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Effect of Age on Growth of Keeled Mullet Fish *Liza Carinata* (Valenciennes, 1836) in Different Environmental Conditions (Wild And Lab.)

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ABSTRACT

This study was carried out in the central laboratory for aquaculture research and the National Institute of Oceanography and Fisheries, Suez branch on the Keeled mullet, *Liza carinata* as two parts. In the first part within the wet laboratory, four treatments were formed by ratio densities 40, 60, 80, and 100 fish per cubic meter within a wet laboratory. This experiment expanded for 13 weeks. The fish fed on commercial diets 32% crude protein 6 days per week for two times as 3% of biomass weight of fish. The following parameters were measured: growth performance during the experimental period and gonadosomatic index at the end of the experiment. Results showed that females' final weight, gain weight, daily weight gain, and SGR were slightly higher than those of males. GSI ranged from 0.19±0.003 to 0.24±0.005 for females and males, respectively. The second part within wild, monthly random samples *L. carinata* were collected from the commercial catch of artisanal boats at Suez Bay during the period from September 2018 to September 2019. The length-frequency for more than 943 specimens of *L. carinata* was grouped in 1cm length classes. In the laboratory date of capture, total length to the nearest mm, total weight to the nearest 0.1g. The equation for growth in length was $L_t = 22.45\ (1 - e^{-0.52\ (t+0.34)})$. The equation for growth in weight is: $W_t = 133.96\ (1 - e^{-0.52\ (t+0.34)})^{3.12}$

INTRODUCTION

Mullets are the most vital species contributing in the fishery of the Red Sea where they contribute about 0.31% of the yearly Red Sea production according to **GAFRD (2017)**. Although this species always spawn at sea, they are highly euryhaline and succeed in a wide range of salinities **(McDowall, 1988)**. The mullets are global distributed species in tropical and temperate shore waters. In spite of the importance of mullets to fishery resources in the Suez Bay, no managing rules have been established to protect this valuable resource in the Bay *L. carinata* represented about 18% of the total catch of the Suez Bay during the last ten years **(GAFRD, 2012)** recorded by **El-Ganainy and El-Boray (1999)**. The keeled mullet *Liza carinata* nearby named "Sehlia" is a mugilid species of commercial value for fisheries and aquaculture in Gulf of Suez and Suez Canal sector **(Mehanna, 2004** and **Mehanna *et al*., 2019).** *Liza carinata* inhabit tropical and warm-temperate bays **(Pombo *et al*., 2005)** and well-thought-out as respected food sources and very representative species for rearing in fish farms.

The Mugilidae family is widely scattered throughout the biosphere. In the Mediterranean Sea there are eight mullet species: *Chelon labrosus* Risso, 1827, *Liza aurata* Risso, 1810, *Liza ramada* Risso, 1827, *Liza saliens* Risso, 1810, *Mugil cephalus* Linnaeus, 1758, *Oedalechilus labeo* Cuvier, 1829, *Liza carinata* Valenciennes, 1836, and *Liza haematocheila* Temminck and Schelegel, 1845, this is cited by **Thomson (1997)**. The flathead grey mullet, *Mugil cephalus*, is the most public and has an important economic value in the area **(Whitfield *et al.*, 2012**). After spawning off–shore, *M. cephalus* larvae migrate to estuarial or freshwater parts where juveniles continue until they reach sexual maturity **(Chang and Iizuka, 2012 and Whitfield *et al*., 2012)**. Family Mugilidae is extensively blowout and representing an imperative species for farming in fish farms. Mugil species, frequently known as mullets, are pelagic-coastal fishes universal scattered. *Liza carinata* commonly occupy tropical and warm-temperate estuaries **(Pombo *et al.*, 2005)**. **Laffaille *et al*. (2002)** and **Almeida (2003)** showed that mugilidae play a vital ecological role where this fish public seems to be particulate organic matter trailer and could play a substantial role in the global energy funds of environment. This fish are respected food sources and ecologically important as primary consumer at coastal and estuarine food chains, and also very characteristic species for rearing in fish farms **(El-Halfawy, 2004)**.

