Growth and Reproductive Characteristics of the Thinlipped Grey Mullet, *Liza ramada* (Risso, 1826) Inhabiting in Gökova Bay (Muğla), the Southern Aegean Sea, Turkey

Cahit KASIMOĞLU [1], Fevzi YILMAZ[2], Hatice TORCU KOÇ[3*]

[1]*University of Mugla, Institute of Science and Technology, Biology Section, 48000, Mugla,*
[2]*University of Mugla, Faculty of Science and Arts, Department of Biology, 48000, Mugla,*
[3]*University of Balikesir, Faculty of Science and Arts, Department of Biology, Çagış Campus, 10145, Balikesir*

Abstract

In this study, the determination of growth and reproductive characteristics of the thinlipped grey mullet (Liza ramada) living in the Gökova Bay (Mugla) were carried out. For this purpose, 120 individuals were obtained by monthly sampling during the period between June 2007 and May 2008. The total length ranged from 154 mm to 480 mm and weight varied between 35.0 and 505.5 g. Age groups varied between I and VI for this species in Gökova Bay, with the second and third year-classes dominating. Sex ratio was 1.26:1 (M:F), corresponding to 55.84% male and 44.16% female of the population (P>0.05, χ^2 test). The length-weight relation was found as $W= 0.0005L^{2,25}$ for all individuals. The von Bertalanffy growth equation was calculated as: $L_t= 489.19[1-e^{-0,21(t+1,01)}]$ by using the data of 120 L. ramada specimens. Significant statistical differences in condition factors between age classes and sexes were not found (P>0.05, t-test). Monthly examination of condition factor showed that similar condition cycle is evident in both sexes, peaking in August (1.135 for males and 1.136 for females). Spawning period of this species in Gökova Bay occured between October and December, showing a peak in November.

Keywords: *Gökova Bay, Liza ramada, growth, condition, gonadosomatic index*

Güney Ege Denizi, Gökova Körfezi (Muğla)'nde Yaşayan *Liza ramada* (Risso, 1826)' nın Büyüme ve Üreme Özellikleri

Özet

Bu çalışmada, Güney Ege Denizi, Gökova Körfezi (Muğla)'de yaşayan Liza ramada' nın büyüme ve üreme özelliklerini belirlemek amacıyla, Haziran 2007 ve Mayıs 2008 tarihleri arasında aylık olarak örneklenen 120 adet birey incelenmiştir. İncelenen

* Hatice TORCU KOÇ, htorcukoc@hotmail.com

balıkların total boyları 154– 480 mm; ağırlıkları 35.0– 505.5 gr arasında değişmiştir. Gökova Körfezi'nde bu tür için yaş grupları, II. ve III. yaş grupları en fazla bireyle temsil edilerek, I. ila VI. arasında değişmiştir. Populasyonun % 44.16' sının dişi; % 55.84' sının da erkek bireylerden oluşmuş ve eşey oranı 1.26:1 (E:D) olarak saptanmıştır ($p<0.05$, χ^2 test). Tüm bireyler için boy-ağırlık ilişkisi denklemi $W= 0.0005L^{2,25}$ olarak bulunmuştur. The von Bertalanffy büyüme eşitliği ise, 120 bireyin verileri kullanılarak $L_t= 489.19[1-e^{-0,21(t+1,01)}]$ şeklinde hesaplanmıştır. Yaş grupları ve eşeyler arasındaki kondisyon faktörü değerleri istatistiki olarak anlamlı bulunmamıştır ($P>0.05$, t-test). Her iki eşey için ortalama kondisyon faktörü (K) değerlerinin aylık değişimlerinin benzer olduğu ve Ağustos ayında (erkekler için 1.135; dişiler için 1.136) pik yaptıkları belirlenmiştir. Gökova Körfezi'deki bu türün yumurtlama periyodu Kasım ayında pik yaparak, Ekim-Aralık arasında oluşmaktadır.

Anahtar kelimeler: *Gökova Körfezi, Liza ramada, büyüme, üreme*

1. Introduction

The fish of the Mugilidae (grey mullets) are euryhaline and euryterm that enter coastal lagoons during early life stages to complete growth previous to sexual maturation. The thinlipped (*L. ramada*) and the sharpnose (*L. saliens*) mullets are diadromous species that enter coastal lagoons during early life stages to complete growth previous to sexual maturation [1]. This family has also a worldwide distribution in warm waters, where its members grow well on algae and detritus [2].

