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Some biological and fisheries studies on the Lessepsian migrant shrimp scad *Alepes djedaba* from the Eastern Mediterranean coast of Egypt.

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ABSTRACT

The Lessepsian migrant shrimp scad *Alepes djedaba* is an important component of the purse seine fishery in the Egyptian Mediterranean Sea. This study aimed to investigate the state of the fishery of *A. djedaba*. A total of 1391 specimens were collected from two landing sites in the Eastern Mediterranean (Damietta and Port Said) from January to December 2019. The estimated length-weight relationship (W= 0.003 $L^{3.419}$) showed positive allometric growth. Aging by otolith readings was corroborated by length-frequency analysis and the results revealed three age groups with the second age group is dominant in the catch. The von Bertlanffy growth parameters estimated at L_∞ = 29.21 cm, K= 0.301, W_∞= 307.4 g and t_o= -1.2. The growth performance index was ϕ=2.41. The yield and biomass per recruit analysis showed that the current rate of fishing mortality (F_{curr} = 0.872) was higher than the estimated biological reference points (F_{max}, $F_{0.1}$ and $F_{0.5}$). The percentage of the current biomass per recruit to the unexploited level was 20.76% which implied recruitment overfishing. The management measures should include reduction of fishing effort and controlling fishing gear.

INTRODUCTION

Carangids fish inhabit marine and brackish waters, they are active swimmers and live in school or small groups (Berry and Smith, 1978), many species of them are important for the commercial, recreational and aquaculture fisheries (Katsuragawa and Matsuura, 1992). Family Carangidae is represented in the purse seine fishery of the eastern Mediterranean by three genus and four species, *Alepes djedaba* (Forsskal, 1775) , *caranx crysos* (Mitchill, 1815), *Trachurus mediterraneus* (Steindachner, 1868) *and Trachurus trachurus* (Linnaeus, 1758). The Shrimp scad *Alepes djedaba* (Forsskål, 1775) is one of the most abundant carangids accounted an average of 95 ton during 2017 to 2020 (GAFRD, 2019).

Shrimp scad *Alepes djedaba* fishes (Forsskål, 1775) are widely distributed in tropical regions (Argente *et al*., 2014). They spread in Red Sea and East Africa (van der Elst,

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1993) to the Hawaiian Islands, north to Japan, and south to Australia. Immigrant to the eastern Mediterranean through the Suez Canal (Golani, 1998), westward to Malta (Lanfranco, 1993). Adults of shrimp scad form large schools near inshore reefs (Sommer *et al*., 1996), they feed on small shrimps, copepods, decapod larvae and other crustacean larvae and small fish (Allen & Erdmann, 2012).

Alepes djedaba was first reported from the Mediterranean as *Caranx calla* by Steinitz (1927) then the names *Caranx djedaba*, *Atule djedaba* and *Alepes* (*Atule*) *djedaba* (Golani, 2005). The presence of *A. djedaba* were reported in Turkish Mediterranean water (Raje ,1993) and (Artüz and Kubanç, 2014). Recently the species has been recorded in the Black Sea (Turan *et al*., 2017).

Because of its wide distribution and economic importance there were some studies covered the biological and fisheries aspects of *Alepes djedaba* species in the Indo-pacific region (Sivakami, 1990; Reuben *et al*., 1992; Raje, 1993; Osman and Abdulhadi., 2011; Shuaib and Ayub, 2011; Abdel Barr, *et al;* 2014, Siwat *et al*., 2016 and Sajana & Nadan, 2017). Information regarding the biology and population structure of *A. djedaba* in Egypt is very scarce (Akel, 2005; El-Aiatt, 2018 and Ragheb *et al*., 2019). This study aims to throw light on the population parameters of *A. djedaba* as a commercial species to manage its fishery in the Mediterranean.

MATERIALS AND METHODS

Sampling: A total of 1391 specimens of *Alepes djedaba* were collected from the purse seine vessels landings in the fishing harbors of Port Said and Damietta (Fig. 1), during January 2019 to December 2019.

In the laboratory, the length frequency distribution applied for all samples and the studied sub sample were about 718 specimens. Total length to the nearest mm and total weight to the nearest gram were measured and samples dissected to male and female, otolith were extracted and preserved.

Length weight relationship

Length weight relationship were studied according to (Sparre *et al*., 1989):

$$W= a L^b$$

Where, W = total weight (g), L = total length (cm) and a and b are constants.

Condition factor

The condition factor as a Fulton's condition factor (*K*) was estimated from the equation of (Le Cren, 1951; Froese, 2006). $K=100W/L3$, where W is total weight in gram, L is total length in cm and the factor 100 is used to bring K close to unity.

Fig. 1: Map showing the study area Damietta and Port Said fishing harbor on the Mediterranean Sea.

Ageing

Age of *Alepes djedaba* was determined by reading annuli of otolith and confirmed by the decomposition of length frequency distribution by Bhattacharya's method (1967) available in the FiSAT software (Gayanilo *et al*., 1994). The estimation of growth parameters was performed through a non-linear least squares technique (Prager *et al.*, 1989); the mean square error was used as an index of goodness of fit. The empirical equation of Pauly (1979) was used to estimate the hypothetical age (t_o) of fish, which would have at zero length. The growth performance index (Φ) was estimated by (Pauly and Munro, 1984) method:

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

Where, K and L∞ are von Bertalanffy parameters.

