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SOME BIOLOGICAL PARAMETERS OF THE COMMON SOLE; *SOLEA SOLEA* FROM THE BARDAWIL LAGOON EGYPT

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ABSTRACT

Due to the economic importance of Common sole, *S. solea*, and the importance of fish biological measurements in managing the fisheries of Bardawil Lake, the study was conducted on Common sole *S. solea*, during the fishing season 2019. The most important measurements: The length – weight relationship of *solea solea* described by the power equation $W= 0.0091L^{3.0104}$, $W= 0.0059 L^{3.1495}$ and $W= 0.0067 L^{3.1056}$ for males, females and combined sexes respectively The back-calculated length of combined sexes of solea soleasexes17.8, 22.2, 25.7 and 27.9 cm for1st, 2nd, 3rd and 4th years of life respectively. Growth parameters of the common sole *Solea solea* from Bardawil lagoon as L∞ = 33.76cm; K= 0.55 year−1 and t0 = -1.24 years for combined sexes, L∞ = 37.57 cm; K= 0.2356year−1, t0 = -1.79 years for females and L∞ =30.96 cm; K= 0.49 year−1 and t0 = -0.68 years for males during fishing seasons (2019). The total, natural and fishing mortalities were 0.8356, 0.3201 and 0.5155 year−1 respectively for males, 0.8342, 0.2170 and 0.6172 year−1 respectively for females and 0.8342, 0.2768 and 0.5574year−1 respectively for sexes combined. Correspondingly, the exploitation ratio was E = 0.62, 0.74 and 0.67/y for males, females and sexes combined respectively. The estimated length at first capture Lc was 18.4, 20.3 and 19.8 cm for males, females, combined sexes, respectively while these results reflect the high level of the exploitation of *S. solea*, and The study recommends the need to expedite taking the necessary steps to preserve the catch of Common sole *S. solea* fish and urgent management regulations to conserve this fish.

Keywords: Common sole *S. solea*, Bardawil lagoon, length – weight relationship, Mortality rates.

INTRODUCTION

Common sole; *S. solea*, which locally known as Mousa is one of the most important commercial fish species in Bardawil lagoon. Despite the great importance of *soleid species* to the economy of the Egyptian fisheries, some authors studded Common sole *S. solea* in Bardawill lagoon as (Mehanna *et al*., 2010; Mehanna and Salem, 2012 and EL Aiatt *et al*., 2019). Mosaad and El-Sayed (1991b) studied the female reproductive cycle of Solea vulgaris from the North-Western part of the Red Sea. El-Gammal *et al*. (1994) estimated the mortality and yield per recruit of *S. solea* from Lake Bardawil.The population parameters of the common sole in the Egyptian waters are sparsely studied specially in Alexandria region (El-Gammal *et al*., 1994; Mehanna and Salem, 2012; Salman, 2014; Mehanna, 2014 and Mehanna *et al*., 2011& 2015).

El-Gharabawy (1977) studied the taxonomy of soles in Egyptian Mediterranean waters. Kerolus (1977) studied the meristic characters and used the vertebrae in age determination of *Solea vulgaris* in Lake Qarun. Zaki and Hamza (1986) studied the reproductive biology and induced spawning of *Solea solea* in Egypt. Mosaad and El-Sayed (1991b) studied the female reproductive cycle of *Solea vulgaris* from the North-Western part of the Red Sea. Mehanna (2007) studied the rational exploitation and management of *Solea aegyptiaca* stock in the southeastern Mediterranean (Port Said region, Egypt). Soles (*Solea spp. and Pegusa spp*.) are common in the Mediterranean Sea, the Black Sea and along the Eastern Atlantic coasts from Great Britain to Senegal. These species are found in marine to slightly brackish environments such as coastal lagoons and estuarine areas. Mehanna *et al*. (2010) studied the population dynamics and management of *Solea aegyptiaca* stock in Bardawil lagoon

The relation between body weight and length is a simple but essential in a fishery management (Chien- Chung, 1999). This relation represents one of the most studied biological characters of fish biology. It is known that weight of a fish increases as a function of its length. Length-weight relationship is an essential biological parameter needed to appreciate the suitability of the environment for any fish (Moussa, 2003). Length–weight relationships for fish used extensively to provide information on the condition of fish, their isometric or allometric growth, in the analysis of on to genic changes, to compare life histories of fish species between regions as well as other aspects of fish population dynamics. In fisheries biology, length–weight relationships are 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; Koutrakis and Tsikliras, 2003 and Ecoutin *et al*., 2005).

The objective of the present study was to determining some biological parameters as length-weight relationship, age, total mortality, natural mortality, fishing mortality, exploitation rate and yield per recruit of the common sole, *Solea solea* in Bardawil lagoon as basic parameters for its management.