Determination of growth and reproduction of fish populations which vary to physicochemical and hydrographic conditions of water systems is the main subject of fisheries biology. Fish are an important alternative sources to other food. Therefore, in order to protect and better use of these available living resources, fish growth, reproduction time, and condition should be determined. It should be necessary that fish are allowed to reproduce at least once, and the determination of length restrictions in natural fish stocks should depend on the age and size of sexual maturity. In water systems, knowledge of growth, reproduction and fishing prohibition regulations have great importance for the protection and the survival of natural stocks [3, 4].

Liza ramada is one of the target fish species of commercial fishing along Aegean coasts and Gökova Bay [5]. In the literature, studies carried out in lagoons on the growth and reproduction of thin-lipped grey mullet were reported by Minos [6] from Greece and Gorenko et al., [7] from Middle Adriatic Sea. The information about the seasonal occurrence, composition, growth, reproduction, parasite communities of *L.ramada* were published by Torricelli et al., [8], Almeida et al., [9], Dzikowski et al., [10], Mureno et al., [11], and Matić-Skoko et al., [12], from lagoons of Sardinia, Eastern Middle Adriatic, and El-Halfawy [13] in Timsah Lake. Ergene [14] determined growth, reproduction, sex maturity age of *L.ramada* Inhabiting Akgöl-Paradeniz Lagoons (Göksü Delta) while Göçer and Ekingen (15) determined the age composition, sex ratio, age-length, age-weight, length-weight relations and condition factor of *L. ramada* in the Mersin Bay.

The aim of the present study was to describe data on age, growth, and sex ratio, gonadosomatic index, condition of thinlipped mullet from Gökova Bay, located in

southern Aegean Sea of Turkey. So, it is hopeful that this investigation will contribute to clarify the population structure of thinlipped mullet in Gökova Bay today, comparing with the relevant studies.

2. Material and Methods

Aegean Sea is divided to sub-region as northern and southern Aegean Sea due to bio-ecological differences. Gökova Bay located between Bodrum and Marmaris has total area of 52000 hectares, including 24500 hectares territorial waters. This area is declared as "Natural Protection Area" with high biological potential and touristic importance since 1989. In addition, Gökova Bay is the clearest and the richest in fish species of Aegean Sea because of the geological structure, nutrients and fresh water input [16, 17]. (Figure 1).

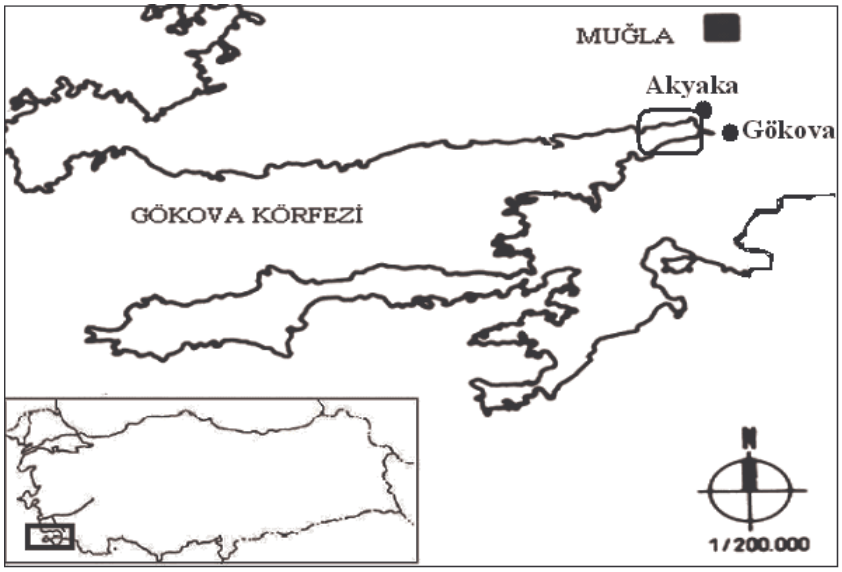

Figure 1. Sampling Area

Sampling was carried out monthly at Gökova Bay between June 2007 and May 2008 to obtain a total of 120 specimens. Fish samples were transported to the laboratory for analyses of total length (TL) to the nearest 0.1 mm, and weight to the nearest 0.1 g.

Scales were used for determining age, especially due to difficulty of otolith interpretation [18]. Ten to 15 scales from the left side of the body between the lateral line and dorsal fin were removed and dry mounted between two slides. for binocular microscopy. The scales were prepared according to a commonly used method [19, 20]. To determine age, the scale preparations were examined by stereo microscope and checked by micro projection three times [21]. Bagliniere and Louarn's [18] methods, were used with the scale preparations and in annulus determination was used to determine the age of the fish.

