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SOME BIOLOGICAL ASPECTS OF SHRIMP SCAD, *Alepes djedaba* (FORSSKAL, 1775) LANDING AT NORTH COAST SINAI, MEDITERRANEAN SEA, EGYPT

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ABSTRACT

This paper concentrates on measuring some biological parameters of Shrimp scad, Alepes djedaba such as age, growth rate, length at the first capture, and length at first sexual maturity. For that purpose, a total of 2591 fish individuals were collected from eastern Mediterranean Sea (North Sinai Coast) in the period from January to December 2019. Aging was estimated by reading the rings on otolith. Lengths of samples ranged from 9.7 to 26.9 cm and the corresponding weight were 6.5 to 206.7 g. All fishes aged from 0 to 5 years, with age 1st, 2nd, 3th year being the most dominant age groups, while the fishes older than 5th years were disappeared. The length-weight relationship indicated negative isometric growth (b =2.9903). Back – calculation lengths were 13, 15.67, 18.4, 20.18 and 21.77 cm to for ages 1st, 2nd, 3th, 4th and 5th years, respectively. Von-Bertalanffy growth parameters (VBGP) were L∞=29.26, K=0.1895yr-1, t0= -1.9956yr-1. The growth performance (φ) was 2.22. The sex ratio of males to females (M: F) of *Alepes djedaba* was ≈ 1:1.17. Reproductive activity period was expressed by GSI. The maximum values of Gonado-Somatic index (GSI) were recorded in the period from May to October (ranged from 4.3- 4.8). The length at first capture (Lc) was estimated at 17 cm for combined sexes and the length at first maturity (Lm) was estimated at 18.4, 19.1 and 18.8 cm for males, females and combined sexes, respectively. Length at first maturity (Lm) must be increased by widening the net mesh size to catch *Alepes djedaba* at lengths greater than 19.1cm.

INTRODUCTION

The shrimp scad *Alepes djedaba* is one of five species of fish in the scad genus Alepes, which itself is one of thirty genera in the jack family Carangidae. The Carangidae are Perciform fishes in the suborder Percoidei **(Zhu *et al.*, 2007)**.

The shrimp scad (*Alepes djedaba*) is one of the species migrations through the Suez Canal and inhabit the east coast of the Mediterranean Sea around Israel, Lebanon and Egypt **(Taskavak and Bilecenoglu, 2001)**. Length-weight relationships are important for comparative growth studies **(Moutopoulos and Stergiou, 2002)**.

The shrimp scad (*Alepes djedaba*) is distributed throughout the IndoPacific region from South Africa in the west, along the coasts of East Africa, India, Asia, Indonesia, Northern Australia, Japan (**Iwatsuki and Kimura, 1996)** and extending as far east as Hawaii **(Carpenter and Volker 2001)**. They are also one of the species involved in the Lessepsian migration through the Suez Canal and

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inhabit the east coast of the Mediterranean Sea around Israel, Lebanon and Egypt **(Taskavak and Bilecenoglu, 2001)** and Sea of Marmara **(Artüz and Kubanç, 2014)**.

Information on biology of *Alepes djedaba* is scanty except, for a few reports. Feeding habits and breeding biology of the species was studied by **Kuthalingam (1955)** from Madras, **Venkataramani *et al.* (1984)** from Porto Novo, **Sivakami (1990)** from Cochin and **Raje (1993)** from Veraval coasts. **Akel (2005)** estimated the growth, mortality and yield per recruit of the species from Abu Qir Bay, Egypt. **Shuaib and Ayub (2011)** studied some aspects of biology of the species from Pakistan coastal waters and **AbdelBarrr *et al.* (2014)** reported on stock evaluation of *Alepes djedaba* from Arabian Gulf off Saudi Arabia.

This work aimed to assess the status of this fish which are exploited in Mediterranean Sea coast of North Sinai. to providing information required for resource management purposes.