MATERIALS AND METHODS

Bardawil Lagoon is a shallow, hyper saline lagoon, located in the north of Sinai southern east the Mediterranean Sea Its coordinate is about 31^o 10́ N 33^o 12́ E.It extends for about 80 km with a maximum width 20 km and a maximum depth of 3 m (Fig. 1) (EL Aiatt *et al*., 2019) .

Fig. 1: Bardawil lagoon.

Sole samples collected monthly from local fish market of Bir al-Abed city, North Sinai Egypt during fishing season 2019. The sole catch sorted into species and for *S. solea*; each fish measured to the nearest mm for total length and weighed to the nearest 0.1-gram total weight, and individuals dissected to determine the sex from visual traits of the gonads .

Otoliths extracted from each specimen, cleaned and stored for age determination. Distance between the focus and the successive annuli measured to the nearest 0.001 mm. The relationship between otolith radius of the otolith (S) and total fish length (TL) was determined by least square method where TL = a + b (S). The value of intercept (a) used as a correction factor for back-calculated lengths at the end of each year of life from otolith measurements by Lee's equation as follows: Ln = (Lt – a) Sn/S + a (Lee, 1920) where a intercept of regression line with the Y- axis.

The relationship between total length and body weight of the sole specimens expressed by the following equation: $W = a L^b$ (Beckman, 1948 and Le Cren, 1951), where W = total weight, L = length, and (a, b) = constants whose values estimated by the least square method. The growth performance index (ø) was estimated using Pauly and Munro, (1984) formula as ø = Log K + 2 Log L∞.

The length at recruitment (Lr) was determined as the smallest sole specimen in the catch. The length at first capture (Lc); the length at which 50% of the common sole retained in the gear estimated by the analysis of catch curve using the method of (Pauly, 1984). Length at first sexual maturity

Total mortality coefficient (Z) estimated as the geometric mean of three different methods; 1-Chapman and Robson (1960) as Z= -Ln S). 2- Beverton and Holt (1957) based on length data as $Z=K*((L\infty-\bar{Lc})/(\bar{Lc}-Lc))$ Where Lc The length of the fish at 50% of the catch of the catch , $\bar{Lc}$ Average fish in catches of 50% even bigger fish in the sample. 3-Estimation of Z from a linearized catch curve based on age composition data as Z=-b.

The natural mortality coefficient (M) was estimated as the geometric mean of the methods; Tanaka (1960) $M=2.5/T_{max}$, Ursin (1967) $M=W'^{(-1/3)}$ and Frisk *et al*. (2001) $M \approx 0.436*K^{0.42}$. The fishing mortality coefficient estimated by subtracting the value of natural mortality coefficient from the value of total mortality coefficient as follows:

F = Z – M and the exploitation ratio estimated by the formula suggested by Gulland (1971) as E= F/Z.

Gulland, 1969 model as, estimated yield per recruit (Y/R):

$$Y/R = F\, e^{-M\,(tc-tr)}\, W\infty\, [(1/Z) - (3S/Z + K) + (3S2/\, Z + 2K) - (S3/\, Z + 3K).$$

Biomass per recruit (B/R) was obtained by (Beverton and Holt, 1957) equation as B/R = Y/R / F where "F" is the fishing mortality. Biological reference points "BRP", "F_{max}" and "F0.1" obtained according to (Cadima, 2003). The effects of age and length at first capture on yield per recruit at the present value of fishing mortality and at different fishing mortality values were calculated using (Gulland, 1969) model.

RESULTS

A total of 2205 specimens of Common sole, *Solea solea* were obtained from the Bardawil Lagoon from May to December, 2019 (Fig. 2). Total length ranged from 13 to 29.9 cm and the observed total weight from 21 to 279 g. Length frequency of *S. solea* (Figure 3) showed that the length group (18-18.9 cm) was the most frequent, since it constitute 17.0% of the catch, whereas the length group (13-13.9 cm) were lowest since it represented 0.2% in the catch.

Fig. 2: Image of Common sole, *Solea solea*, from Bardawil Lagoon, 2019.

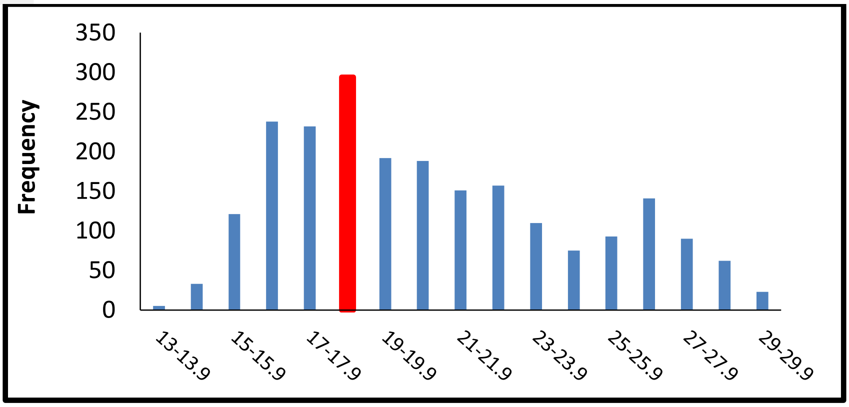

Fig. 3: Length frequency distribution of *S. solea* in Bardawil lagoon season, 2019.