Length-weight relationships were calculated by applying an exponential regression equation $W = aLb$, where W is the weight (g), L is the total length (mm), and a and b are constants,

Von Bertalanffy growth equations were calculated according to $L_t = L_\infty[1 - e^{-k(t - to)}]$ for FL, where L_t is the length of fish in mm at age t, L_∞ is theoretical maximum individual size, e is the base of natural log (2.71828), t is the fish age (year), t_0 is the hypothetical time at which the length of the fish is zero, K is the rate at which the growth curve reaches the asymptote [22, 23].

Condition coefficients were calculated for both sexes using the equation:

$CF= (W/TL^3)$ x100 (24, 25).

Sex was determined by macroscopic observation of the gonads. The overall sex ratio and stages of sexual maturity were also determined. Gonads were removed and weighed to the nearest 0.1 g. Deviations from 1: 1 null hypothesis were tested statistically by chi-squared analyses [22]. The spawning period was determined by identifying monthly changes in the gonadosomatic index (GSI%). The GSI was calculated using the equation:

GSI%: Gonad weight/(Body weight-Gonad weight) x100 (25).

Statistical analyses were carried out with SPSS, STATISTICA for Windows V 11.0.

3. Results

3.1. Length–frequency distribution

Of 120 specimens measured, TL of females ranging from 160 to 480 mm; the range (154–380 mm) for males was lower than for females (Figure 2). However, the difference between TL means of female and male fish for all year-classes was not significant ($P > 0.05$, t-test).

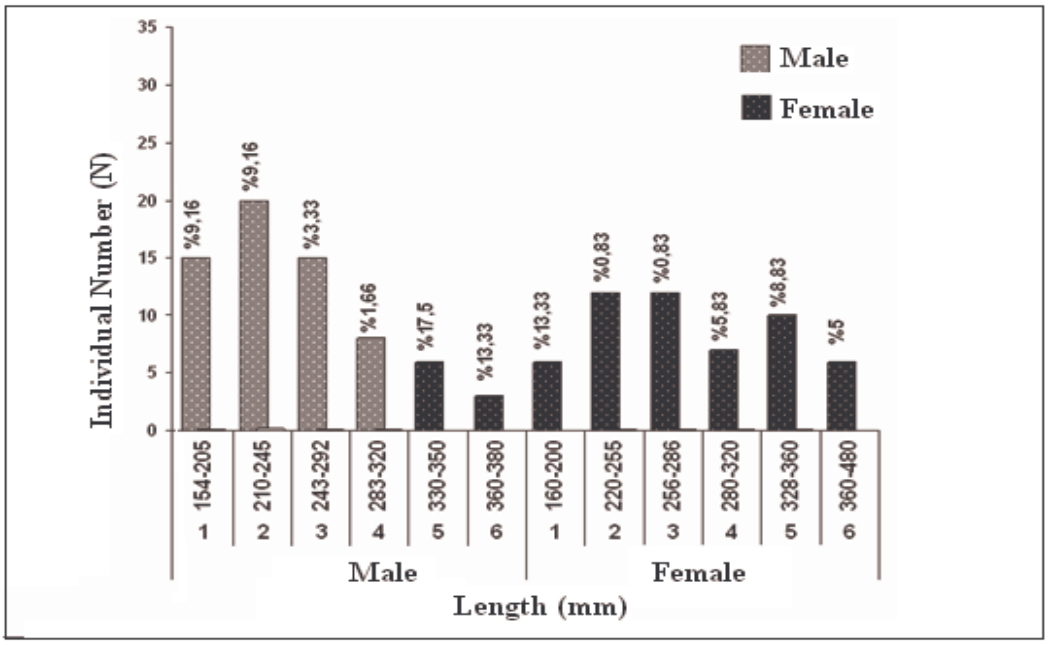

Figure 2. Length–frequency distribution of males and females of *Liza ramada* in the Gökova Bay as determined from monthly samples taken in June 2007 and May 2008.

3.2. Weight–frequency distribution

Of 120 specimens measured, weight of females ranging from 40.5 to 505.5 g.; the range (35.0–380.5 g.) for males was lower than for females (Figure 3). However, the difference between weight means of female and male fish for all year-classes was not significant ($P > 0.05$, t-test).