MATERIALS AND METHODS

Monthly, random samples of the shrimp scad (*Alepes djedaba*) were collected of main the landing site at the Mediterranean Sea coast of Sinai, The sampling period lasted during the fishing season 2019.

The total length of 2591 individuals of *Alepes djedaba* 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. Length-weight relationship was determined according to **Le Cren (1951)** for males, females and combined sexes by using the following equation:

$$W = a\ Lb$$

Where W is the total weight in grams and L is the total length in centimeters a and b are constants, whose values were estimated by the least square method. Otoliths were used for the age determination. The back–calculated lengths to age classes were recorded using Lee's equation as:

$$Ln = \{(L-a)\ (Sn/S) + a\}$$

Where: Ln is the total length in centimeters, Sn is magnified otolith radius to "n" annulus, S is the otolith radius in millimeters and L is the total length in centimeters (**Lee, 1920**). The back–calculated weights at the end of each year of life were estimated by applying the equations of length–weight relationship. Theoretical growth in length was obtained by fitting the von Bertalanffy growth model, using the **Gulland and Holt (1959)** method. **Von Bertalanffy (1949)** for theoretical growth in length can be written in the form:

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

Where: Lt = the length at age t, L∞ = the asymptotic length, K = growth coefficient and t_0 = age at which the length is theoretically nil.

The coefficient of condition was calculated monthly in the period from January to December 2019. The coefficient of condition was calculated by the folowing equation:

$$Kc = (W \times 100) / L3$$ **(Hile, 1936)**

Where: Kc = coefficient of condition, W = weight in g., and L = length in cm.

The growth performance index (φ) was estimated as:

$$\varphi = \log K + 2 \log L\infty$$

Where: K and L∞ are parameters of von Bertalanffy) **(Pauly and Munro, 1984)**.

All Fishes were dissected for sex determination and maturity investigation. When sexual differentiation is not possible, individuals were removed. The gonads after being removed were weighted to the nearest 0.01 g. Monthly gonado-somatic indices (GSI) were calculated by the equation of **Bariche *et al.* (2003)** as follows:

GSI= (Gonad Weight/(Body Weight - Gonad Weight)) ×100

Maturity stages were determined by the naked eyes and by microscopic examination in young specimens. The length at first sexual maturity (Lm) was determined by 50% of fish which reach their sexual maturity. Then Lm was estimated as the point on the X-axis corresponding to 50% point on the Y-axis.

RESULTS AND DISCUSSION

Age Determination

Otoliths of 1323 specimens of shrimp scad (*Alepes djedaba*)-(Fig.1) were used for the age determination Age. Specimens ranged from 11.1 to 26.9 cm (Lt) and the corresponding weight was 6.5 to 206.7 g (Wt)

The length frequencies for all individuals are presented in Fig. 2.

The maximum length in the present study (26.9) cm was close to that of **El Aiatt (2018)** who recorded 25.3 cm, but more than that given by **El Ganainy *et al.* (2021)** who recorded 24.6 cm for the same species in Mediterranean Sea, Egypt. Age-length key of *Alepes djedaba* for all age classes are presented in Table 1. All fishes aged from 0 to 5 years. Most of the investigated fish were belonging to 1-3 age classes (≈ 70.0%). Stock assessment is based on estimates of numbers of fish per age classes. All age-at length data of the investigated stock are often combined without weighing, under the assumption that differences between gear types and regions can be disregarded **(ICES, 2005)**.

In the present study, the calculated values of 'b' of length and weight of Shrimp scad, *Alepes djedaba* was 2.9903, (Fig. 3). These results show that the relationship between the length and weight was Isometric where was the value of b in the relationship between length and weight is very close to 3.