In fish sex ratio varies significantly from species to species but in the common it is close to 1:1 (as the hypothetical value) in which the estimated birth number of females and males are the same **(Vazzoler, 1996)**. It differs from population to another of the same species and may differ from year to year in the same population **(EL-Halfawy *et al.*, 2007)**. S**elman and Wallace (1989)** stated that the uppermost values of the GSI gained in the month of December to February evidently representing the spawning months. *L. parsia* is a yearly breeder showing a single peak value in a year. From March onwards GSI decreases intensely indicating the onset of post-spawning or spent phase and reach its lowermost level in the month of June, when the fish remain in resting phase. According to the pattern of the oocyte development, the ovaries of the fishes have been classified into three types.

In a synchronic type of ovulation, diverse development stages of the oocyte maturation and ovulation in groups may be found within the ovaries **(Nejedli *et al.*,**

2004). According to (**Yueh and Chang, 2000)** changes of the oocytes of black porgy during maturation were similar to that of other teleosts. From the GSI data and as per the spreading of oocytes, it can be disguised that *L. parsia* is an annual breeder fish and follows the synchronous mode of development. The development of the length based stock assessment methodologies, it is possible to investigate population dynamics of fish stocks in tropical waters **(Pauly and Morgan, 1987)**. The multispecies fishery in the Persian Gulf is conquered by many commercially vital species including *Liza klunzingeri*, *Pampus argenteus*, *Acanthopagrus spp*., *Epinephelus tauvina*, *Formio niger*, *Tenualosa ilisha*, *Pomadasys kaanan*, *Otolithes argenteus*, *O. ruber* **(Bishop, 2002& 2003**).

Aim of the work

The present work aimed to study the relation between age and growth of keeled mullet fish (*Liza carinata)* **(Valenciennes, 1836)** in different environments (in laboratory and in the wild).

MATERIALS AND METHODS

This study was carried out in the central laboratory for aquaculture research and National Institute of Oceanography and Fisheries, Suez branch on the Keeled mullet, *Liza carinata* as two parts.

1-First part within wet lab

Four treatments were formed by ratio densities 40, 60, 80 and 100 fish per cubic meter within wet laboratory of National Institute of Oceanography and Fisheries, Suez branch (aquaria were used in this experiment, each aquarium 40wX50LX60h cm). First treatment (T1) was distributed in three replicate aquaria, each aquarium has four fishes, second treatment (T2) was distributed in three replicate aquaria, each aquarium has six fishes, third treatment (T3) was distributed in three replicate aquaria, each aquarium has eight fishes and fourth treatment (T4) was distributed in three replicate aquaria, each aquarium has ten fishes. This experiment expanded for 13 weeks. The fish fed on commercial diets 32% crude protein 6 days per week for two times as 3% of biomass weight of fish. The following parameters were measured: growth performance during the experimental period, gonadosomatic index at the end of the experiment, and water quality during the experiment.

a-Growth performances parameters:

Growth performance parameters were measured biweekly and calculated at the end of the experiment. Weight gain (g/fish) = W2 – W1. Daily weight gained = weight gained/ time of experiment. Specific growth rate (SGR) = 100 [Ln Wt1– Ln Wt0] / T

Where: Ln = Normal logb. Wt1 = The final weight (g). Wt0 = The initial weight (g). T = the time of experiment (days).

b-Gonadosomatic Index:

Gonadosomatic index (G.S.I) was computed as the percentage weight of the fish gonads to the total weight of the fish and it was used as an indication of maturity. It was calculated from the following formula: G.S.I. = (Gonad weight / weight of fish X 100)

2-Second part within wild:

Monthly random samples *L. carinata* were collected from the commercial catch of artisanal boats at Suez Buy during the period from September 2018 to September 2019. The length frequency for more than 943 specimens of *L. carinata* was grouped in 1cm length classes. Specimens represented all length classes of the species were taken as a sub-sample for age determination. In the laboratory, samples were examined and the following data were recorded for each specimen: date of capture, total length to the nearest mm, total weight to the nearest 0.1g.