Length-weight relationships:

2205 specimens of *S. solea* obtained from the commercial catch of Bardawil Lagoon from May 2019 to December 2019. The fish total length ranged from 13 to 29.9 cm and the observed total weight ranged from 21 to 279 g. The length – weight relationship described by the power equation as:

W= 0.0091L $^{3.0104}$ (R2 = 0.9425) for males.

W= 0.0059 L $^{3.1495}$ (R2 = 0.939) for females.

W= 0.0067 L $^{3.1056}$ (R2 = 0.9367) for combined sexes (Fig. 4).

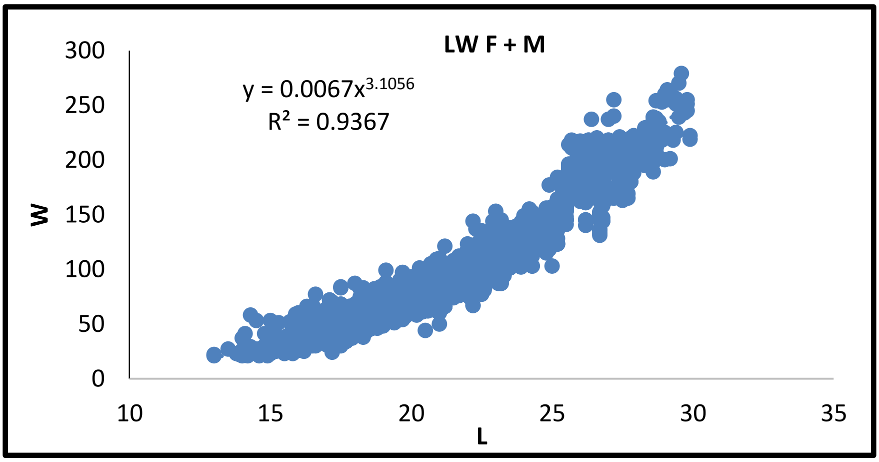

Fig. 4: Length weight relationship of combined sexes of *S.sole* in Bardawil lagoon 2019.

The back-calculated length at the end of each year of life for males, females and combined sexes of *S. solea* were for males 17.4, 22.2, 26.6 and 27. g for 1st, 2nd, 3rd and 4th year of life respectively, while those for females are18.1, 22.3, 25.3 and 28.0 cm for1st, 2nd, 3rd and 4th years of life respectively and for combined sexes17.8, 22.2, 25.7 and 27.9 cm for[1]st, [2]nd, [3]rd and [4]th years of life, respectively (Fig. 5).

Back-calculated weight at the end of each year of life for males, females and combined sexes of *S. solea* for males 49.3, 102.4, 177.4 and 201.7 g for 1st, 2nd, 3rd and 4th year of life, respectively. For females 53.8, 103.3, 154.7 and 212.4 g for1st, 2nd, 3rd and 4th year of life respectively and for combined sexes 51.2,102.0,161.1 and 206.5 cm for1st, 2nd, 3rd and 4th years of life respectively (Fig. 6).

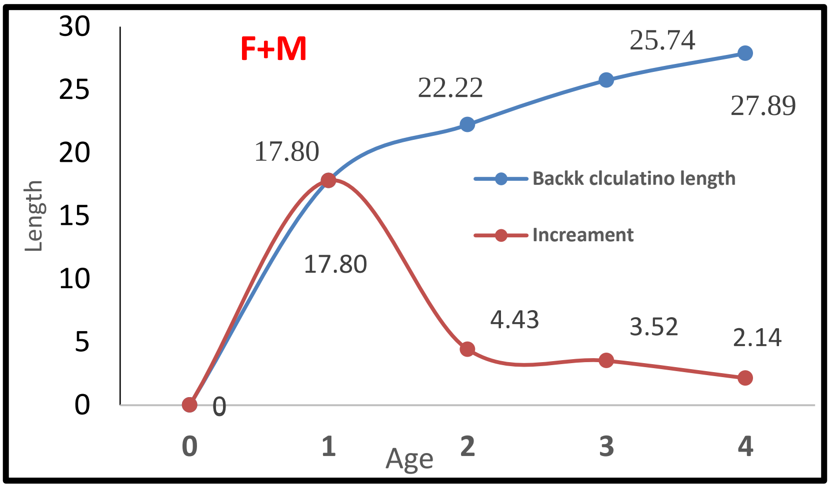

Fig. 5: Back calculation length of combined sexes of *S. solea* in Bardawil lagoon 2019.