These results were equal with the results obtained from **Reuben *et al.* (1992)** , **Akel (2005) , Shuaib and Ayub (2011), Wang *et al.* (2016)**, **Sajana and Nadan (2017) and El Aiatt (2018)** where the values of b were 3.134, 2.964, 2.97, 3.084, 2.976 and 3.147, respectively. Also our results less than the results that obtained by **Roul *et al.* (2020) and El Ganainy *et al.* (2021),** the value b were 3.3419 and 3.267, respectively. But higher than that the obtained by **Raje (1993), Osman and Abdulhadi (2011), Chu *et al.* (2011) and Siwat *et al.* (2016),** since the value b was 2.939, 2.58, 2.916 and 2.923 respectively. These differences may be due to that the proportion of small fish was high in the present study. b values in fish is species-specific and varies with sex, age, seasons, physiological conditions, growth increment and nutritional status of fish, health, habitat, nutrition, environmental conditions (such as temperature and salinity), area, degree of stomach fullness, differences in the length range of the caught specimen, maturity stage and techniques of sampling fishing gear **(Le Cren, 1951; Tesch, 1968; Begenal and Tesch, 1978)**. Environmental factors were not analyzed in the present study.

Back-Calculation in Length and Weight

To estimate previous growth history of *Alepes djedaba*, the relationship between scale radius and the total length was studied by back-calculation (Table 2).

The back-calculated length at the end of each year of life was calculated by using Lee's Formula. The highest annual increment was occurred during the first year of life, while a noticeable decrease was observed in the second year, reaching its minimal value during the fifth year of life, these results agree with **Akel (2005)** in Abu Qir Bay eastern Alexandria Egypt and with many authors in different areas. In the present study the increment of length in the first year was 59.91% and decreases gradually with age.

Fig. 1. Shrimp sacd, *Alepes djedaba* collected from eastern Mediterranean Sea (North Sinai Coast)

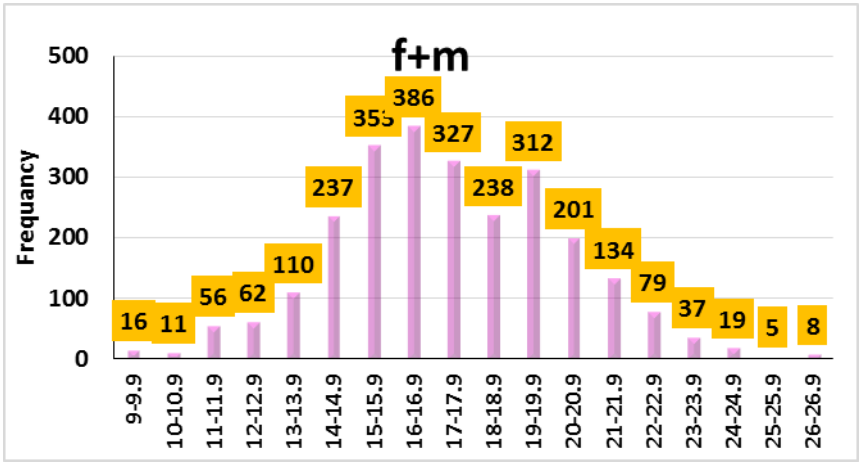

Fig. 2. Length frequency of Shrimp sacd in Mediterranean Sea coast of Sinai during fishing season, (2019)

