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Original Article

Some biological aspects of European seabass *Dicentrarchus labrax* in Egyptian Mediterranean water and aquaculture, Egypt

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Abstract

Biological aspects between cultivated and wild sea bass, *Dicentrarchus labrax* were evaluated. Fish samples were collected seasonally from Boughaz El-Maadiya in the eastern Mediterranean coast and fish farm. The length-weight relationship of seabass from two habitats were calculated and condition factor for seabass captured from El-Maadiya region (Mean ± S.d = 1.044 ± 0.0905) was lower than that for fish farm (Mean ± S.d = 1.158 ± 0.8119). The mean value of natural mortality coefficient for wild seabass was 0.172 ± 0.017. Significant seasonal difference in degrees of stomach fullness of seabass from El-Maadiya region ($F = 3.589$, $df = 3$, $p<0.05$) and fish farm ($F = 8.381$, $df = 3$, $p<0.01$). sex ratio for seabass from El-Maadiya region (X^2 =5.21, $p < 0.05$) differ significantly from cultivated in fish farm. The average of gonadosomatic index (GSI) (0.258 ± 0.2865), hepatosomatic Index (HSI) (1.20 ± 0.5714) and spleen-somatic index (SSI) (0.102 ± 0.0518) for fishes from El-Maadiya region was lower than GSI (0.940 ± 1.5601), HSI (1.486 ± 0.5247) and SSI (0.157 ± 0.2406) for cultured seabass.

Keywords: *Fishery biology, Natural mortality, Feeding intensity, biological indices*

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Introduction

European seabass (*Dicentrarchus labrax*) is now considered an important economic species. It constitutes 1.4% of the total catch off the Egyptian Mediterranean coast (GAFRD, 2012). The European seabass were produced in limited amounts in marine fish farms, which depend on fry collected from the wild. Recently, fish hatcheries are used to cultivate and breed a large number of fish in an enclosed environment, eliminating the need to find the fish in the wild. This is necessary to avoid the negative effect of fry collection on fish stock in natural resources. The wild fry of sea bass are collected and disbursed from five collecting stations located in, Behira (El-Maadiya), Damietta, Port Said, Ismaelia and Suez. The aquatic environment with its water quality is considered the main factor, which are controlled the state of health and disease in both cultured and wild fishes. Boughaz El-Maadiya is considered as one of the most important collecting stations of sea bass fries. This is receiving from Abu-Qir Bay considerable amounts of raw industrial wastes from many factories through El-Tabia pumping station with an average about 1850 X 10^3 m^3/day (Aboul-Ezz and Soliman, 2000). In addition, to sea bass fry when introduce to Lake Edku for feeding exposed to drainage water coming from mainly, two drains: El-Khairy from the east and Barsik from the south discharge their effluents into the lake. El-Khairy Drain is joined to three sources of drainage water coming from El-Bosily, Edku and Damanhur sub-drains which transport domestic, agricultural and industrial (Khalil *et al.*, 2008). The present study aimed to compare some biological aspects, such as length-weight relationship, coefficient of condition, natural mortality , organs indices and Feeding intensity, between cultivated and wild seabass to evaluate Impact of physical Environmental conditions .In addition to determine suitable food requirements of examined species. This comparison may be lead to decrease depends of fish farm on the collection of seabass fry from natural waters which in essence helping conservation on European seabass stock.

Materials and methods

Study area description

Boughaz El-Maadiya in the eastern Mediterranean coast off Lake Edku is considered as one of the most important collecting stations of seabass fries. It is situated at longitudes 30° 10 E and latitudes 31° 18 N located about 40 km eastern of Alexandria and 20 km western of Rosetta branch of the River Nile in Egypt (Figure 1). It is receiving from Abu-Qir Bay considerable amounts of raw industrial wastes from many factories through El-Tabia pumping station with an average of about 1850 X 10^3 m^3 / day (Aboul-Ezz and Soliman, 2000). Moreover, it receives through Tabia pump station about 1.4 x 10^9 m^3/y of brackish agricultural water from Lake Edku (Abdel-Moati and Nour El-Din, 2001). El-Esraa private fish farm situated at Wadi-Mariout, Alexandria, it lying on 39 km West Alexandria in Alexandria- Matrouh coastal road. The farm has a total area of about 22 Fadden, its water supply is brackish water (16-20 ppt) from underground salty water source mixed with fresh water from the West Nubaria Drain.