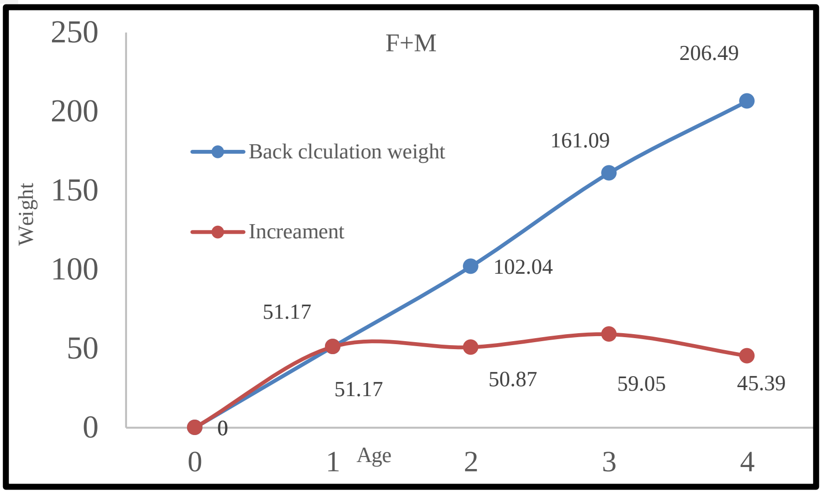

Fig. 6: Back calculation weight (Tw g) of combined sexes of *S. solea* in Bardawil lagoon 2019.

Theoretical growth in length and weight of *S. solea* in Bardawil lagoon by Von Bertalanffy (1938) growth equation for length and weight and fitting the Ford (1933) and Walford (1946) plot (table 1). Constants of Von Bertalanffy's growth equation (L∞, K, t_o and W∞) by using Ford (1933) and Walford (1946) method was (L33.67 cm ,k-1 0.3368 , T0 -1.2404 and W 373.99 g) .

Table 1: Theoretical growth in length and weight of *S. solea* in Bardawil lagoon 2019.

Males	**length**	$Lt = 30.96\ (1 - e^{-0.49\ (t + 1.994)})$
Females		$Lt = 37.57\ (1 - e^{-0.2356\ (t + 1.7853)})$
Combined sexes		$Lt = 33.76\ (1 - e^{-.3342(t + 1.2404)})$
Males.	**weight**	$Wt = 279.78\ [(1 - e^{-.49\ (t + 0.6754)})]^{3.0104}$
Females		$Wt = 538.16\ [(1 - e^{-0.2356\ (t + 1.7853)})]^{3.1495}$
Combined sexes		$Wt = 373.99\ [(1 - e^{-0.3342\ (t + 1.2404)})]^{3.1056}$

Growth performance index (φ) as defined by computed for *S. solea* in Bardawil lagoon, found to be 2.6738, 2.5219 and 2.5809 for length for males, females, and combined sexes respectively.

Length (Lr) at recruitment it is the smallest total length in the length frequency distribution of *S. solea* from Bardawil lagoon was 14, 15 and 13cm for males, females and combined sexes respectively. These lengths considered as the estimates of the length at recruitment. Length (Lc) at first capture. The length at first capture (the length at which 50% of the fish at that size are vulnerable to capture) was estimated from the catch curve of Pauly (1984). The resultant curve derived from the catch curve provided an estimate of Lc at 18.4, 20.3 and 19.8 cm for males, females and combined sexes, respectively (Fig. 7).

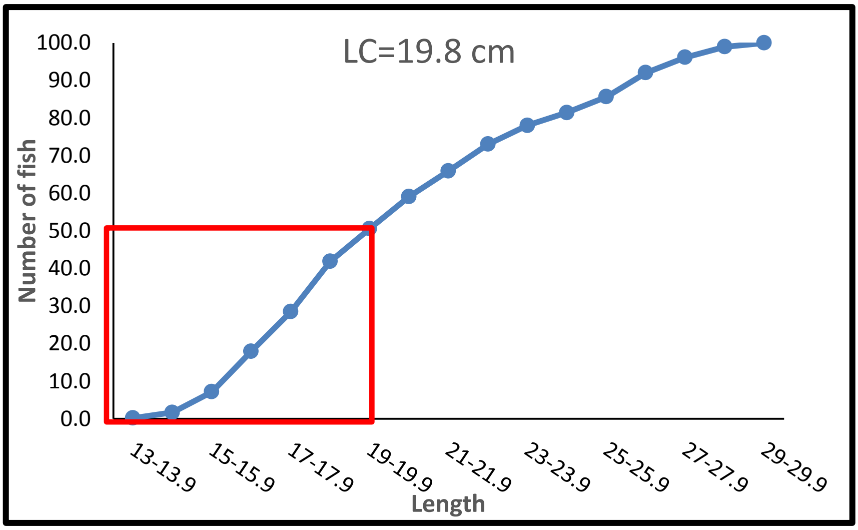

Fig. 7: Lc of *S. solea* in Bardawil lagoon season 2019.