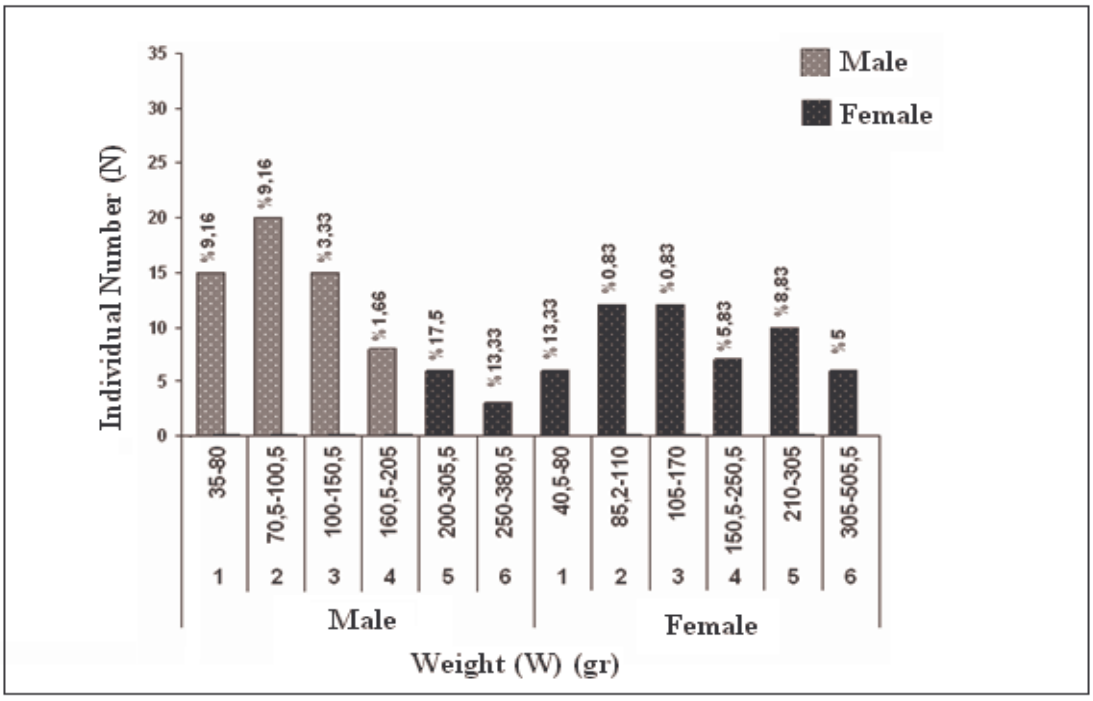

Figure 3. Weight–frequency distribution of males and female of *Liza ramada* in the Gökova Bay as determined from monthly samples taken in June 2007 and May 2008.

3.3. Age composition and sex ratio

Age and sex distribution data are summarized in Figure. 4. Age of captured fish ranged between I and VI, while the second and third year classes were generally the best represented and constituted an important proportion of the catches. Because of selectivity of the nets, the 0 age group was not represented in the samples. There were about 55.84% males and 44.16% females, and differences between sexes according to age were not significant ($P > 0.05$). The sex ratio was skewed in favour of males (1: 1.26) ($P > 0.05$, χ^2 test).