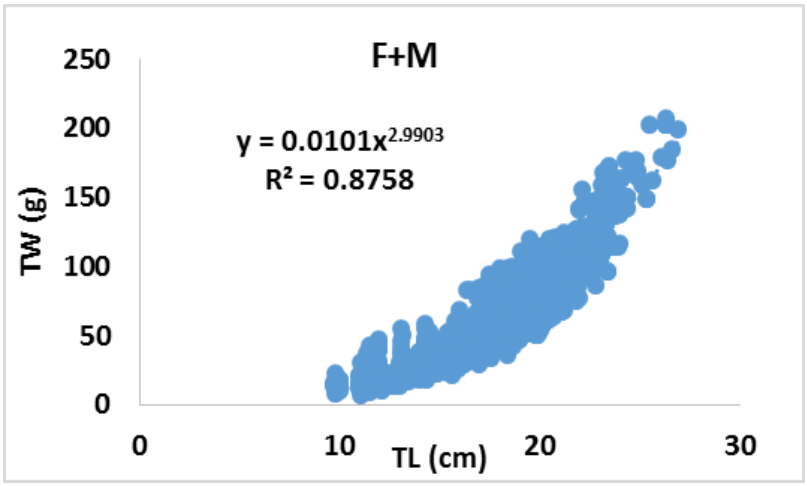

Fig. 3. Length-weight relationship (♀♂) of *Alepes djedaba* collected from the Mediterranean Sea coast of Sinai (2019)

Table 1. Age length key of combined sexes of *Alepes djedaba* in Mediterranean Sea coast of Sinai during fishing season, 2019

Length (CM)/Age	0	I	II	III	IV	V	Ni	Pi
11-11.9	21	0		COMBINED SEXES			21	1.59
12-12.9	28	31					59	4.46
13-13.9	44	41	0	0	0	0	85	6.42
14-14.9	10	153	3	0	0	0	166	12.55
15-15.9	0	53	125	0	0	0	178	13.45
16-16.9	0	25	142	0	0	0	167	12.62
17-17.9	0	10	65	32	1	0	108	8.16
18-18.9	0	0	10	75	12	0	97	7.33
19-19.9	0	0	7	55	30	0	92	6.95
20-20.9	0	0	0	47	45	7	99	7.48
21-21.9	0	0	0	29	51	23	103	7.79
22-22.9	0	0	0	18	42	19	79	5.97
23-23.9	0	0	0	0	11	26	37	2.80
24-24.9	0	0	0	0	8	11	19	1.44
25-25.9	0	0	0	0	0	5	5	0.38
26-26.9	0	0	0	0	0	8	8	0.60
Total	103	313	352	256	200	99	1323	100
(%)	7.79	23.66	26.61	19.35	15.12	7.48	100	0

Table 2. Back-calculated lengths at the end of each year of *Alepes djedaba* collected from Mediterranean Sea coast of Sinai during 2019

Age	No. of fish	Observed length (cm)	Average back calculated lengths at the end of each year (cm)				
			I	II	III	IV	V
0	103	12.7					
I	313	14.5	13.00				
II	352	16.4	13.07	15.67			
III	256	19.4	12.94	16.36	18.40		
IV	200	21.2	12.74	15.86	17.63	20.18	
V	99	23.1	12.72	15.78	17.80	20.27	21.77
	1323		13.00	2.67	2.73	1.78	1.59

These results are in harmony with **Akel (2005)**, who reported that, the increment of length of *Alepes djedaba*) in Abu Qir Bay, eastern Alexandria, Egypt in the first year was 53.73%, also with **El Ganainy *et al.* (2021)**, 68.1% in Mediterranean Sea, Egypt, **El-Aiatt (2018)** 53.06% in Mediterranean Sea, Egypt and **AbdelBarr *et al.* (2014)** 51.45% in Arabian Gulf.

In the present study five age groups were identified, Age group II dominated the catch (26.61%), followed by I age group (23.66%), III age group (19.35%), IV age group (15.12%), 0 age group (7.79%) and V age group (7.48%). The lowest of growth was related to slower growing individuals with highly exploited and disturbances by fishing boats. Environmental conditions and availability and type of food resources could affect fish growth rates and thus lengths at age **(Wootton, 1990)**. The back–calculated weights at the end of years for *Alepes djedaba* in Mediterranean Sea coast of Sinai 2019 were estimated by applying the equation of length–weight relationship as illustrated in Table 3.

Akel (2005) mentioned that the growth in weight of *Alepes djedaba* was minimal at the first year of life (12.75g) then increased throughout the second and third year of life (15.40g and 19.33g), respectively.