Results the relationship between length and age showed that the longitudinal group from 18-18.9 cm was the most abundant 17% of the total production,. In addition, the first age was the most abundant in the catch 38.1%, followed by the second age 32.2%, followed by a group less than one year old and then the third and finally the fourth age 15.0, 11.2 and 3.5%, respectively Table (2).

The total mortality coefficient Z estimated using three different methods and the results summarized in Table (3), natural mortality (M) estimated using three different methods, and the results summarized in Table (3). Fishing mortality F for *S. solea* estimated by different between total mortality and natural mortality. Exploitation rate (E) was estimated as E=F/Z = 0.62, 0.74 and 0.67 for males, females and combined sexes respectively.

Table 2: Age - length key for *S. solea* in Bardawil lagoon during season 2019.

L. groups	Age classes					Total	Pi
	0	1	2	3	4		
14-14.9	16					16	1.5
15-15.9	37					37	3.5
16-16.9	62					62	5.8
17-17.9	44	117				161	15.0
18-18.9	2	154	26			182	17.0
19-19.9		83	20			103	9.6
20-20.9		33	32			65	6.1
21-21.9		0	54			54	5.0
22-22.		21	44			65	6.1
23-23.9			53			53	4.9
24-24.9			37			37	3.5
25-25.9			22	17		39	3.6
26-26.9			50	36		86	8.0
27-27.9			7	36	17	60	5.6
28-28.9				29	9	38	3.5
29-29.9				2	11	13	1.2
total	161	408	345	120	37		
%	15.0	38.1	32.2	11.2	3.5		

Table 3: Z, M, F and E estimation from different methods for *S. solea* Bardawil lagoon.

Parameter	Method	Males	Females	Combined sexes
Total mortality Z	Chapman and Robson (1960)	0.8618	0.8181	0.8355
	Beverton and Holt 1957	0.7956	0.6549	0.8414
	catch curve	0.8493	0.8115	0.8257
	Average	0.8356	0.8342	0.8342
Natural mortality M	Ursin (1967	0.22629	0.2124	0.2224
	Frisk *et al.* (2001)	0.32377	0.2376	0.2752
	Tanaka 1960	0.71028	0.1963	0.2785
	Average	0.3201	0.2170	0.2768
Fishing mortality F		0.5155	0.6172	0.5574
Exploitation rate E		0.62	0.74	0.67

The yield per recruit (Y/R) and biomass per recruit (B/R) were found to be 66.0 gm and 66.7 gm at the actual fishing mortality 0.5574 and 0.75 year-1 respectively. Biomass per recruit was decreased with the increasing of fishing mortality where it maximum (557.2 gm) at F= 0.0 (Fig. 8).

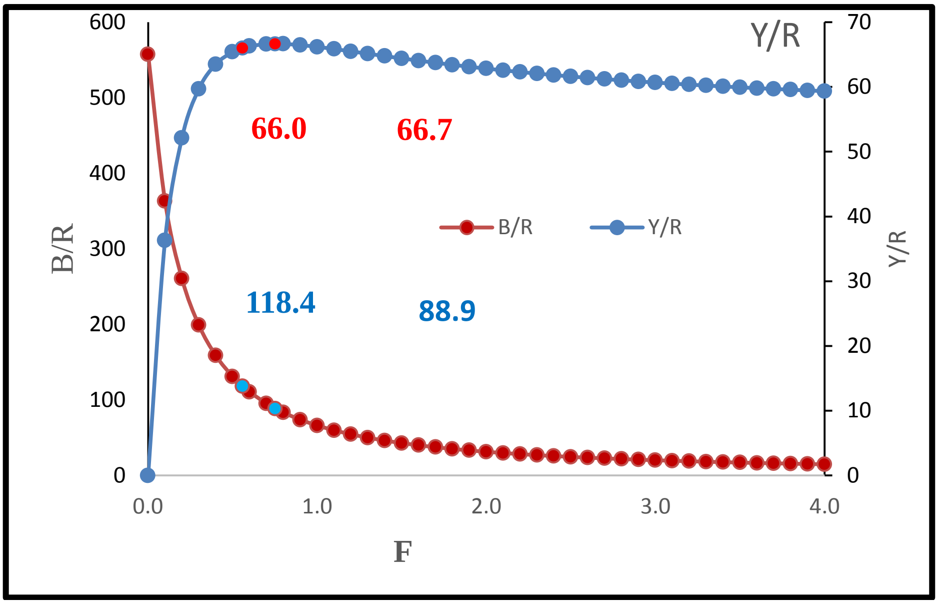

Fig. 8: Y/R and B/R of *S. solea* in Bardawil lagoon during season 2019.