Mortalities and Yield per recruit

Total mortality coefficient "Z" was estimated from the mean length in the catch; by applying the method of Beverton & Holt (1956):

$$Z = K\,(L_\infty - \bar{L}\,) / (L_\infty - L')$$

Where K and L_∞ are the growth parameters of the von Bertalanffy equation, $\bar{L}$ is the mean length in the catch above L' where L' is the cut-off length**.** The natural mortality coefficient "M" was estimated by Jensen (1996) equation (M=3/2 K), where K is the von Bertalanffy growth coefficient. Fishing mortality coefficient (F) was estimated by subtracting the value of natural mortality coefficient (M) from the value of total mortality coefficient (Z) as follow:

$$F = Z - M$$

Length at first capture Lc is the length at which 50% of the fish are vulnerable to fishing gear. It was computed from the equation of Beverton and Holt (1956), which applies the growth constants of von Bertalanffy:

$$Lc = \bar{L} - K (L_\infty - \bar{L}) / Z$$

Where: $\bar{L}$ is the mean length of the catch. K and L_∞ von Bertalanffy growth parameters and Z is the instantaneous total mortality coefficient. The corresponding age at first capture tc was calculated using the following equation of Beverton and Holt (1957):

$$Tc = (-1 / K) (Ln ((1- Lc / L_\infty) + t_o)$$

Where K, L_∞ and t_o are the von Bertalanffy constants. Lc is the length at first capture.
The effect of fishing on the shrimp scad stock in the Mediterranean was examined by applying the models of yield per recruit (Y/R) and biomass per recruit (B/R) derived by Beverton and Holt (1966).

RESULTS

Length weight relationship:

A total of 718 specimens of *Alepes djedaba* were examined. The observed total weights ranged from 15.0 to 182.7 g and their total length ranged from 11.7 to 24.6 cm. The fitted equations for males, females and combined sexes were as follow:

Whole sample	$W= 0.003 L^{3.419}$	($R^2 = 0.931$)
Males	$W= 0.004L^{3.311}$	($R^2= 0.926$)
Females	$W= 0.002L^{3.522}$	($R^2=0.928$)

The results show that the value of the exponent b of the L/W relationship was higher than 3; which indicates positive allometric growth (Fig 2). The differences between the slopes of L/W regressions of the males and females were tested statistically using ANCOVA. There were no significant differences between males and females ($P> 0.05$).

Condition factor:

The condition factor (K) of *A. djedaba* showed minor monthly fluctuations (Fig. 3). The highest values (1.71 and 1.18) were recorded during October and November. Whereas, the lowest value (0.85) was recorded in February.

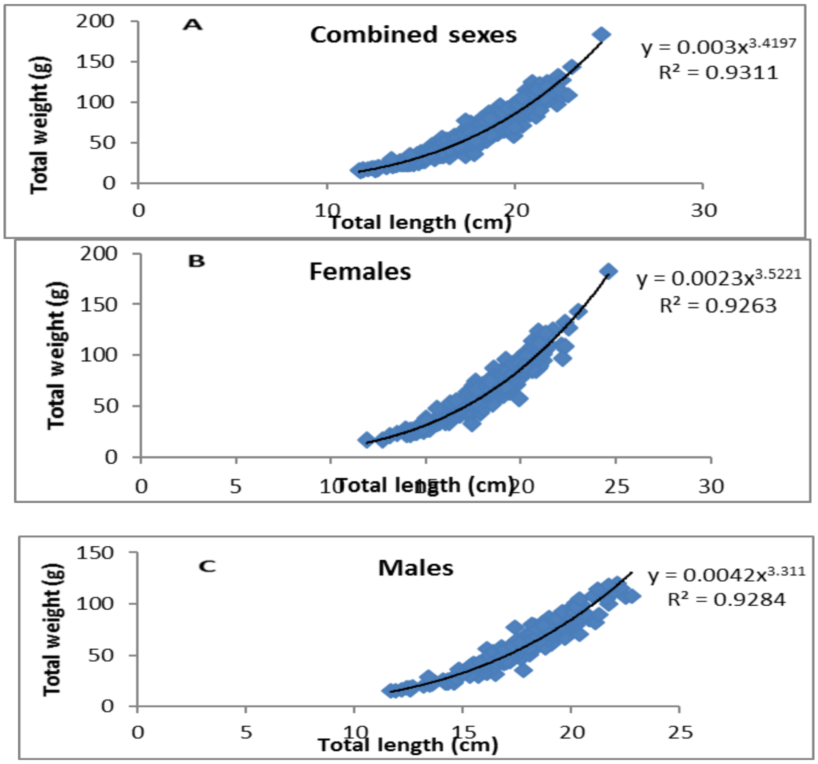

Fig. 2: Length weight relationship for *A. djedaba* from the Mediterranean Sea for A. combined sex, B. females and C. males.