a-Age and growth:

Age was determined by counting the annual rings on the scale of *L. carinata* examined by Lica Zoom 2000 microscope. The cohorts and age determination were gained by splitting the pooled length frequency distributions were analyzed using the appropriate routines of the "FiSAT" computer program (**Gayanilo *et al.*, 1998**). The assigned ages at each length group were used for the estimation of the growth parameters ($L\infty$, K and t_o) according to **von Bertalanffy (1938)** plot growth formula:

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

Where Lt is the length at age, $L\infty$ is the asymptotic length in cm, K is the growth coefficient and t0 is the age at which length equal to zero.

b-Length-weight relationship:

Length-weight relationship was determined according to the following equation:

$$W=aL^b$$

Where W = Weight of fish in g, L = Total length of the fish in cm and a & b are constants whose values are estimated by the least square method.

<u>Statistical Analysis:</u>

The obtained data of fish were subjected to one-way ANOVA. Differences between means were tested at the 5% probability level using Duncan test **(Duncun,**

1955). All the statistical analysis was done using SPSS version 20 (SPSS, Richmond, USA) as described by **Dytham (1999)**.

RESULTS

1.Wet lab study:

The results showed the length, growth and GSI for males and females of keeled mullet *Liza carinata* inside the laboratory which illustrated in tables (1, 2 and 3).

Data in table (1) showed that average means (means±S.D) of growth performance parameters (initial weight (g), final weight (g), initial length (cm), final length (cm), gain weight (g), daily weight gain (g) and specific growth rate (%) during the experimental period for different treatments of males Keeled Mullet. The initial weight was ranged from 4.99±0.02 g to 5.07±0.03 g. final weight was significantly high in treatment (1) 26.25±0.62 g, while it was significantly low (22.5±0.52 g) in treatment (4). The initial length ranged from 2.92±0.07 cm to 2.97±0.21 cm. The highest gain weight and daily gain weight (21.51±0.45 g and 0.24±0.02g) respectively were recorded among the first treatment, while their lowest values (17.45±0.47g and 0.19±0.03g) respectively were recorded among T(4). The highest specific growth rate (1.83± 0.02%) was recorded among T(1), while the lowest SGR (1.66 ± 0.04%) was recorded in T(4).

Table 1. Average means (means±S.D) of growth performance parameters (initial weight (g), final weight (g), initial length (cm), final length (cm), gain weight (g), daily weight gain (g) and specific growth rate (%) during the experimental period for different treatments of males Keeled Mullet Fish.

Males	T1	T2	T3	T4
Initial weight (g)	5.04±0.04^{a}	4.99±0.02^{a}	5.07±0.03^{a}	5.05±0.02^{a}
Final weight (g)	26.25±0.62^{a}	24.99±0.47^{b}	23.19±0.43^{c}	22.5±0.52^{c}
Initial length (cm)	2.97±0.21^{a}	2.94±0.15^{a}	2.92±0.07^{a}	2.95±0.03^{a}
Final length (cm)	13.60±0.32^{a}	14.15±0.41^{a}	13.92±0.38^{a}	13.55±0.35^{a}
Gain weight (g)	21.51±0.45^{a}	20.00±0.67^{b}	18.12±0.73^{c}	17.45±0.47^{c}
Daily weight gain (g)	0.24±0.02^{a}	0.22±0.03^{a}	0.20±0.02^{ab}	0.19±0.03^{b}
SGR (%)	1.83 ± 0.02^{a}	1.79 ± 0.03^{ab}	1.69 ± 0.08^{bc}	1.66 ± 0.04^{c}

Means have the same letter in the same row for the same parameter are not significant (P>0.05)

Data in table (2) showed that average means (means±S.D) of growth performance parameters and ovaries (initial weight (g), final weight (g), initial length (cm), final length (cm), gain weight (g), daily weight gain (g) and specific growth rate (%) during the experimental period for different treatments of males Keeled Mullet. The initial weight was ranged from 4.99±0.03 g to 5.03±0.04 g. final weight was significantly high in treatment (1) 28.66±0.52 g, while it was significantly low (22.91±0.62 g) in treatment (4). The initial length ranged from 2.93±0.05 cm to 2.96±0.12 cm. The highest gain weight and daily gain weight (23.67±0.65 g and 0.26±0.04g) respectively were recorded among the first treatment, while their lowest values (17.89±0.56g and 0.20±0.02g) respectively were recorded among T(4). The highest specific growth rate (1.94± 0.06%) was recorded among (T1), while the lowest SGR (1.69 ± 0.05%) was recorded in (T4).