The yield per recruit (Y/R) of *S. solea* from Bardawil lagoon during season 2019 increasing with the increasing of age at first capture (Tc) or of length at first capture (Lc) with stability fishing mortality to Lc= 23. cm or Tc = 2.2 years and following decreasing of yield per recruitment (Y/R)(Table 4).

Table 4: Relationship between yield per recruit (Y/R), age at first capture (Tc) and length at first capture (Lc) of *S. solea* in Bardawil lagoon during season 2019.

LC	TC	Y/R
13.0	0.2	51.7
13.5	0.3	53.0
14.0	0.4	54.2
14.5	0.4	55.4
15.0	0.5	56.5
15.5	0.6	57.7
16.0	0.7	58.8
16.5	0.8	59.9
17.0	0.9	61.0
17.5	0.9	62.0
18.0	1.0	63.0
18.5	1.1	63.9
19.0	1.2	64.8
19.5	1.3	65.6
19.8	1.4	66.0
20.0	1.4	66.3
20.5	1.6	66.9
21.0	1.7	67.4
21.5	1.8	67.8
22.0	1.9	68.2
22.5	2.0	68.3
23.0	**2.2**	**68.4**
23.5	2.3	68.3
24.0	2.5	68.1
24.5	2.6	67.7
25.0	2.8	67.1
25.5	3.0	66.3
26.0	3.2	65.3
26.5	3.4	64.0
27.0	3.6	62.6
27.5	3.8	60.8
28.0	4.0	58.8
28.5	4.3	56.5
29.0	4.6	53.9

DISCUSSION

In the present work, the length – weight relationship isometric growth and described by the power equation: $W= 0.0091\ L^{3.0104}$, $W= 0.0059\ L^{3.1495}$ and $W= 0.0067\ L^{3.1056}$ for males, females and combined sexes respectively. EL Aiatt *et al*., (2019) mentioned that the estimated length - weight equations of *Solea solea* from Bardawil lagoon were, $W= 0.0055\ L^{3.171}$, $W= 0.0047\ L^{3.2334}$ and $W= 0.0048\ L^{3.2215}$ for males, females and combined sexes respectively. Mehanna *et al*., (2015) mentioned that the estimated length - weight equations of *Solea solea* from Egyptian Mediterranean coast off Alexandria were, $W= 0.0201\ L^{2.7032}$, $W= 0.0125\ L^{2.8883}$ and $W = 0.0131\ L^{2.8615}$ for males, females and combined sexes respectively. Desouky (2016) pointed out that the length–weight relationship of *Solea solea* in Lake Qarun described by the equation: $W= 0.01L^{2.932}$. Başaran *et al*. (2008) found that the length- weight relationship of *S. solea* in Izmir Bay, Turkey, was represented by a power equation ($W= 0.0025L^{\mathbf{3.3631}}$). These differences may be due to food availability, size range and/or physicochemical parameters.

The growth parameters of the present study for males, females and sexes combined of *S. solea* from Bardawil lagoon with those reported by other researchers for the same species given in Table ٥. The difference in growth parameters between regions can be attributed to the difference in size composition of the species in each area. Growth performance Index (Ø') The computed growth performance index for *S. solea* in Bardawil lagoon was 2.674, 2.522 and 2.581 for male, female and sexes combined respectively. It was obvious that of *S. solea* in Bardawil lagoon was higher than the other places as Iskenderun Bay, Güllük Bay, Izmir Bay, Adriatic, Spain and North Sea also our results lower than other places (Table 5).

Age determinations the otoliths of 1071 individuals used for age determination. Fishes chosen randomly to obtain various length classes without considering their sexes. Therefore, the number of females and males varies . Ages were between 0-4 years. Ages distributed between age 0 (161individuals), age 1 (408 individuals), age 2(345 individuals), age 3 (120 individuals) and age 4 (39 individuals).

Table 5. Some growth parameters of common sole from different locations.