Theoretical Growth in Length and Weight

In the present study, the Von-Bertalanffy growth parameters of *Alepes djedaba* were $L\infty$=29.26 cm, K=0.1895yr-1, t0= -1.9956yr-1. The growth parameters and lifespan in the present results were lower than that obtained by **AbdelBarr *et al.* (2014)** in Arabian Gulf for the same species ($L\infty$=41.7cm, K=0.36yr-1 and t0=-0.76 yr-1). The lowest value of $L\infty$ may be due to the overfishing at the last period, and the rarity of larger and older individuals within the landings. **Parsons (1982)** stated that, in general, the older the year class, the higher the $L\infty$ value. The growth coefficient (K) is related to the longevity of fish. In the present study, the growth coefficient (K) is lower comparing with the similar previous studies. **Akel (2005), El-Aiatt (2018) and El Ganainy *et al.* (2021)** in Mediterranean Sea, Egypt of the same species recorded that K = 0.301, 0.295 and 0.247yr-1, respectively. The K value (determines how fast the fish approaches its $L\infty$) contributed with the lifespan of fish and fast growth. Therefore, this parameter affected by growth factors such as food availability and environmental factors .

In the present study, the growth performance (φ) for *Alepes djedaba* was φ = 2.22. This value was lower than that obtained by **El-Aiatt (2018) and El Ganainy *et al.* (2021)** since φ =2.41 and 2.33 for the same species, respectively. These differences in growth performance (φ) are related to temperature **(Ricker, 1975)**, salinity **(Popper and Gundermann, 1975)** and possibly to differences in food items **(Golani, 1993)**.

The condition indices portrayed by morphometric measurements represent a basis for developing an explanatory hypothesis about biological responses or different ecological scenarios for populations **(Liao *et al.*, 1995)**. The condition factor (Kc) is used for comparing the condition, fatness, or well-being of fishes **(Mir *et al.*, 2012)**. In the present study, the condition factor of *Alepes djedaba* was recorded monthly and according to different lengths (Fig. 4).

Length at first capture (L_c)

Fig. 5 illustrated that the length at first capture (L_c) of combined sexes of *Alepes djedaba* in Mediterranean Sea coast of Sinai was 17.0 cm.

Sex Ratio

A total of 609 males (46.0%) and 714 females (54.0%) *Alepes djedaba* were sexed by opening the abdomens and examining the gonads. The percentage of males to females with age classes are illustrated in Table 4.

Table 3. Back-calculated weights at the end of each year of life of *Alepes djedaba* collected from Mediterranean Sea coast of Sinai during 2019

Age	No. of fish	Observed weight (g.)	Average back calculated weight at the end of each year (cm)				
			I	II	III	IV	V
0	**103**	**21.7**					
I	**313**	**29.5**	21.63				
II	**352**	**45.3**	22.00	37.85			
III	**256**	**76.1**	21.34	43.07	61.15		
IV	**200**	**99.0**	20.37	39.23	53.79	80.61	
V	**99**	**131.2**	20.27	38.61	55.35	81.67	101.15
	1323	**Increment**	21.63	16.22	23.30	19.46	20.54