Table 2. Average means (means±S.D) of growth performance parameters (initial weight (g), final weight (g), initial length (cm), final length (cm), gain weight (g), daily weight gain (g) and specific growth rate (%) during the experimental period for different treatments of females Keeled Mullet Fish.

Females	**T1**	**T2**	**T3**	**T4**
Initial weight (g)	4.99±0.03[a]	4.95±0.04[a]	5.03±0.04[a]	5.02±0.03[a]
Final weight (g)	28.66±0.52[a]	25.80±0.51[b]	23.69±0.39[c]	22.91±0.62[c]
Initial length (cm)	2.96±0.12[a]	2.91±0.09[a]	2.94±0.08[a]	2.93±0.05[a]
Final length (cm)	13.90±0.23[a]	14.20±0.44[a]	14.00±0.43[a]	13.4±0.36a
Gain weight (g)	23.67±0.65[a]	20.85±0.49[b]	18.66±0.53[c]	17.89±0.56[c]
Daily weight gain (g)	0.26±0.04[a]	0.23±0.04[a]	0.21±0.05[a]	0.20±0.02[a]
SGR (%)	1.94 ±0.06[a]	1.83 ±0.03[b]	1.72 ±0.07[c]	1.69 ±0.05[c]

Means have the same letter in the same row for the same parameter are not significant (P>0.05)

Data of gonads weight and gonadosomatic index for both males and females were shown in table (3). Testes weight was significantly high among the first two treatments (0.06±0.003g and 0.06±0.002g) respectively, while it was significantly low among T(3&4) (0.05±0.002g). the highest gonadosomatic index for males (0.24±0.005%) was recorded in treatment (2), while the lowest values (0.22±0.005 and 0.22±0.003 %) was recorded among T(3&4) respectively. Ovaries weight was significantly high among the first treatment (0.06±0.003g), while it was significantly low among T(3&4) (0.04±0.002g and 0.04±0.004g) respectively. The highest gonadosomatic index for females (0.21±0.003%) was recorded in treatment (1), while its lowest value (0.17±0.002 %) was recorded among T(3&4).

Table 3. Average means (means±S.D) of testes weight (g), ovaries weight (g) and Gonadosomatic index (%) for both males and females at the end of the experimental period for different treatments of females Keeled Mullet Fish.

	T1	**T2**	**T3**	**T4**
Testis weight (g)	0.06±0.003[a]	0.06±0.002[a]	0.05±0.002[b]	0.05±0.002[b]
GSI for males (%)	0.23±0.004[b]	0.24±0.005[a]	0.22±0.005[c]	0.22±0.003[c]
Ovary weight (g)	0.06±0.003[a]	0.05±0.003[b]	0.04±0.002[c]	0.04±0.004[c]
GSI for females (%)	0.21±0.003[a]	0.19±0.003[b]	0.17±0.002[c]	0.17±0.002[c]

Means have the same letter in the same row for the same parameter are not significant (P>0.05)

2.Wild study:

In this study, we collected samples during one year and separated different ages in these samples.