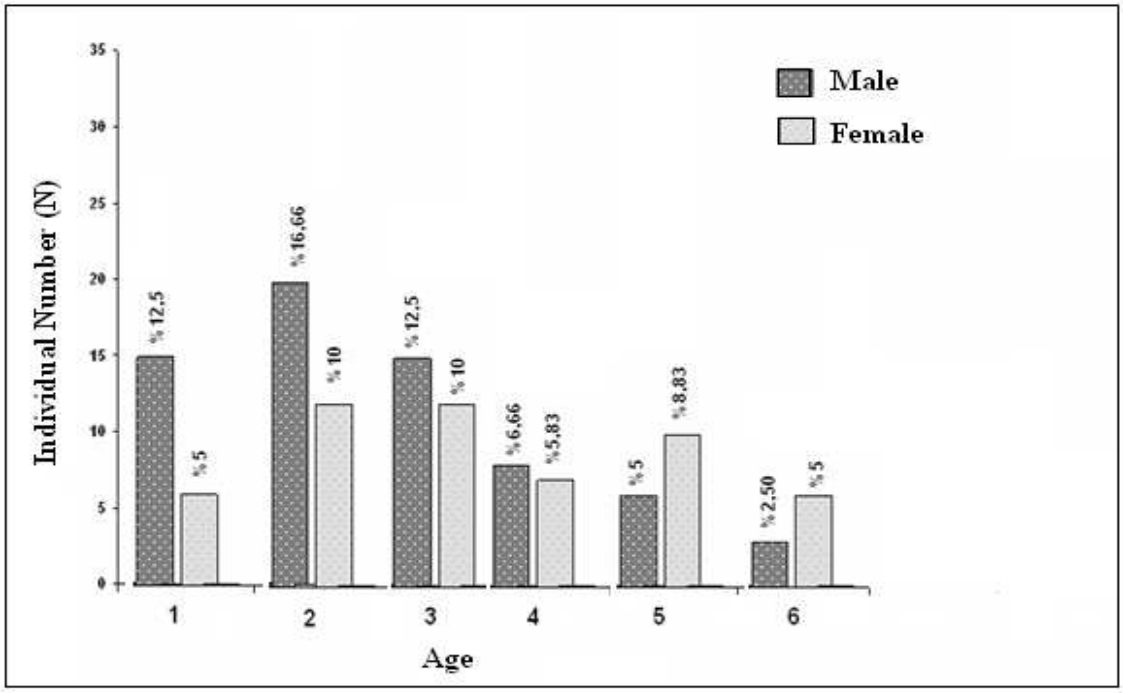

Figure 4. Age and sex ratio of male and female of *Liza ramada* in the Gökova Bay as determined from monthly samples taken in June 2007 and May 2008.

3.4. Growth

According to Von Bertalanffy growth equations of all individuals, a theoretically maximal length of 489.19 mm is realistic because the largest specimen sampled during the surveys was 480.0 mm.

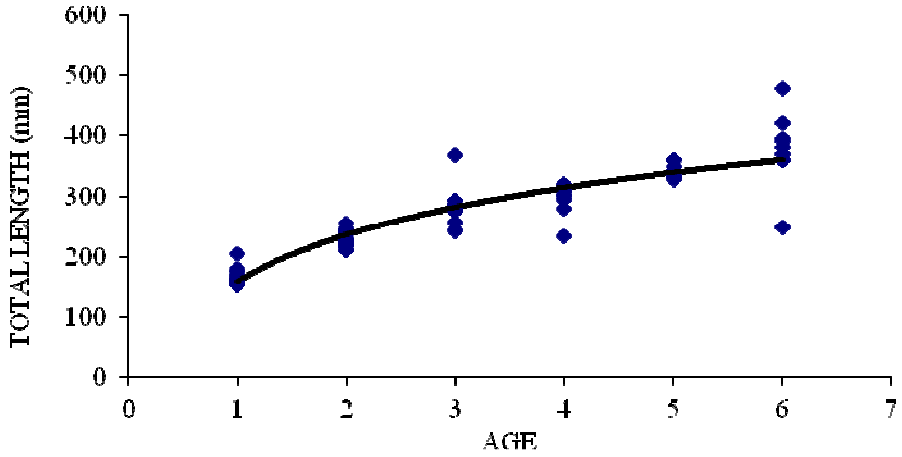

Figure 5a. Age–length relationship in all individuals of *Liza ramada* in the Gökova Bay as determined from monthly samples taken in June 2007 and May 2008.

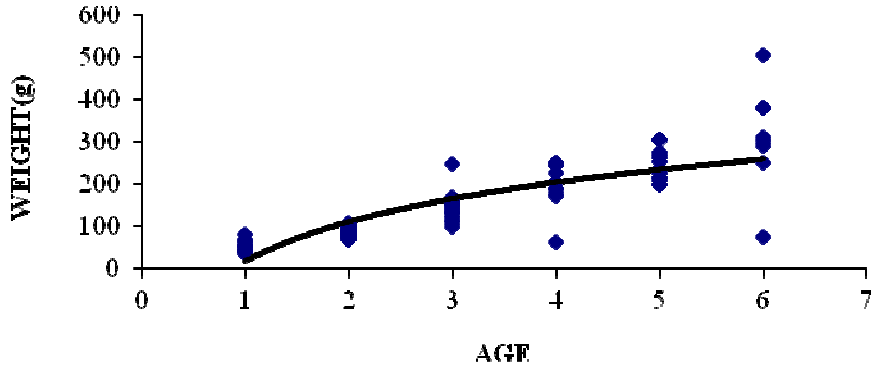

Figure 5b. Age–weight relationship in all individuals of *Liza ramada* in the Gökova Bay as determined from monthly samples taken in June 2007 and May 2008.

3.5. Length–weight relationship

Length–weight relationship was calculated by using the data of 120 *L. ramada* specimens. This was found to be $W= 0.0005L^{2,253}$. Weight increased negative allometrically with size since the value of b = 2.253 had a significant difference from the value 3.0 (t-test , $p < 0.05$) (Figure 6).