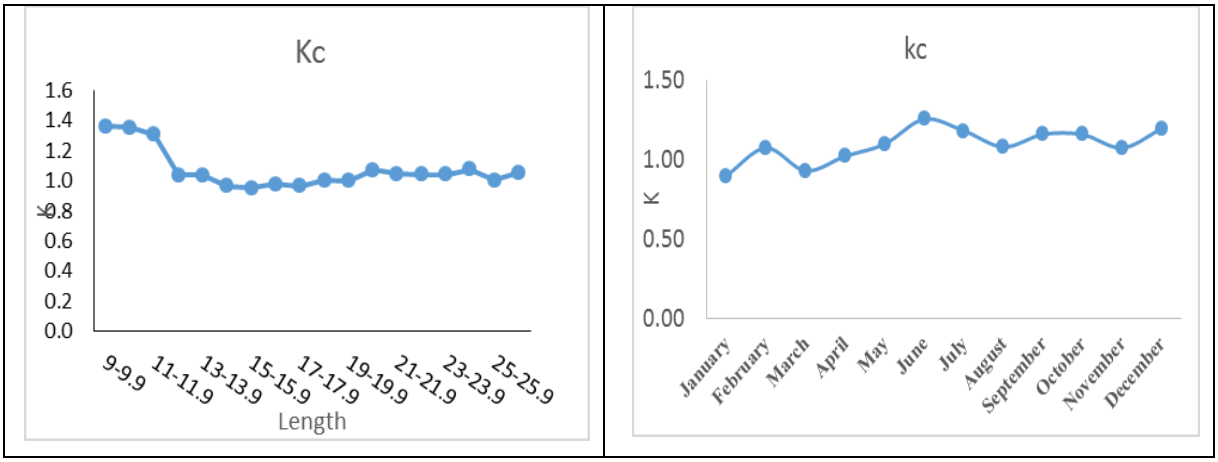

Fig. 4. Average Kc of *Alepes djedaba* in Mediterranean Sea coast of Sinai during fishing season, 2019

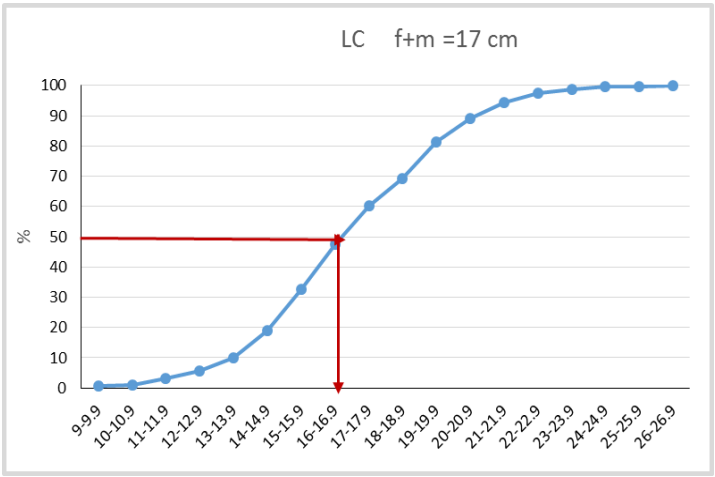

Fig. 5. Length at first capture (L_c) of combined sexes (♀♂) of *Alepes djedaba* in Mediterranean Sea, coast of Sinai during fishing season, 2019

Table 4. Sex ratio of *Alepes djedaba* collected from Mediterranean Sea coast of Sinai, 2019

Age		Males		Females	
	Total	No.	(%)	NO	(%)
0	103	43	41.7	60	58.3
I	313	148	47.3	165	52.7
II	352	160	45.5	192	54.5
III	256	116	45.3	140	54.7
IV	200	97	48.5	103	51.5
V	99	45	45.5	54	54.5
	1323	609	46.0	714	54.0

In the present study, the sex-ratio of *Alepes djedaba* was 1:1.17. This ratio did not deviate from the normal ratio of 1:1, that is males and females were almost equal in number in the population. **Raje (1993)** reported that the males dominated over females in the population of catches landings at Veraval, Gujrat, India. **Nasir and Zarrien (2011)** reported that the monthly distribution of sexes at the Karachi Fish Harbour, Karachi, Pakistan fluctuated significantly in favour of males in months of October 2009 and March 2010, while the sex ratio was significantly in favour of females in March 2009. A similar trend of monthly sex-ratio variation in *Alepes djedaba* has been reported from Veraval, Gujrat, India **(Raje, 1993)**. The deviation in the sex ratio could be due to partial segregation of mature forms through habitat preferences (**Reynolds, 1974**) due to migration **(Collignon, 1960)** or behavioural differences between sexes **(Polonsky and Tormosova, 1969)** thus rendering one sex to be more easily caught than another.