2.1.Age determination:

The results indicated that, the maximum life span of *L. carinata* is three years. Mean of the lengths corresponding to the various ages of *L. carinata* are 12.11, 15.87 and 18.15 cm TL for the 1st, 2nd and 3rd year of life respectively. It was found that, the species reach its highest increase in length during the first year of life, after which a gradual decrease in growth increment is observed with further increase in age until reaches its minimum value at the end of last year of life (3th year) fig. (1). while, growth in weight of *L.carinata* was found the mean weight for each age group is estimated to be 19.41, 45.14 and 68.62 g during the three years of life respectively. It is clear that, the growth in weight is much slower in the first year of life and annual increment in weight increase with further increase in age until reaches its maximum value at age group (II), after which a gradual decrease in annual increment is observed fig.(2). Age cohorts were separated by using **Battacharya** method **(1967)** and are shown in three cohort components can be successively separated from the length frequency distribution for *L. carinata*, which indicates that its life span may reach three years. three cohorts were identified for *L. carinata* on comparing the mean lengths of cohort components of the pooled data with those of the mean total lengths at capture as measured (Fig. 3), these lengths don't deviate so much from those of the other authors who worked on *L. carinata*. Therefore, length frequency could be considered as simple method for aging fish beside reading of otoliths, scales and other hard parts.

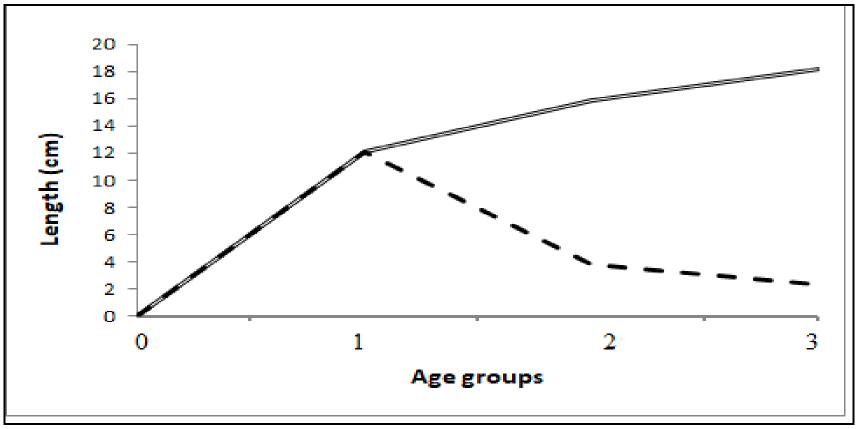

Fig. 1. Back calculated length and annual increment of L. carinata, from Suez Bay

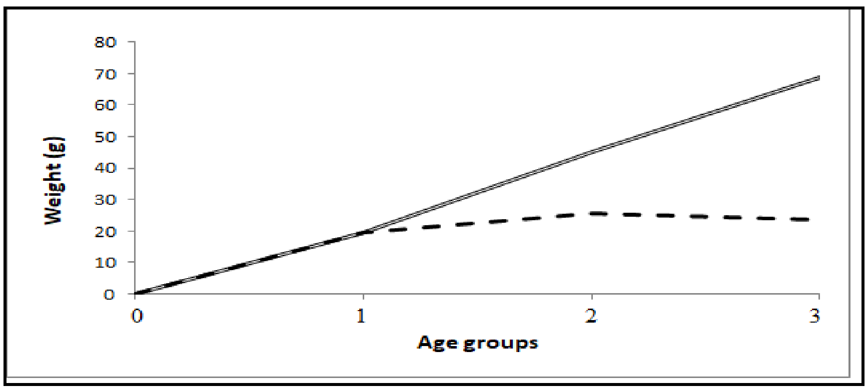

Fig. 2. Calculated weight (g) and annual increment of L from carinata, from Suez Bay