Sampling

Sampling of wild European seabass (*D. labrax*) was carried out by fishing operations of commercial purse- seine vessel in day light in the Egyptian Mediterranean waters near Boughaz El-Maadiya off Lake Edku. It was collected seasonally during the period from autumn 2013 to summer 2014. Length-weight relationship was determined from the formula of Le Cren, (1951). The gutted weight was used in order to exclude the effect of stomach

contents and weight of gonads (Lagler, 1956; Ricker, 1975). The coefficient of condition (K) was calculated from the equation:

K=100 W/L3 (i.e. Fulton condition factor). Where W= gutted weight in grams, L= total length in cm. This factor is often used as an approximation even when the allometric factor is theoretically more appropriate (Bagenal and Braum, 1971; Ricker, 1975). The natural mortality coefficient "M" was calculated by the method described by Ursin (1967).

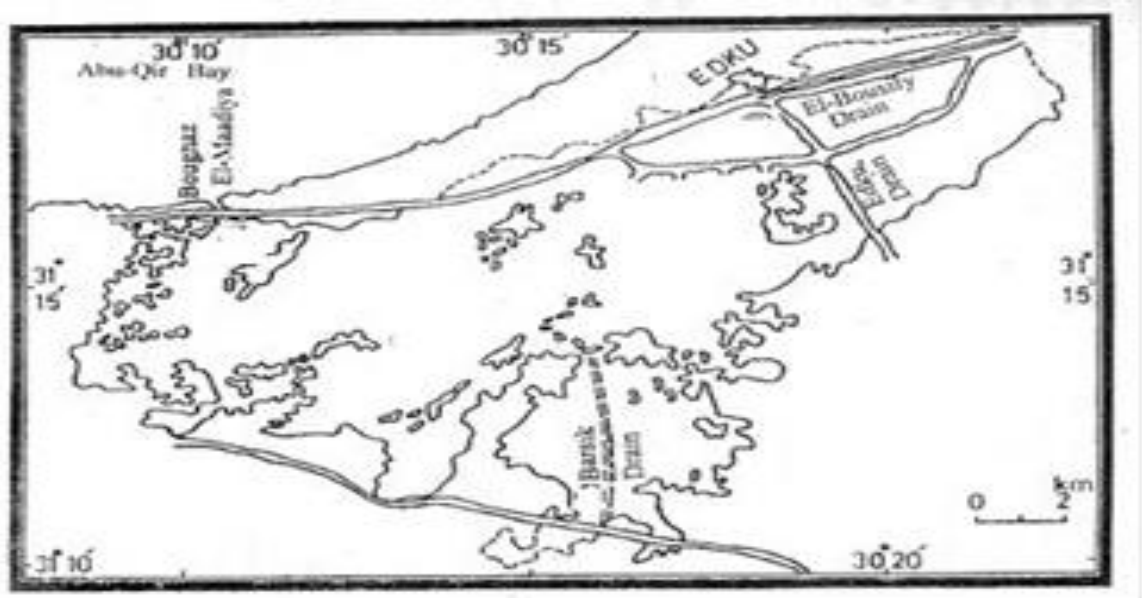

Fig.1. Map of Boughaz El-Maadiya.

Size composition, condition factor and natural mortality for seabass from the two different regions were statistically analyzed using analysis of variance but differences in length-weight relationships and sex ratios were examined by covariance and chi-square test analyses respectively. Fullness index (FI) was calculated according to Berhaut (1973). FI = 100W/ / W, where W/ is the weight of stomach contents and W is the gutted weight of the fish. This index was used to determine differences in feeding intensity for fish from El-Maadiya region in Egyptian Mediterranean waters and fish farm. The differences between localities and seasons in feeding intensity of seabass were statistically analyzed using one-way ANOVA.Gonadosomatic index (GSI) was determined by using the equation: GSI = Gw/ Bw X 100, Where Gw and Bw are gonad weight and body weight. Hepatosomatic index (HSI) was calculated to examine monthly variations in feeding intensity and to correlate these variations with breeding cycles, using following formulae: HSI = Lw/ Bw X 100, Where Lw and Bw are liver weight and total weight, respectively. Spleen-somatic index (SSI) was determined by using the equation: SSI = Sw/ Bw X 100, Where Sw and Bw are Spleen weight and total weight, respectively. All collected data in the present study were subjected to the statistical treatment by using STATISTICA12program.

RESULTS AND DISCUSSION

In the present study, the fishing operations were carried out by the

commercial purse- seine vessel in day light near El -Maadiya of Lake Edku. The average catch rate of seabass was 2.7 kg/ hr. the highest catch rate was obtained 4.5 kg/ hr while the lowest catch rate was 1.8 kg/ hr.