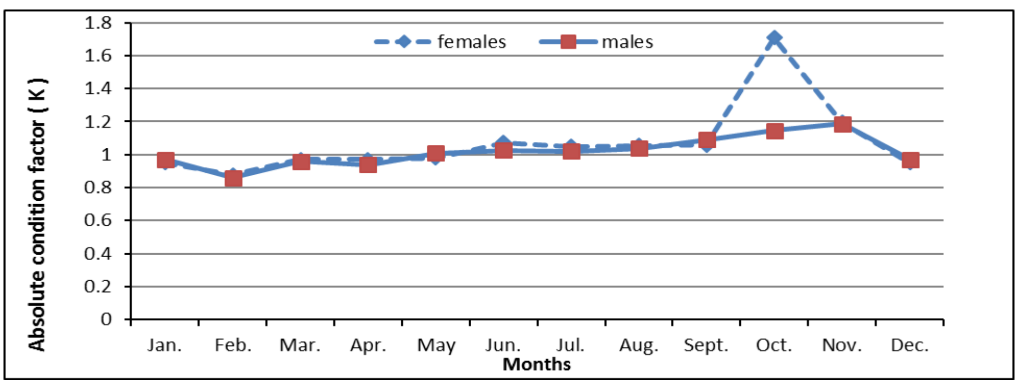

Fig. 3: The absolute condition factor of male and female *A. djedaba* from the Mediterranean Sea.

Length frequency distributions*:*

Monthly length frequency distributions (Fig. 4) showed that the bulk of the catch is composed of lengths ranged from 11.7 to 24.6 cm. The smallest individuals (<16 cm) were collected during February and constituted about 21.8% of the samples, while the long individuals > 21 cm were represented by about 8.9%. The largest recorded specimen (24.6 cm) was collected during June.

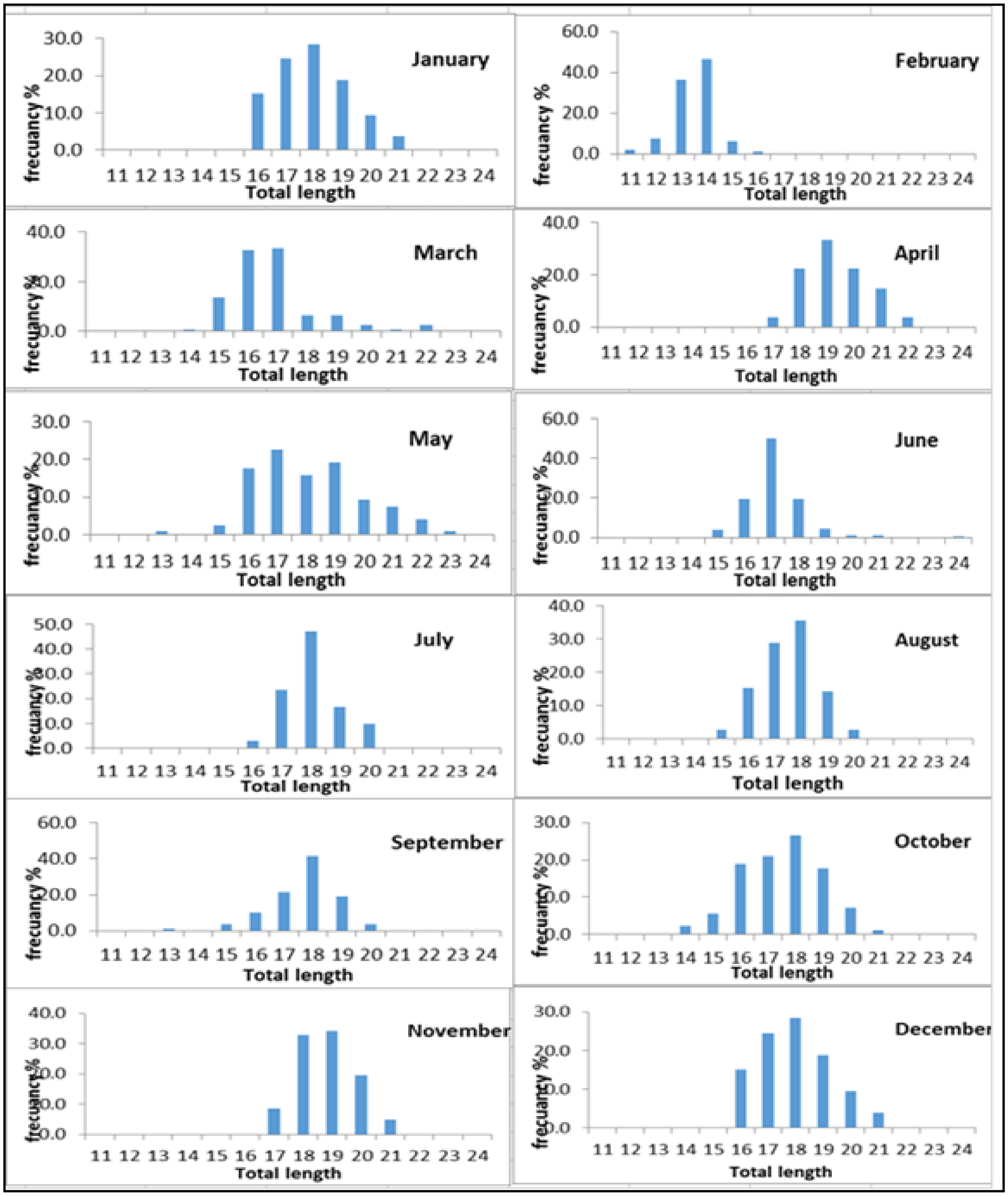

Fig (4): Monthly length frequency distributions of *A. djedaba* from the Mediterranean Sea.