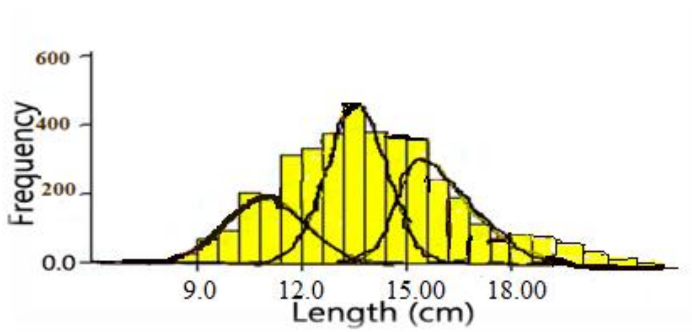

Fig. 3. Cohorts identified length frequency distributions of *L. carinata* collected from the Suez Bay**.**

a. Length-Weight Relationship:-

In the present study, the total length of *L. carinata* ranged between 8 to 19 cm, while their total weights are varied between 5 g and 75 g. The obtained length weight relationship equation (Fig. 4) was $W = 0.0081\ L^{3.1202}$. where "b" value was (3.1202) it is clear that, "b" value is equal to 3, indicating a tendency towards isometric growth.

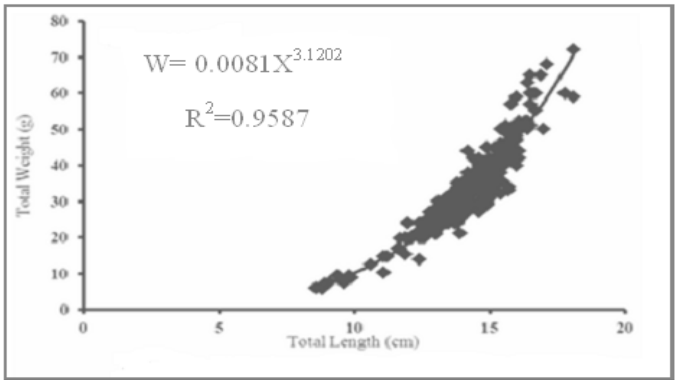

Fig. 4. Length-weight relationship of *Liza carinata* collected from Suez Bay.

b. Growth Parameters:

In the present study, the growth model of von Bertalanffy was applied to describe the theoretical growth of *L. carinata* in the Suez Bay obtained L_∞ of *L. carinata* (22.45 cm). Also growth coefficient (K value) in the present study was (0.52/year). The constants of The von Bertalanffy's growth model constants were estimated by equations were as the following:

For growth in length:

$$L_t = 22.45\ (1 - e^{-0.52\ (t + 0.34)})$$

While, the present study the growth model of von Bertalanffy was applied to describe the theoretical growth in weight of *L. carinata* in the Suez Bay obtained W_∞ (133.96 g).

For growth in weight:

$$W_t = 133.96\ (1 - e^{-0.52\ (t + 0.34)})^{3.12}$$

The age, length and weight of Liza carinata in Lab. and Wild was shown in table (4). Ages determined from wild were 1, 2 and 3 years, while in the lab the maximum age was 5 months. Total fish length was 13.66 cm in 6 months period indoors, but outdoors the it was recorded 12.11, 15.87 and 18.15cm in 12 months, 24 months and 36 months respectively. Fish weight was 26.25g in 6 months indoors. While it was recorded 19.41g, 45.14g and 68.62 g in 12 months, 24 months and 36 months respectively for the outdoors.

Table 4. Comparison between age, length and weight of *Liza carinata* in Lab. and Wild

Parameters	Lab.	Wild		
		12 month	24 month	36 month
Age	2+3 (5 months)	1	2	3
Length	13.66 cm/6 month	12.11 cm	15.87 cm	18.15 cm
Weight	26.25 g/6 month	19.41 g	45.14 g	68.62 g

DISCUSSION

Length, weight and gonads development of keeled mullet (*Liza carinata*) are directly relationship with age within lab, and wild. The keeled mullet, (*Liza klunzingeri)*, has been found from numerous parts of the Indian Ocean, the Mediterranean Sea as well as shore waters of Japan and China **(Golani, 2002)**. It is reported that there are weighty stock numbers in the waters of the Persian Gulf (**Valinassab *et al.*, 2006)**. The maximum distinguished length was 142mm, although lengths of 200mm and 150mm have been recorded by **Carpenter *et al.*, (1997)**. Maximum lengths of 225mm for this species have been recorded by **Valinassab *et al.*, (2006)** in Khouzestan waters. World aquaculture is rising rapidly to participate in facing the problem of protein food deficiency especially in the developing countries. This industry causes high pressure on the environment due the great waste products in water bodies **(Gutierrez-Wing and Malone, 2006; De Schryver *et al.*, 2008)**. Females in the present study showed high abundance in large sizes more than males, which confirmed with **Lawson *et al.*, (2010)** for the same species, (**Albieri and Araújo, 2010)** for *Mugil liza.*