Length-weight relationship

Calculated and observed values of length-weight relationship of seabass captured from El-Maadiya region and cultivated in fish farm are shown in Table (1). The regression equations representing length-weight relationships for these fishes are presented in figure 2. The relationships of total length (L) versus gutted weight (W) for fish in different habitats were expressed:

A For El-Maadiya region in Egyptian Mediterranean waters.

Log W= - 0.029 + 2.678 Log L (r = 0.956)

B- For cultured in fish farm.

Log W= 0.005 + 3.216 Log L (r = 0.988).

Morphometric relationship between length and weight (LWR) is of great importance in fishery biology assessments. According to Lagler *et al*., (1977), length-weight relationship leads itself to comparison of individuals within and between different populations. LWR can be used to assess the well-being of individuals and to determine the possible differences between separate unit stocks of the same species (Ndimele *et al*., 2010; Kumolu-Johnson and Ndimele, 2011). In the present study it was found that length-weight relationship gives an indication of the degree of the well-being of farm fish than that inhabit in El-Maadiya region.

Condition factor

The mean values of condition factor for seabass captured from El-Maadiya region (Mean ± S.D = 1.044 + 0.0905) was lower than that for fish farm (Mean ± S.d = 1.158 + 0.8119). It is indicated that conditions in fish farm more suitable for seabass than that in El-Maadiya region. The seasonal differences in condition factor for examined species from these two regions are shown in Tab. 2. Analysis of variance tested revealed that there are significant differences in the mean values of condition factor for different seasons of seabass from El-Maadiya region ($F = 3.693$, $p<0.01$), while fish farm showed no seasonal significant differences in the mean values of condition factor ($F=0.789$, $p<0.05$). Least significant difference (LSD) test were used to determine the variations in condition factors between seasons for fish inhabited in El-Maadiya region .this test was attributed the significant differences between spring, both of autumn ($p<0.002$) and winter ($P<0.039$). The condition factor is used in order to compare the condition, fatness or wellbeing of fish. It is based on the hypothesis that heavier fish of a particular length are in a better physiological condition (Bagenal, 1978). Condition factor is also a useful index for monitoring of feeding intensity, age, and growth rates in fish (Oni *et al*., 1983). It is strongly influenced by both biotic and abiotic environmental conditions and can be used as an index to assess the status of the aquatic ecosystem in which fish live (Anene, 2005). However, the results revealed that the mean value of condition factor for seabass from fish farm was higher than that captured from El- Maadiya region. It may be attributed to fish farm do not suffer the deficiency of food and it was obvious in there are significant differences in the mean values of condition factor for different seasons of seabass from El-Maadiya region, while fish farm showed no seasonal significant differences in the mean values of condition factor.

Table 1. Length-weight relationship of seabass captured from El-Maadiya region and cultivated in fish farm

	EL-Maadiya		**Aquaculture**	
	Gutted weight (g)		Gutted weight (g)	
TL (cm)	Empirical	Calculated	Empirical	Calculated
18	0.00	0.00	56.00	54.44
19	0.00	0.00	64.33	64.78
20	68.00	88.42	99.00	76.40
24	151.00	144.08	0.00	0.00
26	200.00	178.52	198.00	177.63
27	202.67	197.51	214.00	200.56
28	210.00	217.71	238.67	225.44
29	242.29	239.17	260.00	252.37
30	257.55	261.90	305.31	281.44
31	266.67	285.93	334.14	312.74
32	0.00	0.00	395.66	346.36
33	0.00	0.00	413.5	382.39
34	0.00	0.00	479.5	420.93
35	0.00	0.00	477.5	462.05
37	0.00	0.00	503.00	552.47
38	555.5	493.24	0.00	0.00
39	0.00	0.00	637.00	654.39
40	0.00	0.00	0.00	0.00
41	0.00	0.00	0.00	0.00
42	0.00	0.00	0.00	0.00
43	0.00	0.00	0.00	0.00
44	0.00	0.00	987.00	964.53
45	0.00	0.00	1036.50	1036.82

Table 2. Condition factor of seabass captured from El-Maadiya region and cultivated in fish farm.

Season	**Spring**	**Summer**	**Autumn**	**Winter**
EL-Maadiya	0.988 ± 0.0578	0.913 ± 0.0796	0.878 ± 0.0746	0.913 ± 0.1098
Aquaculture	1.565 ± 0.0905	1.048 ± 0.174	1.062 ± 0.856	1.445 ± 0.0445