In the present work, the Gonado-Somatic Index (GSI) of *A. djedaba* was computed at different months to confirm the spawning period. It was found that, the lowest values of GSI were recorded in the period from January to March (0.9-1.6), and the maximum one was observed in the period from May to October (4.3- 4.8). indicating maturation of large fraction of these species. Most samples which were collected in June were matured (Fig. 6).

The GSI may refers to the gonad index **(Batts, 1972)** and according to **Wydoski and Cooper, (1966)** it may give indication of maturity coefficient or maturity index. The gonad somatic index (GSI) revealed that the *A. djedaba* in the Mediterranean Sea have prolonged spawning season with two peaks during May and October. This is agreed with **Sivakami (1990) Reuben *et al.* (1992), Raje (1993), Shuaib and Ayub (2011) and Sajana *et al.* (2019)** who indicated that the spawning season of *Alepes djedaba* were observed almost throughout the year with two peaks of spawning, from March to April and from August to December periods.

Length at first sexual maturity for pelagic fishes is usually close to two thirds of the fish maximum total length **(Woodhead, 1978)**. This assumption is in agreement with our results as the maximum-recorded size was 26.9 cm and the lengths at first sexual maturity were 18.4 and 19.1 cm for male and female respectively (Fig. 7). These results indicated that the stock of *A. djedaba* in the Mediterranean Sea is over exploited as the length at first capture in our results 17.0 cm.

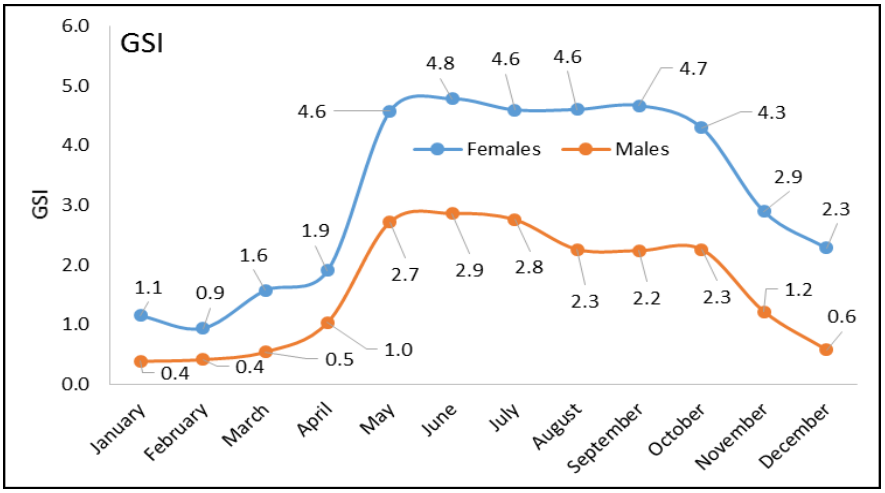

Fig. 6. Gonado-Somatic Index (GSI) of males and females of *Alepes djedaba* in Mediterranean Sea coast of Sinai during 2019