Growth and theoretical growth in length:

Otoliths were used for age determination of *A. djedaba*, the reading showed three age groups with the predominance of age group two (55.7% of the catch). One annulus was formed per year (Fig 5) and the increase in growth is accompanied with decrease in rate of growth (Fig. 6). The pooled length frequency distributions were analyzed for the separation into component distributions, three components could be detected and considered as age groups (Table 1 and Fig 7). The theoretical growth in length of *A. djedaba* was described by von Bertalanffy growth equation as:

$$Lt = 29.21 [1 - e^{-0.301(t + 1.2)}].$$

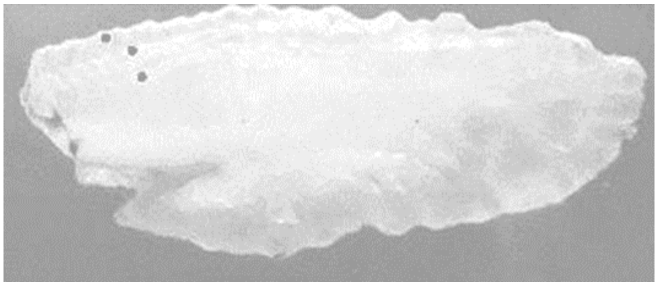

Fig (5) the otolith of *A. djedaba* sample with length of 24.0cm and 3 years age.

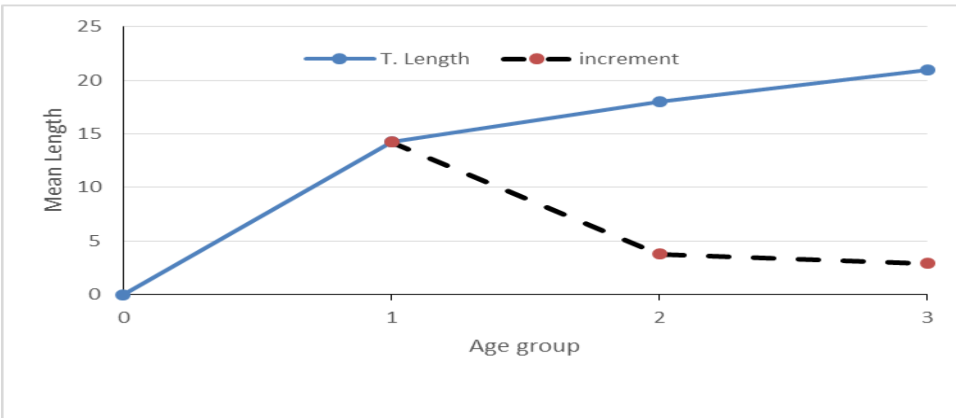

Fig (6) Growth in length and increment of *A.djedaba* from the Mediterranean Sea.

Table (1) Mean length at age estimated from direct age reading and from length frequency distribution (Bhattacharya, 1967 method)

Age	Age reading			Bhattacharya method			
	Number of fish	Mean Length (cm)	SD	Population	Mean Length (cm)	SD	S.I.
I	128	14.25	1.02	614	14.23	0.88	-
II	167	18.03	1.48	932	18.12	1.55	2.19
III	15	20.94	0.63	21	21.00	0.58	2.18

SD = Standard deviation **S.I. = Separation index**

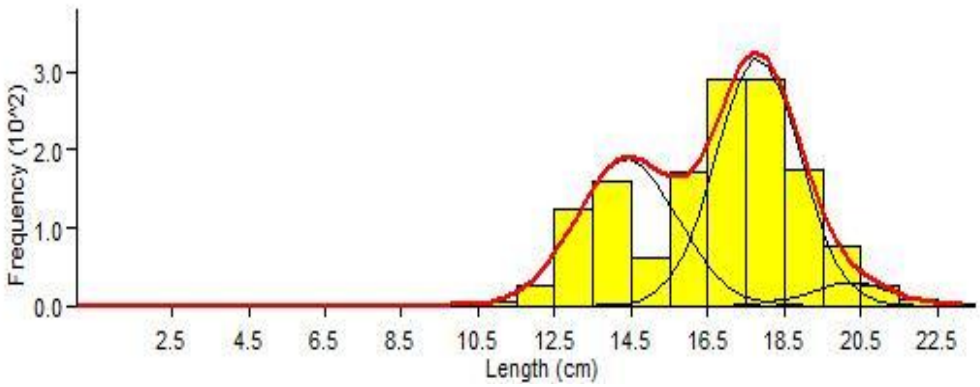

Fig (7) Decomposition of the length frequency distribution of *A. djedaba* by Bhattacharya (1967) method.

Mortalities and exploitation rates:

The length frequency distributions of *A. djedaba* were used for the estimation of the mean length in the catch ($\bar{L}$=17.22 cm) and the cut-off length (L'= 14.5 cm). Applying these values with the von Bertalanffy growth parameters in the Beverton and Holt (1956) equation gives an estimate for total mortality coefficient as Z = 1.322 year^{-1}. The natural mortality coefficient (M) was estimated as M= 0.45 year^{-1} and the fishing mortality coefficient was 0.87 year^{-1}. Exploitation rate was E= 0.66.

Length and age at first capture:

The length at which the fish may become vulnerable to fishing gears (L_c) for *A. djedaba* was computed as 14.5 cm and the corresponding age at first capture t_c which marks the beginning of the exploited phase was 1.01 years.