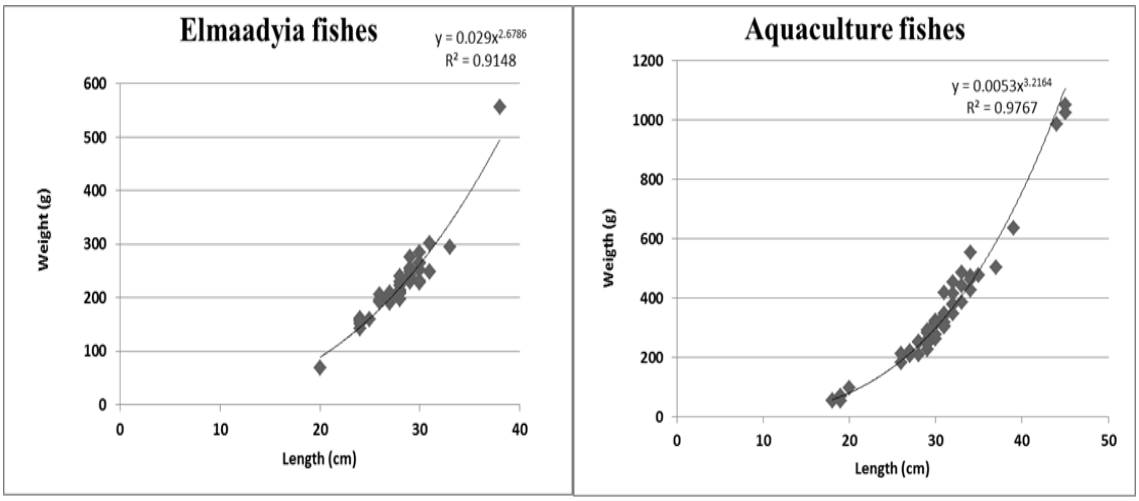

Fig. 2. Calculated and observed values of length-weight relationship of seabass captured from El-Maadiya region and fish far

Natural mortality

The mean value of natural mortality coefficient for seabass captured from El-Maadiya region was 0.172 ± 0.017; it was ranged from 0.124 to 0.197. The seasonal differences in natural mortality coefficient for seabass from El-Maadiya region are shown in Tab. 3, fig.3. Analysis of variance tested showed that there are significant differences in the mean values of natural mortality for different seasons of seabass from El-Maadiya region ($F = 5.234$, $p<0.01$). LSD test indicated that natural mortality between seasons for fish inhabited in El-Maadiya region revealed significant differences between spring, both of autumn ($P<0.012$) and summer ($P<0.001$) also between summer and winter ($p<0.005$). According to Ricker, (1975), the natural mortality is deaths from all causes, except man's fishing, including predation, senility, epidemics, pollution, etc. The value of natural mortality in study area was found to be low comparable with values found by Kent and Ford, (1990) (M = 0.117 - 0.258). Likewise, Thomas, (1968) calculated natural mortality rates for white seabass from the recreational and commercial fisheries, which were M= 0.303. The lowest value of natural mortality for seabass inhabiting in El-Maadiya region, in spite of the poisoning effect of pesticides and trace metal, as well as low quality of water body indicated that this species have high tolerance to the unsuitable environmental living conditions.

Feeding intensity

The maximum value of fullness index for seabass captured from El-Maadiya region was 9.61 while lowest one was 2.75. The maximum and lower values of fullness index for cultured fish were 9.42 and 0.46, respectively. Analysis of variance tested showed that there aren't significant differences in the mean values of fullness index for fishes from different locality ($F = 0.01$, $p<0.05$). Seasonal variations of fullness index (F.I) for seabass from El-Maadiya region indicated that lowest values was found in spring (4.33) increased seasonally to reach to 6.49 in winter, while the highest percentages of fullness index for cultivated fish 6.47 and 3.87 were observed in summer and spring respectively Fig.4

Table 3. Natural mortality of seabass caught from Lake Edku.

Natural Mortality (Lake Edku)		
Seasons	**Mean ± S.d**	**Range**
Spring	0.183 ± 0.0094	0.167 - 0.197
Summer	0.157 ± 0.0147	0.124 - 0.166
Autumn	0.167 ± 0.0070	0.153 - 0.177
Winter	0.178 ± 0.0248	0.153 - 0.253
Total	0.172 ± 0.017	0.124 - 0.197