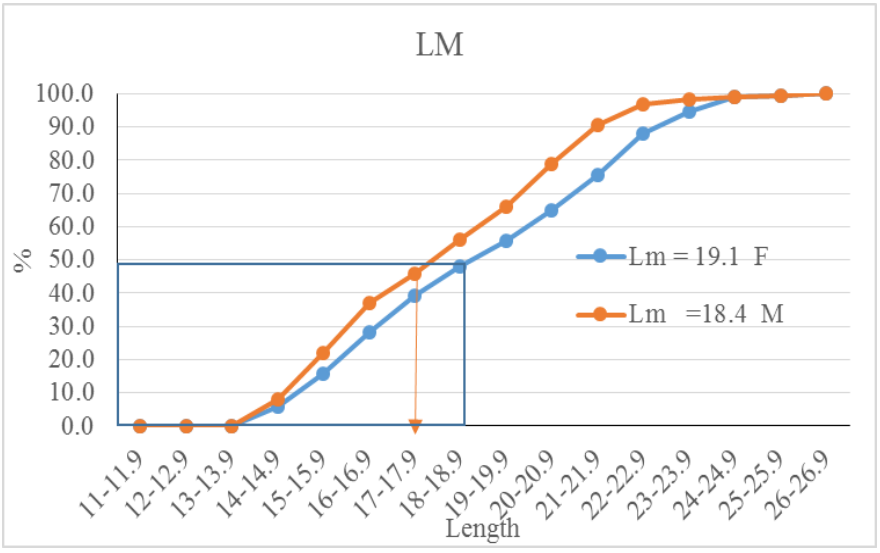

Fig.7. L_m of *Alepes djedaba* (males and female) in Mediterranean Sea coast of Sinai during fishing season, 2019

Osman *et al.* (2021) found that Lm for *A. djedaba* were 16 and 16.7 cm for male and female respectively. **Sajana *et al.* (2019)** found that Lm for *A. djedaba* were 19.3 and 17.4 cm for males and females respectively with maximum fish size of about 32cm. The analysis of gonado somatic index values provides important information regarding to the measure of gonad size relative to body weight **(Wootton, 1990)** and also the studying of the spawning season **(Ahirrao, 2002)**.

For better status of *A. djedaba* stock in Mediterranean Sea coast of Sinai during fishing season 2019, the recommendation should be directed to equal (or increase) the length at first capture to length at first maturity. This can be achieved by widening the net mesh size. We recommend further studies on catch and effort for complete management strategies for the stock of such species.

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الملخص العربي

بعض القياسات البيولوجية لأسماك الميره التي تم تجميعها من ساحل شمال سيناء على البحر المتوسط مصر

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تم دراسة بعض الصفات البيولوجية لسمكة الميره المجمعة من ساحل شمال سيناء المطل على البحر المتوسط خلال الفترة من يناير إلى ديسمبر 2019م مثل العمر والنمو والعلاقة بين الطول والوزن والنسبة الجنسية والطول عند بداية الصيد والطول عند بداية النضج الجنسي ... 2591 عينة تم جمعها من أسماك الميره التي تم صيدها من شرق البحر المتوسط وتم تقدير العمر عن طريق قراءة الحلقات العمرية عل حلقة الاذن، تراوحت الأطوال ما بين9.7 إلى 26.9 سم والوزن ما بين 6.5 إلى 206.7 جرام .جميع الأسماك تراوحت عمرها ما بين صفر إلى خمس سنوات وكانت الفئة العمرية الأولى والثانية والثالثة هي الفئات العمرية السائدة، بينما تختفي الأسماك الأكثر من خمس سنوات. العلاقة بين الطول والوزن علاقة متماثلة (b=2.9903) والحساب الرجعي للطول كان 13 و15.67 و18.4 و20.18 و21.77 للأعمار من الأول إلى الخامس على الترتيب. ثوابت فونبرتلانفى للنمو ($L\infty$=29.26, K=0.1895yr^{-1}, t0= -1.9956yr^{-1}) ودليل النمو 2.22 والنسبة الجنسية كانت واحد ذكر لكل 1.7 أنثى، والسمكة لها موسم تكاثر محدد من يونيو الى أكتوبر وذلك من دراسة معامل الدليل المنسلى كزيادة في وزن المناسل. الطول عند بداية الصيد 17 سم والطول عند بداية النضج الجنسي للإناث 19.1 سم. ومن التوصيات الهامة لهذا البحث يجب زيادة الطول عند النضج الأول (Lm) عن طريق توسيع حجم الشبكة الشبكية لصيد أسماك الميرة بأطوال أكبر من 19.1 سم.

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