Author	K	L∞	T_0	ϕ		Locality
De Veen (1976)	0.25	28.2		2.3		North Sea
Ramos, (1982)	0.22	46.4		2.68		Spain
Froglia&Gianetti (1985)	0.041	38.25	-3.5	1.78		Adriatic
Vianet *et al*., (1989)	0.24	48.8		2.76		France
Papaconstaninou, *et al* .(1990)	0.38	34.88	-0.4	2.66		Amvrakikos Gulf
Denial (1990)	0.39 0.33	42.4 48.2		2.88 2.85		Male France Female
El-Gammal *et al*., (1994)	.33	30.04		2.47	6	Bardawil lagoon
Oral (1996)	0.273 0.729 0.629	37.12 35.79 28.63	-1.1 -1.0 -0.9	2.58 2.97 2.71		F+m Sea of Marmara F M
Stergiou *et al*., (1997)	.38	34.9				Hellenic seas
Hossucu *et al*., (1999)	0.28 0.17 0.33	34.75 42.54 31.14	-1.1 -1.9 -1.0	2.53 2.49 2.51		F+M Izmir Bay F M
Turkmen (2003)	0.22 0.18	26.03 29.95		2.17 2.21	8	Male Iskenderun Bay Female
Mehanna and Salem, (2012)	.33	44.36		2.81	6	Bardawil lagoon
Salman (2014)	0.47 .55	32.72 37.23	-.2	2.7 2.88	4	Male Bardawil lagoon Female
Mehanna *et al* (2015)	0.55 0.625	34.77 36.24		2.82 2.91	4	Male Alexandria Female
The present Study	0.3342 0.2356 0.49	33.76 37.57 30.96	-1.2 -1.8 -0.9	2.581 2.522 2.674	4	F+M Bardawil lagoon F M

Length at ages given in (Table 6). Methods of the previous studies' age determinations were similar. However, some of the total lengths, which related to their ages in other previous studies, are larger or smaller than the present study results. Firstly, the difference in size-compositions could be an effect on these Variations. On the other hand, these variations could have originated due to some environmental factors such as pollution (Authman *et al*, 2015), fishing and temperature (Tu *et al*., 2018) and especially food availability (Ujjania *et al*., 2012; Gupta and Banerjee, 2015). Furthermore, size variation may be affected by genetic factors (Exadactylos *et al.*, 2013). Therefore, the growth of common sole could not be correlated with just food availability and other environmental factors could be responsible for length at age variation. size variation.

Table 6. Age-length distribution of common sole from different locations.

Author		Age							Locations
		I	II	III	IV	V	VI	VII	
Ghirardelli (1959	F+M	16.8	21.4	23.9	25.6	33.1			Adriatic
Ramos (1982)		17.1	22.4	26.5	30.3	33.7	36.3	38.4	Western Medit.
Gonzalez and Carillo (1985)	F M	11.3 13	17 16.9	22.9 20.3	26.6 23.1	32.0 26.7			Atlantic
Froglia and Gianetti (1985)	F+M	18	25.63	30.94	32.5	36.3			Adriatic
Papaconstantinou *et al*. (1990)	F+M	18.09	24.16	26.61	28.39	29.99	33		Aegean Sea
Oral (1996)	F+M	16.42	21.52	25.32	27.65	29.9	31.88	33.2	Sea of Marmara
Hoşsucu *et al*. (1999)	F M	16.8 15.3	21.3 20.6	24.52 22.75	26.98 25.08	29.36 27.04			İzmir Bay
Gurbet (2000)	F+M	18	22.5	25.8					İzmir Bay
Mehanna *et al.* (2015)	F+M F m	16.57 17.44 15.79	25.61 25.9 23.81	29.95 30.92 28.39	33.21 33.30 31.50				Alexandria
Desouky, (2016)		15.43	21.3	24.21	26.35				
This Study	F+M F M	17.8 18.08 17.39	22.22 22.25 22.17	25.74 25.29 26.61	27.89 27.97 27.77				Bardawil lagoon

The total mortality coefficient (Z) estimated as 0.8356, 0.8342 and 0.8342 year-1 of males, females and combined sexes respectively. The value of natural mortality coefficient (M) was 0.3201, 0.2170 and 0.2768 year-1 of males, females and combined sexes respectively, while the fishing mortality coefficient (F) was 0.5155, 0.6172 and 0.5574 year-1males ,females and combined sexes respectively. Exploitation rate (E) computed as 0.62, 0.64 and 0.67 of males, females and combined sexes respectively.

Gulland (1971) suggested that the optimum exploitation rate for any exploited fish stock is about 0.5 at F_{opt} = M. More recent, Pauly (1987) proposed a lower optimum F that equals to 0.4 M. In the present study, F was higher than the two values of F_{opt} given by Gulland (1971) and Pauly (1987) indicating that the stock of *S. solea* in Bardawil lagoon is heavily exploited

With the increasing of fishing mortality F = 0.5574 at Tc = 1.4 year, the maximum yield per recruit will be increase. Increasing of effort (F = 0.5574) to Fmax (F= 0.75) associated with negligible increase in the yield per recruit (66.01-66.7 = 0.69).That meaning of, the increase in fishing effort by 35% over production as much as 1.06% only, this is unacceptable biologically. Also, higher yields that obtained by increase in effort cannot be maintained, and they will have to be followed by a period of much lower yield.