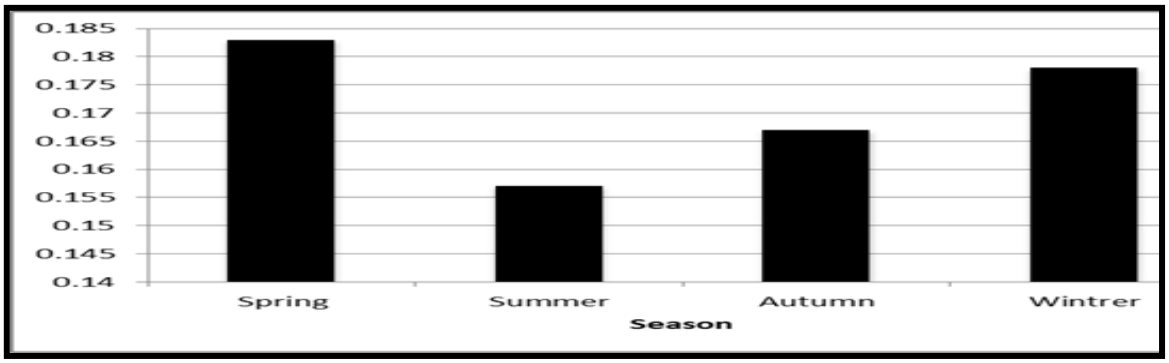

Fig. 3. Natural mortality of seabass caught from El-maadiya region in Egyptian Mediterranean waters.

Table 4. Sex ratio of seabass captured from El-Maadiya region and cultivated in fish farm.

Location	Number		Percentage		Sex ratio	
	Female	Male	Female %	Male %	Female : Male	Chi-square
EL-Maadiya	15	34	30.61	69.39	1:2.27	5.21*
Fish farm	24	30	44.44	55.56	1:1.25	11.60**
Total	39	64	37.86	62.14	1:1.64	6.64**

*** Significant at 5% level** **** Significant at 1% level**

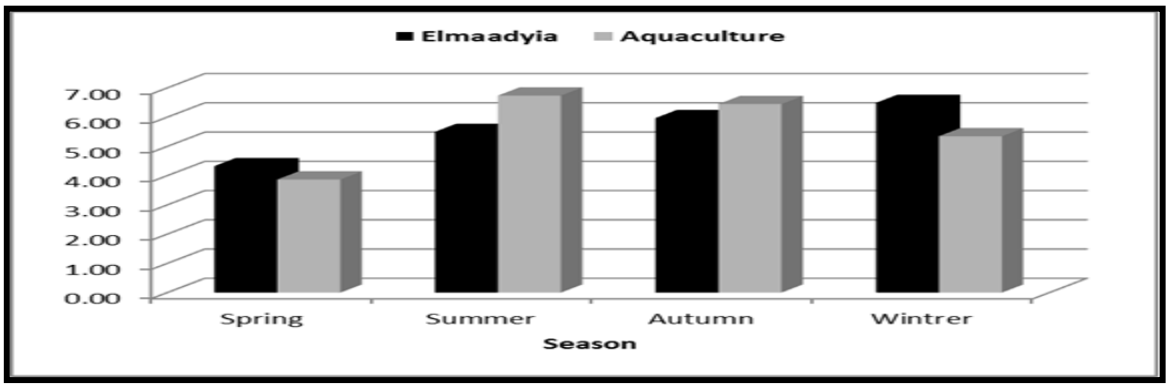

Fig. 4. *Fullness index of seabass captured from El-Maadiya region and cultivated in fish farm.*

One-way ANOVA indicated significant seasonal difference in degrees of stomach fullness of seabass from El-Maadiya region ($F = 3.589$, $df = 3$, $p<0.05$) and fish farm ($F = 8.381$, $df = 3$, $p<0.01$). LSD showed that this significant difference can be attributed for fish inhabited in El-Maadiya region to difference in its values in spring from autumn ($p<0.014$) and winter ($p<0.003$). While in fish farm significant differences were found between all seasons except between autumn and both summer ($p<0.623$) and winter ($p<0.085$). Feeding activity changes with seasons corresponding to variations in the abundance of fish and seasonal changes in water temperature and food organisms (Sakamoto, 1982). In the present study, there aren't significant differences in the mean values of fullness index for fishes from different habitat, in spite of abundance of food in fish farm. Moreover there are seasonal variation in feeding activity indicated that the water temperature and physiological parameter plays important role in Feeding intensity.