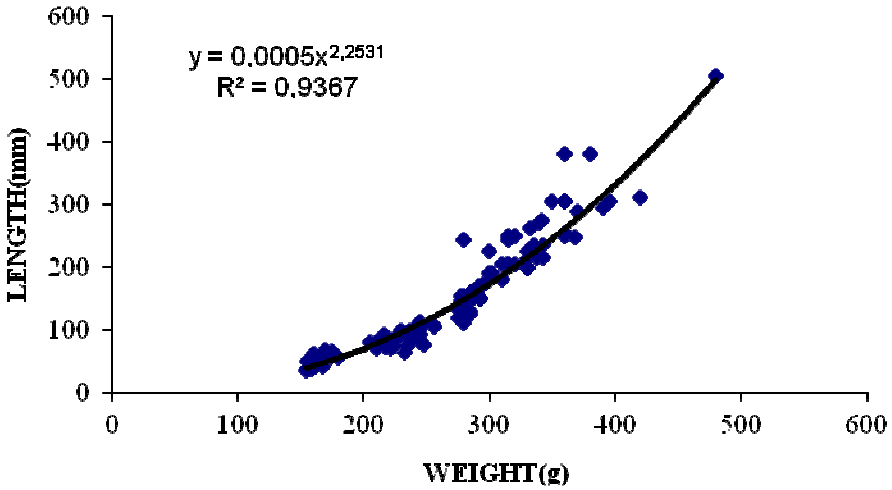

Figure 6. - Length- weight relationship in all individuals of *Liza ramada* in the Gökova Bay as determined from monthly samples taken in June 2007 and May 2008.

3.5. Condition Factor

The mean condition factors for female and male were similiar to each other (Table 1). Additionally, seasonal variations in the condition coefficients were determined for each sex (Figure 7). For both of sexes, monthly condition values were generally quite high during August and early September, declined until October and November and thereafter started to increase again, showing a similiar pattern.

Table 1. Min, max, and mean condition factor (CF), standard error (SE) for different age groups of *Liza ramada* males and females in Gökova Bay as determined by monthly samples taken in the year of June 2007 and May 2008.

Age Groups	Male		Female	
	N	CF±SE (min-max)	N	CF±SE (min-max)
I	15	1.08±0.16 (0.75–1.34)	6	1.2±0.15 0.95–1.34
II	20	0.72±0.09 0.54–0.86	12	0.72±0.06 0.65–0.84
III	15	0.64±0.08 0.52–0.83	12	0.65±0.10 0.49–0.86
IV	8	0.62±0.05 0.53–0.70	7	0.62±0.13 0.45–0.84
V	6	0.61±0.08 0.51–0.71	10	0.60±0.05 0.52–0.69
VI	3	0.59±0.08 0.53–0.69	6	0.57±0.09 0.45–0.69

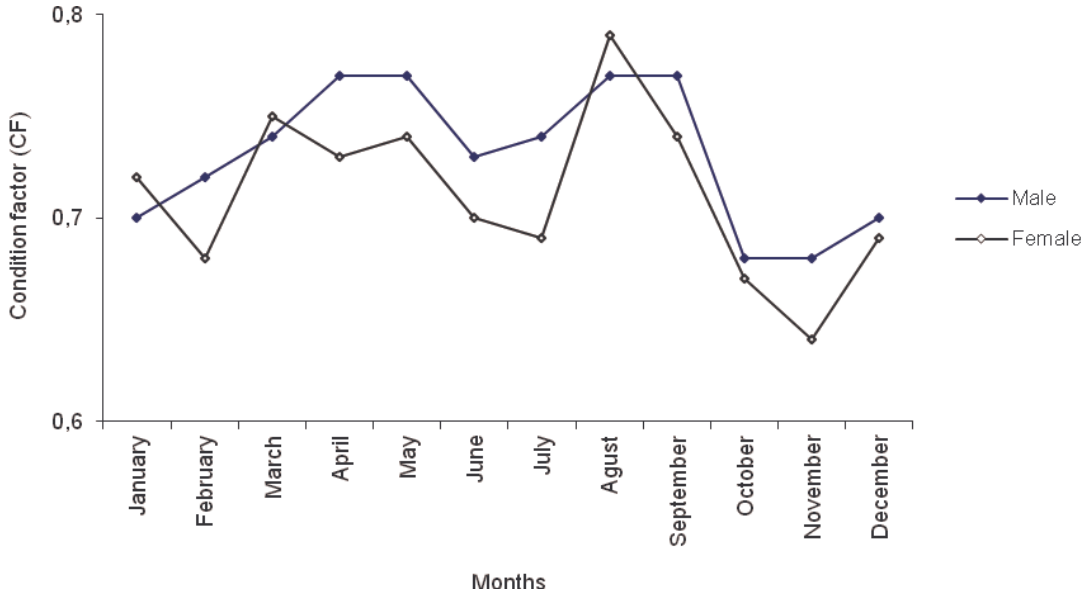

Figure. 7. Monthly variations in condition factor of male and female of *Liza ramada* in the Gökova Bay as determined from monthly samples taken in June 2007 and May 2008.