Yield per recruit and biomass per recruit:

The estimated current yield per recruit and biomass per recruit (Fig. 8) at the current fishing mortality (F= 0.872) for *A. dejedaba* from the Egyptian Mediterranean Sea is 32.9 gm and 38.5 gm respectively. The estimated biological reference points (F_{max}, $F_{0.1}$ and $F_{0.5}$) were 0.853, 0.736 and 0.456 respectively, producing (Y/R) of 32.9 g; 32.8 g and 31.7 g respectively. The current rate of fishing mortality (F_{curr} = 0.872) was higher than the estimated biological reference points. The results show that the percentage of the current biomass per recruit to the virgin biomass per recruit or unexploited level is 20.76%. The estimated $F_{curr}/F_{0.1}$ was 1.41. The biomass per recruit (B/R) at $F_{0.1}$ and F_{max} were 43.18 g and 38.59 g respectively.

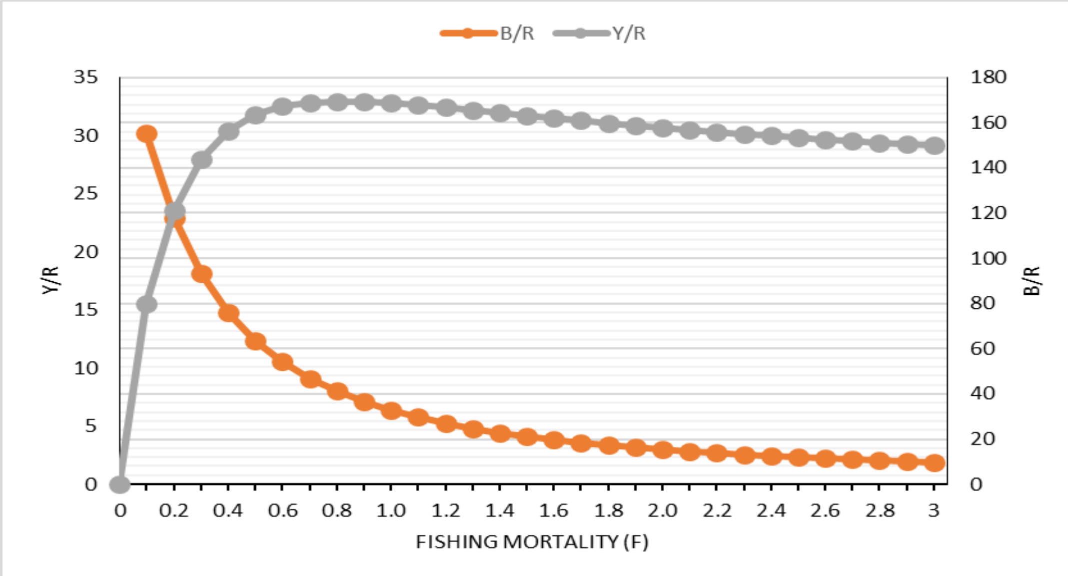

Fig (8) Yield and biomass per recruit of *A. djedaba* from the Egyptian Mediterranean Sea

DISCUSSION

The shrimp scad *Alepes djedaba* is one from the most commercial Carangid species in the purse seine catch of the Egyptian Mediterranean Sea. It is an immigrant species from the Red sea recorded by Golani (1998). The economic importance of shrimp scad fish's fishery in the Mediterranean makes it desirable to have information on the different aspects of its natural history in order to successfully manage its fisheries.

Growth in length studies including length-weight relationship is needed to appreciate the suitability of the environment for fish; and plays an important role in fishery management (Richter, *et al*., 2000). The length weight relationship for *A. djedaba* showed positive allometric growth. Several authors studied the length- weight relationship of *A. djedaba* in the Indo-pacific region and they got variable results (Table 2). Our estimates are in agreement with Reuben *et al*. (1992); El Aiatt (2018) and Roul *et al*. (2020). However, the variations in the estimated values of b are possibly due to factors related to the methods of sampling or to variations in the environmental conditions.

Condition factor K is an important indicator of the degree of well-being and relative robustness of the fish population; it may vary with length, season and habitat for the same species (Lagler, 1956). The condition factor (K) of *A. djedaba* showed the highest value during the end of autumn (after spawning period). Whereas, the lowest value was recorded during winter (before the spawning period directly), this is similar to many species which is in good condition after spawning and it were exhausted during the spawning period (Osman *et al,* 2020, Saber, *et al,* 2020). According to Barnham and Baxter (1998) scale for the *K* value as when k value is 1.00, the fish is in poor condition, long and thin, when k value is 1.20 this indicate that the fish is of moderate acceptable condition. A good and well-proportioned fish would have a *K* value that is approximately 1.40. *A. djedaba* is in wellbeing condition with K value 1.4 during autumn.

Table (2) Estimated length weight relationship constants in different localities

Area of Study	Author	Length range	a	b	R^2
Mediterranean Sea, Egypt	Present study	11.7 – 24.6	0.003	3.419	0.931
Indian Sea	Reuben *et al.*, (1992)		0.0004	3.147	
Mediterranean Sea, Egypt	Akel (2005)	9.0 – 22.0	0.012	2.976	0.997
Arabian Gulf	Osman & Abdulhadi (2011)		0.016	2.916	0.929
Taiwan	Chu *et al.*, (2011)	2.3 – 14.5	0.05	2.580	0.970
China Sea	Wang *et al.*, (2016)	13.7 – 26.8	0.019	2.970	0.996
Indonesia	Siwat *et al.*, (2016)	8.0 – 22.4	0.027	2.939	0.961
Indian Sea	Sajana & Nadan (2017)	11.6 – 32.5	0.011	2.964	0.970
Mediterranean Sea, Egypt	El Aiatt (2018)	11.1 – 25.3	0.006	3.134	0.857
Indian waters	Roul *et al.*, (2020)	12.0 – 33.5	0.004	3.267	0.975

The size composition of *A. djedaba* catch in the eastern Mediterranean during the period of study showed that about 22% of the catch belong to length groups <16 cm these sizes corresponding to age 1.5 to 2 years and are smaller than the length at first maturity (Lm = 16.0 and 16.7 cm for males and females respectively, unpublished data) This implies that juvenile individuals are the target of the fishery, and the stock dynamics of this species would be seriously affected. The high vulnerability of small sized fish to capture would result in the reduction of the future yield of the species.