Sex ratio

The overall ratio of females to males of seabass was 1: 1.64. Statistical analysis by chi-square test indicated that sex ratio was significantly different from the expected ratio of 1: 1($X^2 = 6.64$, $p < 0.01$). Comparing sex ratio for seabass from El-Maadiya region and cultured in fish farm showed significant differences, whereas chi-square values were $X^2 = 5.21$, $p < 0.05$ and $X^2 = 11.60$, $p < 0.01$, respectively (Table 4). In most vertebrates, sex is genetically determined in most cases by sex chromosomes, yielding stable 50: 50 primary sex ratios. In the sea bass, populations comprised a high proportion of males%, (Piferrer *et al*., 2005).this in agreement with we found that the percentages of females are significantly lower than males for seabass from fish farm and captured from El-Maadiya region. This is seen because females grow faster than males, 25% higher body weight at 1 year, (Saillant *et al*., 2001; Gorshkov *et al*., 2003) and mature one year later. In parallel, several studies investigated the effect of environmental factors on sex determination in sea bass, with a major interest on temperature. Indeed, temperature is the most frequent factor of environmental sex determination, and is rather common in reptiles, amphibians and fishes (Kraak and Pen, 2002). In sea bass, it appears that high temperatures (<17°C) during early development (before 60 days post fertilization) promote the appearance of increased numbers of males in the populations (Mylonas *et al.*, 2005 and Navarro-Martin *et al*., 2009). Moreover, this can be attributed to the sexual differences in the degree of accumulation of trace metal in males and females organs (Miller *et al*., 1992 and Shakweer and Abbas, 1996).

Gonadosomatic index (GSI)

The mean value of GSI for seabass captured from El-Maadiya region (0.258 ± 0.2865) was lower than that of cultured in fish farm (0.940 ± 1.5601). Analysis of variance tested showed highly significant differences in GSI index for fishes from different locality ($F = 8.864$, $p<0.01$). The seasonal differences in GSI for sea bass from El-Maadiya region revealed that the highest values were found in summer and lowest one in spring. While for fish cultivated in fish farm the maximum value of gonadosomatic index were found in spring and minimum value in autumn as shown in Table 5 and figure 5. LSD were determined that these significant differences can be attributed to difference in its values in summer from spring ($p<0.021$) and autumn ($p<0.015$) for fish inhabited in El-Maadiya region. While in fish farm siginficant differences were found between winter and other seasons ($p<0.001$). GSI is one of the important parameters of the fish biology, which gives the detail idea regarding the reproduction and reproductive status of the species and help in ascertaining breeding period of fish (Shankar and Kulkarni,

2005). The spawning season can be defined by observing the mean monthly variation in the gonadosomatic index, whereas during spawning season GSI reaches its maximum value. In the Mediterranean population there is only one breeding season per year, which takes place from December to March (Moretti *et. al*., 1999). This is in agreement with that found in the present study, where the highest values of GSI were found in summer for seabass inhabiting in El-Maadiya region and in spring and summer for fish farm.

Table 5. Seasonal variations in gonadosomatic index of seabass captured from El-Maadiya region and cultivated in fish farm.

Seasons	EL-Maadiya region	Fish farm
	Mean ± S.d	Mean ± S.d
Spring	0.181 ± 0.2262	0.388 ± 0.2797
Summer	0.505 ± 0.1261	0.367 ± 0.2730
Autumn	0.196 ± 0.2252	0.254 ± 0.3672
Winter	0.269 ± 0.3887	3.658 ± 1.9421
Total	0.258 ± 0.2865	0.940 ± 1.5601

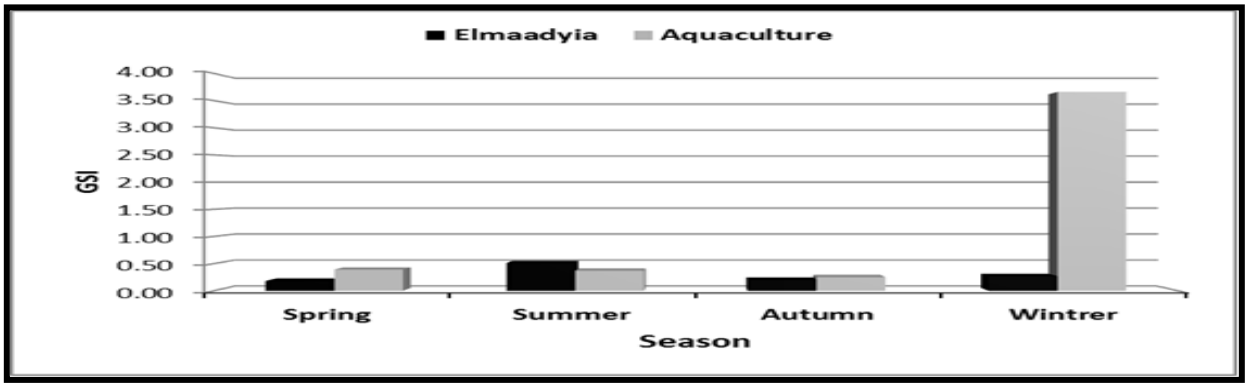

Fig. 5. Gonadosomatic index of seabass captured from El-Maadiya region and cultivated in fish farm.