3.5. Gonad development and spawning period

Gonad development was followed using the GSI. Monthly changes are plotted in Figure 8. Spawning occurred between October and December, showing a peak in November.

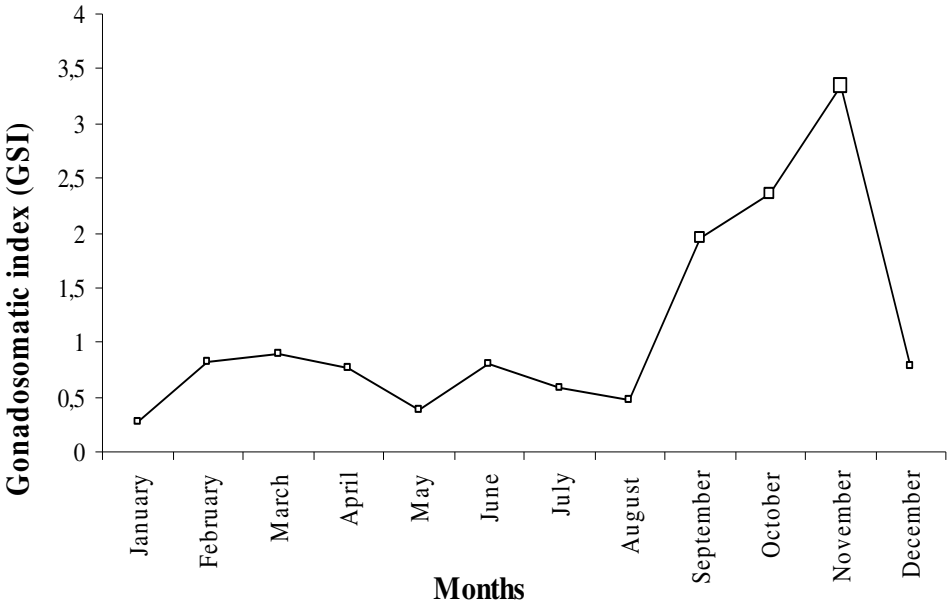

Figure 8. Gonadosomatic index (GSI) changes of *L*iza *ramada* in the Gökova Bay as determined from monthly samples taken in June 2007 and May 2008.

4. Discussion

In this study, a total of 120 specimens of *L. ramada* from Gökova Bay were examined from June 2007 to May 2008. The age of captured fish ranged between groups I and VI. The most of the obtained specimens were between ages II and III indicates that the population were young individuals. Ergene [4, 14] and Mureno et al., [11] confirmed the findings found in this study. The population consisted of 55.84% males and 44.16% females. In this study, the sex ratio was 1: 1.26 (F: M) and not significantly different from 1: 1 ($p<0.05$, χ^2 test). This result may be attributed to the random sampling used during the study. Although the sex ratio in most of the species was close to 1, this may vary from species to species, differing from one population to another of the same species, and may vary year after year within the same population [26]. Brusle [27] reported that the ratio of males increased during reproduction migration. Generally, the ratio of males to females is higher in the early stages of life, while at later stages the situation is reversed, with females becoming more abundant [26]. This situation was confirmed in the present study, as the sex ratio favored males in the younger age-classes and females in the older age-classes. Similar patterns have been found in many other studies [28-30] conducted in Europe. Brusle [27] and Göçer and Ekingen [15] also confirmed the sex ratio found in this study.

Variations in fish growth in terms of length and weight can be explained as an adaptive response to different ecological conditions [26, 31]. As males were longer and heavier at earlier life stages, females were longer and heavier at later stages. This situation was similiar to those reported by Ergene [4, 14], Göçer and Ekingen, [15], and Bilgin et al., [32].

As the largest size of *Liza ramada* reported in Gökova Bay is found as 480 mm at 6 years old, this is higher than the size (364 mm and 42.0 cm at 6 years old, respectively)

determined by Farrugio [33] from Tunusie and Yerli [34] from Köyceğiz Lagoon, Kalay et al., [35] and lower than growth rates (420 mm at 5 years old, 41.5 cm at 6 years old, 70 cm at 8 years old) from Akgöl-Paradeniz [14]. The von Bertalanffy growth equation was estimated as $L_t= 489.19[1-e^{-0,21(t+1.01)}]$ for all individuals in Gökova Bay. The theoretical maximum length was close to those estimated for Cabras Lagoon in Central-Western Sardinia [11] except for Tagus River [9], the Neretva River Delta [36]. Differences about the data of age- length-weight relations can be explained by the various biotic and abiotic factors like adequacy of the food; density of the population; and peculiarity of physical and chemical of the water [26, 31]. The von Bertalanffy growth equations were: $L_t= 489.19[1-e^{-0,21(t+1.01)}]$ for all individuals in Gökova Bay. The theoretical maximum length was close to those estimated for *L.ramada* in Tagus River, Cabras Lagoon, Sibenik Bay (Adriatic Sea) [37] except for the Krka River [38], North-Western Portugal [39], West Greece [40].

