gilthead seabream *Sparus aurata* in Mellah lagoon (north-eastern Algeria), SCIENTIA MARINA 70 (3) September, 545-552, Barcelona (Spain) ISSN: 0214-8358.

De Giosa; M; P. Czerniejewski; Rybczyk, A., 2014. Seasonal changes in condition factor and weight-length relationship of invasive carassius gibelio (Bloch, 1782) from Leszczynskie Lakeland, Poland. Adv. Zool.

El-Ganainy, A. A. and A. I. Ahmed, 2002. Growth, mortality and yield -per- recruit of the rabbitfish, *Siganus rivulatus*, from the eastern sid of the gulf of Suez, Sinai Coast, Red Sea. Egypt. J. Aquat. Biol. & Fish., 6 (1): 67-81.

Faggio, C., Piccione, G., Marafioti, S., Arfuso, F., Fortino, G., and Fazio F., 2014. Metabolic response to monthly Variations of *Sparus aurata* Reared in Mediterranean On-Shore Tanks. Turkish Journal of Fisheries and Aquatic Sciences 14: 567-574.

FAO, 2005. Cultured Aquatic Species Information Programme. *Sparus aurata*. Text by Colloca, F.; Cerasi, S. In: FAO Fisheries and Aquaculture Department [online].

Ford, E., 1933. An account of the herring investigation conducted at Plymouth. J. Marin. Biol. Ass. U.K., Vol. 19: 305 – 384p.

GAFRD, 2012. Report of General Authority for Fish Resources Development on Bardawil lagoon.

Gulland, J. A., 1971. The fish resources of the Oceans. Fishing News Books Ltd., England. 255p.

Hadj-Taieb, A.; Ghorbel, M.; Ben Hadj-Hamida, N. and Jarboui, O., 2013. Sex ratio, reproduction, and growth of the gilthead sea bream, Sparus aurata (Pisces: Sparidae), in the Gulf of Gabes, Tunisia. Ciencias Marinas, 39(1): 101–112.

Heather, F.J.; Childs, D.Z.; Darnaude, A.M. and Blanchard, J.L., 2018. Using an integral projection model to assess the effect of temperature on the growth of gilthead seabream, Sparus aurata. PLoS ONE 13(5):1-9.

Khalifa, U.S., 1995. Biological studies on gilthead bream, *Sparus aurata* Linn (Pisces: Sparidae) in lake Bardawil. M. Sc. Thesis, Fac. Sci., Cairo Univ., 361pp.

Kraljevic, M. and J. Duleic, 1997. Age and growth of gilthead sea bream *Sparus aurata* in the Mirna Estuary, Northern Adriatic. Fish Res., 31: 249-255.

Le Cren, E. D., 1951. The length-weight relationship and seasonal cycle in gonad weight and condition in the Perch (Perca fluviatilis). J. Anim. Ecol., 20: 201-219.

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 Ministry of Agriculture, Fisheries and food 4 (2).

Mcllwain, J. L.; M.R. Claereboudt; H.S. AL-Oufi; S. Zaki and G.S. Goddard, 2005. Spatial variation in age and growth of the Kingfish (Scomberomorus commerson) in the coastal waters of the Sultanate of Oman. Fish. Res., 73: 283 – 298.

Mehanna, S. F.; I. M. Shaker and A. Farouk, 2014. Population dynamics of gilthead seabream *Sparus aurata* in the Bardawil lagoon, North Sinai, Egypt. 4th scientific conference "Fisheries resources between science and application", Abbasa, 11-13.

Moretti, A., M.P. Fernandez-Criado, G. Cittolin and R. Guidastri, 1999. Manual on Hatchery Production of Seabass and Gilthead seabream. Vol. 2, Food and Agriculture Organization of United Nations, Rome, Itlay, pp: 152.

Mosbh, M.M., 2013. Studies on the effect o some environmental factors on ish production in Bardawil lagoon. North Sinai, Egypt. MSc. Thesis, Fac. Agri. Al-Azhar University.

Mourad, C.; Rafik, Z.; Houcine, G.; Hechmi, M; Othman, J., 2008. Length-weight relationships for 11 fish species from the Gulf of Tunis (SW Mediterranean Sea, Tunisia).Pan-American Journal of Aquatic Sciences, 3 (1): 1-5.

Ozaydin, O. and Taskavak, E., 2006. Length-weight relationships for 47 fish species from Izmir Bay (eastern Aegean Sea, Turkey) ACTA ADRIAT., 47(2): 211–216.

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

Salem, M., 2010. Age, growth and population biology of gilthead sea bream *Sparus aurata* from Bardawil lagoon, North Sinai, Egypt. The 3rd Global Fisheries & Aquaculture Research Conference .Nov., 29 – 1 Dec. 2010.Egypt.

Salem, M., 2011. Population dynamics and fisheries management of Gilthead sea bream, *Sparus aurata* (f. Sparidae) from Bardawil lagoon, North Sinai, Egypt. Egypt J. Aquat. Biol. & Fish., Vol.15, No.1: 57- 69 :1110 –1131.

Tharwat, A. A.; Emam, W. M. and Ameran, M. A. A., 1998. Stock assessment of the gilthead seabream, *Sparus aurata*, from Bardawil lagoon, North Sinai. Egypt. J. Aquat. Biol. and Fish., 2 (4): 483-504.

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., 1949. Problems of organic growth. Nature, 163: 156 – 158.

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

Wassef, E. 1978. Biological and physiological studies on marine and acclimatized fish Chrysophrys auratus. PhD. thesis. Cairo: Fac. Sci. Cairo Univ. 225 pp.

Zaher, F. M.; Rahman, B. M. S.; Rahman, A.; Alam, M. A.; Pramanik, M. H., 2015. Length-weight relationship and GSI of hilsa, Tenualosa ilisha (hamilton, 1822) fishes in Meghna river,