The otolith reading and decomposition of the length frequency distribution revealed that the population of *A. djedaba* in the Mediterranean Sea comprise three age groups. A good agreement between length at age determined through direct otoliths reading and those from the length-based method was observed. The maximum life span of three years recorded in this study is in agreement with Akel, (2005) who observed three age groups on the otolith of the species from Abu Kir Bay, eastern Mediterranean. Abdel Barr *et al,* (2014), recorded four peaks in the length frequency distribution of *A. djedaba* in the Arabian Gulf, this longer life span may be due to the higher maximum recorded length in the Arabian Gulf (Lmax = 32.5 cm).

The study of growth pattern of *A. djedaba* indicated that the fish attained its highest increment in length during the first year of life, then growth increment decreased gradually with the increase in age. The estimated growth parameters revealed that *A. djedaba* is a short lived species with relatively slow rate of growth. Few studies recorded the growth parameters of the shrimp scad (Table 3), it seems that there is no agreement in the growth pattern estimated by the different authors. However, the growth performance index (ϕ**)** is comparable to that estimated by Akel, (2005) and lower than that recorded by Reuben *et al.,* (1992) and Abdel Barr *et al,* (2014). The difference in environmental conditions and ecosystem characteristics in the different areas may explain the variation in the estimates.

Table (3): L_∞, K and ϕ of the *A. djedaba* of the present study compared with the previous studies.

Area of study	Author	**L_∞**	**K**	**ϕ**
Mediterranean Sea, Egypt	Present study	29.21	0.301	2.41
Indian Sea	Reuben *et al.*,(1992)	32.6	0.61	2.81
Philippine	Corpuz *et al.*, (1985)	17.0	1.2	2.54
Abo Quir Bay	Akel (2005)	33.2	0.24	2.45
Arabian Gulf	Abdel Barr *et al.*, (2014)	41.7	0.36	-
Semarang waters, Indonesia	Siwat *et al.*, (2016)	23.0	-	-
Mediterranean coast of Sinai, Egypt	El Aiatt (2018)	26.94	0.2946	2.33

The estimation of mortality coefficient of a fish stock is an essential step for the calculation of the potential yield, optimum yield per recruit and the optimum fishing effort. In the present study, although the estimates of the total mortality coefficient (Z) could be affected by the absence of large individuals due to size-specific selectivity of small schooling fishes, our Z estimate of 1.322 is lower than that estimated by Abdel Barr *et al,* (2014) (Z= 2.07) in the Arabian Gulf and Akel, (2005) (Z= 1.82) in the eastern Mediterranean. The present estimate of the natural mortality coefficient (M= 0.45) is lower than that recorded by Abdel Barr *et al*, (2014) (M = 0.8) and Akel, (2005) (M = 0.62). However, their M were estimated by Pauly (1980) empirical equation which tend to overestimate the natural mortality coefficient (Grandcourt *et al*., 2007).

The estimated length at first capture (Lc= 14.5 cm) and the length compositions indicate that about 40% of the shrimp scad caught in the Egyptian Mediterranean waters were under the age of 50% maturity (Lm = 16.0 and 16.7 cm for males and females respectively, unpublished data). Lc as estimated in the present work corresponds to age group 1^+, this means that fishes of *A. djedaba* are caught before reaching sexual maturity, and this population in the Egyptian Mediterranean waters suffer from overfishing and recruitment would seriously affected.

The long-term objectives of fisheries management is mentoring the fishing level values which allow bigger catch and ensure conservation of the stock and the main purpose of carrying out stock assessment studies is to advice governments on whether the current amount of fishing on a stock is too high or too low, and what adjustments in the amount of fishing would be needed to bring the fishery into a more desirable state (Gulland, 1983).

According to the applied Y/R model and the point estimates of F_{max}, $F_{0.1}$ and $F_{0.5}$, the current rate of fishing mortality (F_{curr} = 0.87 $year^{-1}$) is higher than the target, limit and precautionary reference points (0.853, 0.736 and 0.456 respectively), which confirm the situation of overexploitation on the shrimp scad *A. djedaba* stock in the Egyptian Mediterranean waters.

The high fishing mortality would cause a low spawning stock biomass per recruit and recruitment overfishing (Clark, 1991; Mace, 1994). According to Kanyerere (2003), the maximum sustainable yield could be achieved when the percentage of the spawning stock biomass per recruit to the virgin or unexploited stock is between 25% and 50%. The present results indicated that the percentage of the current biomass per recruit to the unexploited level was 20.76% which implied recruitment overfishing.

For the sustainability of the shrimp scad *A. djedaba* stock in the Egyptian Mediterranean waters, the fishing mortality (F_{curr} = 0.87 $year^{-1}$) should be reduced to the level of the limit reference points ($F_{0.1}$ = 0.736). The management measures should include reduction of fishing effort and controlling fishing gear.