Hepatosomatic Index (HIS)

The average of Hepatosomatic Index (HIS) for seabass captured from El-Maadiya region (1.20 ± 0.5714) was lower than that of cultivated in fish farm (1.486 ± 0.5247). Statistical analysis showed highly significant differences in Hepatosomatic index for fishes from different locality ($F = 6.685$, $p<0.01$). The seasonal differences in Hepatosomatic Index for sea bass from different region revealed that the highest values were found in winter, while the lowest one for cultured fish and captured from El-Maadiya region were in spring and summer, respectively (Tab.6 and Fig.6). LSD analysis were revealed that seasonal differences in Hepatosomatic Index can be attributed to difference in its values in summer and winter ($p<0.028$) for fish inhabited in El-Maadiya region. While in fish farm significant differences were found between spring with autumn ($p<0.024$) and winter ($p<0.001$) and varied in summer from winter ($p<0.001$) and autumn ($p<0.031$). HSI has been used in fishery biology as a useful tool for assessing the fish condition. Facey *et al.*, (2005) stated that HSI as a biomarker is often correlated with exposure to various contaminants (e.g., polychlorinated biphenyls, polycyclic aromatic hydrocarbons, and some heavy metals). Exposure to

contaminants can lead to an increase in liver size as a result of increase in hepatocytes size (hypertrophy) or number (hyperplasia) (Hilmy *et al.,* 1983; Hinton and Lauren, 1990). Heath, (1990) and Facey *et al*., (1999) Studies evaluating the relative liver size of fishes from contaminated and reference sites often utilize the HSI. Goede and Barton, (1990) and Ahmed *et al.*, (2011) have used HSI as a biomarker of contaminant exposure. In the present study the highest values of Hepatosomatic index for seabass from fish farm than that captured from El-Maadiya region can be attributed to feed on artificial food in aquaculture comparing with food organisms for fish from El-Maadiya region. Rajaguru (1992) reported that in *C. arel* the lowest values of Hepatosomatic indices were recorded only during the peak spawning period. This is in agreement with our finding in El-Maadiya region, where the lowest values of Hepatosomatic indices were found in spawning season (spring to summer).

Table 6. Seasonal variations in Hepatosomatic Index of seabass captured from El-Maadiya region and cultivated in fish farm.

Seasons	EL-Maadiya region	Fish farm
	Mean ± S.d	Mean ± S.d
Spring	1.113 ± 0.6910	1.205 ± 0.5157
Summer	0.899 ± 0.1845	1.223 ± 0.4134
Autumn	1.167 ± 0.3187	0.160 ± 0.4781
Winter	1.494 ± 0.7781	1.190 ± 0.4232
Total	1.205 ± 0.5714	1.486 ± 0.5247

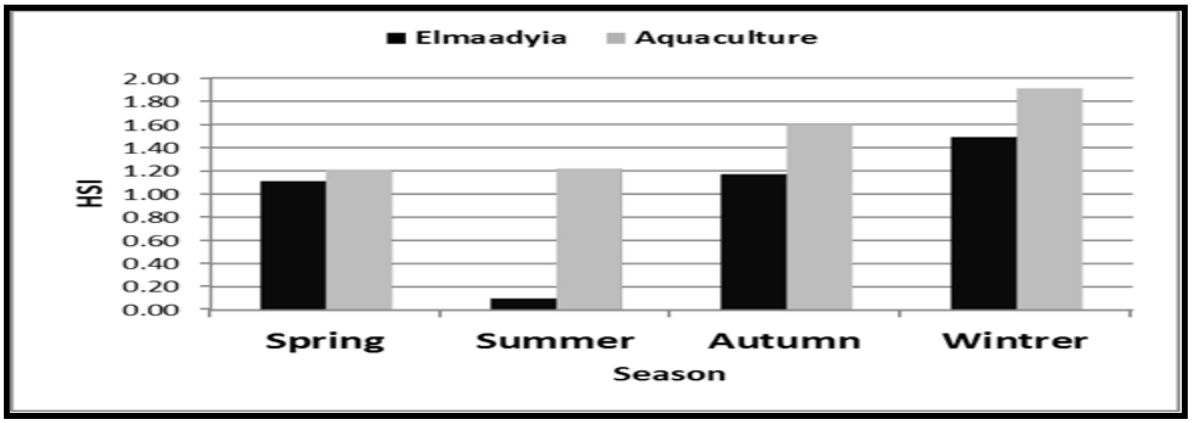

Fig. 6. Hepatosomatic Index of seabass captured from El-Maadiya region and cultivated in fish farm.