The yield per recruit (Y/R) of common sole *S. solea* in Bardawil lagoon were found to be 66.01 g and 66.8 g respectively at the actual fishing mortality 0.5574 and 0.75 respectively. Biomass per recruit was decreased with the increasing of fishing mortality where it maximum Biomass per recruit (525.7 g) at F= 0 .

The variation in yield per recruit with changing of age at first capture Tc, this is closely related to the estimation of the optimum mesh size. Yield per recruit of *S. solea* calculated with changing of the age at first capture Tc = 0.2, 0.52, 0.85, 1.23, 1.4, 1.67, 2.2, 2.8, 3.57 and 4.62 years or with changing of the length at first capture Lc 13, 15, 17, 19, 19.8, 21, 23, 25, 27 and 29 cm The Results indicated that, the maximum yield per recruit will be achieved at Tc = 2.2 year or LC= 23.0cm with current Fishing mortality rate (F = 0.5574) in a long time the maximum yield per recruit retched to 68.4 g.

CONCLUSION AND RECOMMENDATIONS

The results showed that the stock of *S. solea* at Bardawil lagoon over exploited. For the management purpose, the current exploitation rate must be reduced from 0.67 to 0.5. This means that the present level of exploitation should be decreased by about 25.4% to maintain a sufficient spawning biomass.

Accordingly, it should be control mesh size of nets used, and continue the study to assess and manage the different fish stocks. also the need to expedite taking the necessary steps to preserve the catch of Musa fish and finding urgent management regulations to conserve this fishery.

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بعض القياسات البيولوجية لأسماك الموسى من بحيرة البردويل مصر

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الملخــــــص العربــــــي

نظرًا للأهمية الاقتصادية للأسماك الموسى، وأهمية القياسات البيولوجية للأسماك في إدارة مصايد بحيرة البردويل، فقد أجريت الدراسة على أسماك الموسى خلال موسم الصيد ٢٠١٩. اهم القياسات العلاقة بين الطول والوزن لأسماك موسى الموصوفة في معادلة التالية

$W = 0.0067\ L^{3.1056}$ للذكور و $W = 0.0059\ L^{3.1495}$، $W = 0.0091L^{3.0104}$ والإناث والجنسين معا و فيما يتعلق بالطول المحسوب رجعيًا للجنسين معا من ١٧,٨ و ٢٢,٢ و ٢٥,٧ و ٢٧,٩ سم للسنوات الأولى والثانية والثالثة والرابعة على التوالي. تم تقدير ثوابت نمو فون برتالانفي كالتالي $L\infty$ = ٣٣,٧٦سم و K=٠,٥٥ سنة ⁻١ و t_0=-١,٢٤سنة ⁻١ للجنسين معا و$L\infty$ = ٣٧,٥٧ سم وK=٠,٢٣٥٦ سنة ⁻١ و t_0 =-١,٧٩ سنة ⁻ للإناث و$L\infty$ = ٣٠,٩٦ سم وK =٠,٤٩ سنة ⁻١ و t_0 =-٠,٦٨ سنة ⁻١ للذكور و خلال موسم الصيد ٢٠١٩. بلغ مجموع الوفيات الطبيعية ونفوق الصيد ٠,٨٣٥٦ و٠,٣٢٠١ و٠,٥١٥٥ سنة -١على التوالي للذكور و٠,٨٣٤٢ و٠,٢١٧٠ و٠,٦١٧٢ سنة -١على التوالي للإناث و ٠,٨٣٤٢ و ٠,٢٧٦٨ و ٠,٥٥٧٤ سنة-١ على التوالي بالنسبة للجنسين معا. بالمقابل كانت نسبة الاستغلال $E = 0.62$ و٠,٧٤ و٠,٦٧ / سنة للذكور والإناث والجنس معا على التوالي. كان الطول المقدر عند بداية الصيد ١٨,٤ و ٢٠,٣ و ١٩,٨ سم للذكور والإناث والجنس معا على التوالي بينما تعكس هذه النتائج المستوى العالي لاستغلال اسماك موسى وعليه، يجب التحكم في حجم فتحات الشباك المستخدمة، ومواصلة الدراسة لتقييم وإدارة الأرصدة السمكية المختلفة وضرورة الإسراع في اتخاذ الخطوات اللازمة للحفاظ على مصيد أسماك موسى وإيجاد أنظمة إدارية عاجلة للحفاظ على المخزون السمكي لهذه الاسماك.