REFERENCES

Abd el Barrr, M.; Osman, A. M. and Al Abdullauh, H.A. (2014). Fisheries studies and stock evaluation of shrimp scad, Alepes djedaba (Teleostei: Carangidae) caught from Arabian Gulf. Journal of Coastal Life Medicine; 2(3): 203-208.

Akel, E. H. K. (2005). Growth, mortality and yield per recruit of shrimp scade A. djedaba from Abo quir bay eastern Alexandria, Egypt. Eypt. J. of Aqu. Boil. and Fish. 9(4): 145-160

Allen, G.R. and Erdmann, M.V. (2012). Reef fishes of the East Indies. Perth, Australia: Universitiy of Hawai'i Press, Volumes IIII.Tropical Reef Research.

Argente, F. A.T.; Narido, C.I.; Palla, H. P. and Caledonio, M. A. A. (2014). Review on the biology and parasites of the bigeye scad, *Selar crumenophthalmus* (Bloch, 1973). Journal of Multidisciplinary Scientific Research, 5:3

Artüz, M. L. and Kubanç, N. (2014). First record of shrimp scad *Alepes djedaba* (Carangidae) from the Sea of Marmara, Turkey. . Ichthyological note – Note ichtyologique Cybium, 2014. 38(4): 319-320.

Barnham, C. and Baxter, A. (1998). Condition Factor, K, for Salmonid Fish. Fisheries Notes, pp. 1-3.

Berry, F. H. and Smith-Vaniz, W. F. (1978). Carangidae. In: W. FI SHES ed. 1978. FAO species identification sheets for fisheries purposes. Western Central Atlantic. Fishing Area 31. Rome, FAO, Vol.1.

Beverton, H. and Holt, S.J. (1956). A review of methods for estimating mortality rates in exploited fish populations, with special reference to sources of bias in catch sampling, Rapp. et Procès-verbaux des Reunions. Conseil International pour I'Exploration de la Mer, 140: 67–83.

Beverton, R. and Holt, S.J. (1957). On the dynamics of exploited fish populations. Fishery Investigations Series 2. 19:533pp

Beverton, R. and Holt, S.J. (1966). Manual of methods for fish stock assessment. Part 2.Tables of yield functions. FAO Fish. Tech. Pap. 38 (Rev. 1), 67.

Bhattacharya, C. G. (1967). A simple method of resolution of a distribution into Gaussian components. Biometrics, 23:115-135.

Clark, W.G. (1991). Ground fish exploitation rates based on life history parameters. Canadian Journal of Fisheries and Aquatic Science; 48: 734-750.

Chu, W.S, ; Wang, J.P.; Hou, Y.Y.; Ueng, Y.T. and Chu, P.H. (2011)..Length-weight relationships for fishes off the southwestern coast of Taiwan. African journal of Biotechnology. 10(19): 3945-3950.

Corpuz, A.; Saeger, J. and Sambilay, V. (1985). Population parameters of commercially important fishes in Philippine waters. Tech. Rep. Univ. Philli. Visayas, Dept. mar. Fish (6): 99pp.

El-Aiatt, A.O. (2018). Growth, mortality and yield per recruit of the shrimp scad (*alepes djedaba*) from Mediterranean coast of sinai Egypt. Abbassa International Journal of Aquaculture, V0l.11 No. (1):86-108.

Froese, R. (2006). Cube law, condition factor and weight–length relationships: History, meta-analysis and recommendations. Journal of Applied Ichthyology, 22: 241–253.

GAFRD. (2019). Annual statistical report of the General Authority for Fish Resources Development, Egypt.

Gayanilo, F.C.; Sparre, P. and Pauly, D. (1994). FAO-ICLARM stock assessment tools II. Computerized information series fisheries. User's guide. World fish center food and agriculture organization of the United Nations Rome, 2005.pp. 68-72.

Golani, D. (1998). Distribution of Lessepsian migrant fish in the Mediterranean. *Italian* Journal of Zoology., 65(S1): 95-99.

Golani, D. (2005). Checklist of the Mediterranean fishes of Israel. Zootaxa, 947: 1-90.

Grandcourt, E.; Al Abdessalaam, T. and Francis, F. (2007). Al Shamsi A. Population biology and assessment of the white-spotted spinefoot, *Siganus canaliculatus* (Park, 1797), in the southern Arabian Gulf. Journal of Applied Ichthyology. 2007. 23, 53–59. doi:10.1111/j.1439-0426.2006.00796.x

Gulland, J. A. (1983). Fish stock assessment. A manual of basic methods. FAO/Wiley series on food and agriculture, Chichester, John Wiley and Sons.

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

Kanyerere, G. (2003). Age, growth and yield per recruit analysis of Ndunduma-*Diplataxodon limnathrissa* (Teleostei: Cichlidae) in the Southeast arm of Lake Malawi. M.Sc. Thesis, Rhodes University Grahamstown, South Africa.

Katsuragawa, M. and Matsuura, Y. (1992). Distribution and abundance of Carangid larvae in the southeastern Brazilian bight during 1975-1981. Bolm. Institution of Oceanography. 40: 55-78.

Lagler, K. F. (1956). Freshwater Fishery Biology. (W. M. C., Browned) Comp, Dubuque, Iowa. 421 pp.

Le Cren, E. (1951). The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). The Journal of Animal Ecology. 201-219.