SGR was not affected with aquaculture system change and significantly affected by change in protein level. This result disagrees with **Xu *et al.*, (2012)** who recorded that the final weight, weight gain and SGR of *L. vannamei* in the biofloc treatments fed on diets with 30% and 35% CP were significantly higher than those found in the control fed on the diet with 25% CP and there was no significant difference among the BFT25%, BFT30% and BFT35%. **Wasielesky *et al*.,** (**2006)** demonstrated that *L. vannamei* juveniles grown in a BFT had higher growth rate than that grown in CWS. Likewise, **Arnold *et al*., (2009)** found that using biofloc in a high intensity tank system with zero exchange water could significantly improve the growth of Penaeus monodon juveniles.

The GSI can be used as a guide for spawning period, which was recorded from November to March for females and males, showing prolonged spawning period which based on the presence of large number of males and females in stage V to VII (mature to spent) coupled with very high value of GSI recorded in this period these agreement with **Hefny *et al*., (2016)** who estimated the gonado-somatic index for *L. carinata* to determine its spawning behaviour. The GSI of males was lower than that of females. GSI increase progressively with increase in the percentage of ripe individuals towards the spawning season **(Mohamed, 2010**). This was the same with **(Hakimelahi *et al.*, 2011; Hashemi *et al.*, 2013)** for the same species.

El-Ganainy and Mehana (2003); Sabrah (2006); Sabrah *et al*. (2006) stated that otoliths, scales or other hard parts can be used for determination of fish age. while, other authors have used the length frequency to predict age components, so the present study based on the length frequency distribution also an attempt to be compared with other authors from scale reading methods. The present result is in agreement with the findings of **Mehanna (2004)** who gave b-value at 3.0479 from Bitter Lakes and **Huang *et al*., (2018)** who recorded b-value at 3.02. While disagreed with the findings of **Hussain *et al*., (2010)** who estimated b at 2.205 in Northern Arabian Sea, **El-Gannainy *et al*., (2014)** who recorded 2.869 of b-value in Suez Bay and **Mehanna *et al*., (2019)** estimated b-value at 2.8115 in Bitter Likes. It is well known that, the length-weight relationship in fish can be affected by a number of aspects including season, habitat, gonad maturity, sex, diet and stomach fullness, health and preservation techniques and differences in the length ranges of the specimens caught **(Zaahkouk *et al*., 2017)**.

Mehanna (2004) estimated L_∞ as 23.59 cm from Bitter Lakes, while **Hakimelahi *et al*., (2010)** recorded L_∞ was 20.3 cm in Persian Gulf. **El-Ganainy *et al*. (2014)** gave L_∞ equal to 21.28 cm in Suez Bay, and **Mehanna, *et al*., (2019)** estimated L_∞ as 23.5 cm from Bitter Lakes. On the other hand, the present growth coefficient value K= 0.52/year of *L. carinata* was more or less similar to that recorded in the other studies; 0.60/year in Bitter Lakes. **(Mehanna, 2004**), 0.6/year in Persian Gulf (**Hakimelahi *et al*., 2010**), 0.46/year in Suez Bay (**El- Ganainy *et al*., 2014)** and 0.42/ year in Bitter Lakes **(Mehanna *et al*., 2019)**. The lower or higher values of L_∞ may be resulted from the difference in the recorded maximum length, the method used and/or the stress of water pollution or personal error.

CONCLUSION

The current study demonstrated that growth performance and production of keeled mullets (*Liza carinata*) in aquaculture is better than in wild, which can be controlled of percentage of protein in feeding and according to fish density per cubic meter. this was clearly identified in this study by comparing fish of the same age in laboratory and in the wild.

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