Spleen-somatic index (SSI)

The mean value of SSI for seabass captured from El-Maadiya region was 0.102 ± 0.0518, while its value for fish farm was 0.157 ± 0.2406. Analysis of variance tested showed that there aren't significant differences in the mean values of SSI for fishes from different locality ($F = 2.332$, $p<0.05$). The seasonal differences in Spleen-somatic index for seabass from different region revealed that in El-Maadiya region the highest values were found in summer, while the lowest one in spring and autumn. in contrarily for cultivated in fish farm the maximum value and minimum one were found in spring and winter respectively (Tab.7 and Fig.7). LSD were showed that these significant differences

can be attributed to difference in its values in summer from spring ($p<0.031$) and autumn ($p<0.014$) for fish inhabited in El-Maadiya region. While in fish farm seasonal significant difference in SSI were found only between summer and spring ($p<0.048$). The spleen is the body's largest blood filter and it removes damaged or senescent cells unsuitable for continued circulation (Mebius and Kraal, 2005). It stores red cells and disintegrates old blood cells. Alterations in the relative spleen size could signal a dysfunction. A decrease in SSI may result from necrosis and perturbations in cell processing which impairs an individual, s health. An increase, enlargement or swelling of the spleen, on the other hand, indicates disease or immunesystem problems (Goede and Barton 1990). Changes have been observed in the spleen-somatic index of fish exposed to cadmium and tetrachloroguaiacol (Stepanova et al., 1998). Spleen-somatic index measured organ in relation to body mass, which can be directly linked to toxic effects of chemical on target organ (Giullo and Hinton, 2008) and reduced SSIs occurred in cunners (Tautogolabrus adspersus) exposed to petroleum and in Atlantic cod exposed to crude oilas well as in gobies (Zsterisessor ophiocephalus) at a site polluted with PCBs, PAHs, and metals (Kiceniuk and Khan 1987 and Pulsford et al., 1995). Moreover, it can also be used as indices of changes in nutritional and energy status (Maxwell and Dutta, 2005). In the present investigation the seasonal differences in Spleen-somatic index for seabass from different regions can be attributed to seasonal variations in temperature and changes in feeding intensity and energy status as has been mentioned by (Alvarez et al., 1998 and Maxwell and Dutta, 2005).

Table 7. seasonal variations in spleen-somatic index of seabass captured from El-Maadiya region and cultivated in fish farm.

Seasons	El-Maadiya region	Fish farm
	Mean ± S.d	Mean ± S.d
Spring	0.091 ± 0.0522	0.290 ± 0.4916
Summer	0.146 ± 0.0395	0.090 ± 0.310
Autumn	0.089 ± 0.0297	0.140 ± 0.0781
Winter	0.106 ± 0.704	0.114 ± 0.0233
Total	0.102 ± 0.0518	0.157 ± 0.2406

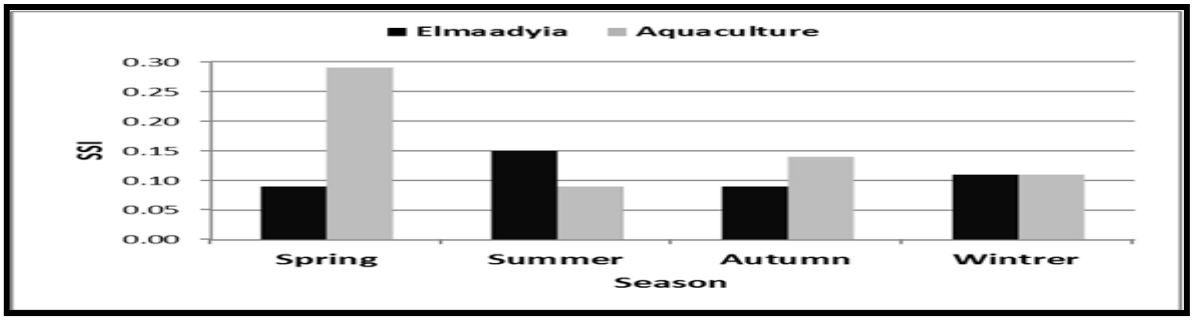

Fig. 7. Spleen-somatic index of seabass captured from El-Maadiya region and cultivated in fish farm.

Conclusion

The present investigation designed to give information to decrease the gaps in the current knowledge of fish biology of wild

and cultured European seabass. The result gives an indication of the degree of the well-being of farm fish than that inhabit in El-Maadiya region. We can concluded from low value of natural mortality for seabass inhabiting in El-Maadiya region that this species have high tolerance to the unsuitable environmental living conditions, the physiological parameter of water plays important role in Feeding intensity. Moreover, the values of gonadosomatic index, hepatosomatic index and spleen-somatic index for El-Maadiya fishes were lower than that were found in cultured seabass, this information's should be taken when European seabass cultured.

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