Lanfranco, G. (1993). The fish around Malta (central Mediterranean). Valletta, Malta, Progress Press Co. Ltd, 132 pp.

Mace, P.M. (1994). Relationships between common biological reference points used as thresholds and targets of fisheries management strategies. Canadian Journal of Fisheries and Aquatic Science. 51: 110-122.

Osman, A.M. and Al Abdulhadi, H.A. (2011). Some aspects of reproductive biology of *Alepes djedaba* (Teleosti: Carangidae) in Arabia Gulf. Egyptian Journal of Aquatic Research. 37(3): 267-274.

Osman, H. M.; Saber, M.A.; El Ganainy, A. A. and Shaaban A. M. (2020). Fisheries biology of the haffara bream *Rhabdosaragus haffara* (Family: Sparidae) in Suez Bay, Egypt. Egyptian Journal of Aquatic Biology & Fisheries, Vol. 24(4): 361 – 372

Pauly, D. (1979). Gill size and temperature as governing factors in fish growth: ageneralization of von Bertalanffy's growth formula. Ber .Inst. Meereskd.Christian -Albrechts-Univ.Kiel, (63): 156 pp

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

Prager, H.; Saila, B.; and Recksiek, W. (1989). FISHPARM: a microcomputer program for parameter estimation of nonlinear models in fishery science. 2nd ed. Old Dominion University (Oceanography Technical Reports), no. 87, 18 pp.

Ragheb, E.; El -Sayed, H.K.A. and Rizkalla, S.I. (2019). Analyses of the non-target catch from the Egyptian Mediterranean trawlers, off Port Said. Egyptian Journal of Aquatic Research. 45, 239–246

Raje, S.G. (1993). Some aspects of biology of *Alepes djedaba* (Forsskål) from Veraval, Gujarat. Indian Journal of Fisheries; 40(3): 189-192

Reuben, S.; Kasim; H.M.; Sivakami S.; Radhakrishnan P.N.; Kurup K.N. and Sivadas, M. (1992). Fishery, biology and stock assessment of carangid resources from the Indian seas. Indian J. Fish., 39 (3-4): 195-234.

Richter, H.; Lukstadt, C.; Focken, U. and Becker, K. (2000). An improved procedure to assess fish condition on the basis of length-weight relationships. Archive of Fishery and Marine Research. 48(3):255-264.

Roul, S. K.; Akhil, A. R.; Retheesh, T. B.; Rajesh, K. M.; Ganga, U. E. M.; Abdussamad, E. M. and Rohit, P. (2020). Length-Weight Relationships of Fifty Fish Species from Indian Waters. Thalassas: An International Journal of Marine Sciences, 36:309–314. https://doi.org/10.1007/s41208-020-00223-x

Saber, M.A.; Shaaban, A. M.; El Ganainy, A. A. and Osman, H. M. (2020). Species composition, length-weight relationships and condition factor of commercial species grasped by trammel nets and gill nets in the Gulf of Suez, Red Sea, Egypt Egyptian Journal of Aquatic Biology & Fisheries. Vol. 24(3): 145 – 156

Sajana, N. and Bijoy Nandan; S. (2017). Morphometry, length-weight relationship and relative condition factor of shrimp scad *alepes djedaba* (forsskal, 1775) off Cochin coast, kerala. Journal of & Fisheries. Vol. 5. pp. 160-167.

Shuaib,N. and Ayub, Z. (2011). Length-weight relationship, fecundity, sex-ratio and gonadal maturation in shrimp scad, *Alepes djedaba* (Forsskal, 1775) landing at the Karachi fish harbour, Karachi, Pakistan. International fisheries symposium., 10-16.

Sivakami, S. (1990). Observations on some aspects of biology *Alepes djedaba* (Forsskal) from Cochin. J. Mar. Biol. Assoc. India, 32: 107-118

Siwat, V.; Ambariyanto A. and Widowati, I. (2016). Biometrics of bigeye scad, *Selar crumenophthalmus* and shrimp scad, *Alepes djedaba* from Semarang waters, Indonesia. AACL Bioflux, 9 (4): 915-922.

Sommer, C.; Schneider, W. and Poutiers, J.M. (1996). FAO species identification field guide for fishery purposes. The living marine resources of Somalia. FAO, Rome.

Sparre, P.; Ursin, E. and Venema, S.C. (1989). Introduction to tropical fish stock assessment. Part 1- manual. FAO Fish Tech. Pap. No. 306, 337

Steinitz W. (1927). Beitrnge zur Kenntnis der Küstenfauna Palنstinas. I. Pubbl. Stn. Zool. Napoli, 8(3-4): 311-353

Turan, C.; Gürlek, M.; Özeren, A. and Doğdu, S. A. (2017). First Indo-Pacific fish species from the Black Sea coast of Turkey: Shrimp scad *Alepes djedaba* (Forsskål, 1775) Carangidae). Short communication. NE Sciences, 2 (3): 149-157

Van Der, R. P. (1993). Marine recreational angling in South Africa: management strategies and their implementation. In Australian Recreational Fishing. Policies for Resource Management. Dovers, S. (Ed). Issues Wat. Mgmt, 7: 15–23.

Wang, J.Q.; Huang, L.M.; Li J., Zhang, Y.Z.; Zhu, G.P. and Chen, X.J. (2016). Length–weight relationships of 45 fish species in the Min River Estuary, East China Sea. Journalof Applied Ichthyology. 32(1):131–133. https://doi.org/10.1111/jai.12910