This variation may be due to different stages in ontogenetic development, as well as differences in condition, length, age, sex and gonadal development [26]. Geographic location and some environmental conditions such as temperature, organic matter, quality of food, time of capture, stomach fullness, disease, parasitic loads [41], temperature, organic matter, quality of food and the water system in which the fish live [32] can also affect weight at- age estimates.
In thinlipped mullets at Gökova Bay, values of condition factor varied from 0.45 to 1.12. while Göçer and Ekingen [15] reported the condition factors of *L.ramada* between 0.44 and 0.95 in Mersin Bay population, Temelli [42], Sarı [43], Yerli [44], Akyol [45], Ergene [14], Hoşsucu [5] and El-Zaeem [46] mentioned the condition factors of *L. ramada* as between 0.82 -1.04, 0.83-0.98, 0.77-0.921, 0.85-1.88, 0.95-0.97, 0.74-0.84, and 0.42 for İzmir Bay, Bafa Lake, Köycegiz Lagoon, Homa Lagoon, Akgöl-Paradeniz Lagoon, Güllük Bay, and Egypt, respectively. This case can be attributed to the richness of nutrients, population density, age, spawning season in studying areas. In addition, the lowest condition was recorded in autumn months corresponding to the known spawning period of *Liza ramada* in Turkish Waters. The findings confirm the relevant studies by Hossucu [5] and Temelli [42] from İzmir and Güllük Bays, Bruslé [27] and Farrugio [33] and from North Africa.

The slope (b) value of the length–weight relationship in all individuals showed that weight increased with length in negative allometry. b value for *L.ramada* population in Gökova Bay was different from those found by Hossucu [5] and Katselis [40].
The b values are often 3.0 and generally between 2.5 and 3.5. As the fish grows, changes in weight are relatively greater than changes in length, due to approximately cubic relationships between fish length and weight. The b values in fish differ according to species, sex, age, seasons and feeding [22; 41]. In addition, changes in fish shape, physiological conditions, different amounts of food available, life span or growth increment can all affect the b growth exponent [47; 48].

In the present study, spawning season of *L.ramada* in Gökova Bay extended from November to December on the basis of GSI values (Figure. 8). Spawning season of *L. ramada* in Timsah Lake extended from November to January [13], while spawning season of this species in Akgöl-Paradeniz Lagoon was found to be November and December [4]. Sagi and Abraham *et al.* [49] reported that *Liza ramada* has maximum GSI values during period of migration to the sea in order to reproduce. Slastenenko (50) mentioned that *Liza ramada* reproduction continues in the Black sea during July

and September. Katavic [51] evaluating the time of emergence of fingerling *Liza ramada* and suggested that spawning occurs between late December, January and February. Yerli [34] found that the values of GSI was 18.96 at November and 16.17 at December while Salem and Mohammed [52] at Crocodile Lake (Egypt) found the GSI % values of Liza ramada in October, November and December to be 2.2 %, 4.3 % and 2.2 % respectively. The GSI % values found in Gökova Bay are lower than the values found in the studies mentioned above. It was found that spawning period as reported for Eisawy *et al.* [55]; Salem and Mohammed [52]; Yerli [34]; Buhan [56]; Sarı [43]; Zaki *et al.* [57], Ergene [4], and El-Halwawy et al., [13] are all in agreement with each other and with the present study. However, due to different ecological and climate conditions, the starting and finishing time of reproduction may include different months. Spawning periods of fish vary with respect to their species; the ecological characteristics of fish are determined by such ecological differences as stagnant or running water, as well as altitude, temperature and quality of food [26].

5. Conclusion

As a result of the mullet species in this study, especially in the Gökova Bay, V-VI age groups, and more at the arrest of individuals belonging to the older age groups are noteworthy. Decreasing of population of this age group indicates the over-fishing. The releasing of the thinlipped mullets in small quantities from nets may be recommended. However, this rootstock is left to nature, especially of those who have matured gonadlara marine environment and can be hunted again considering the possibility it may not be the solution. Therefore, the sexually matured individuals can be supported to spawn in natural enviroment by establishing net cages to areas suitable for laying eggs and, to catch the newly spawning fishes inside the cage can be recommended for the sustainable yield.

The fishing size of mullets has been given as 20 cm by Ministry of Rural Affairs [58]. In spite of these prohibitions and regulations related to mullet fishes, the fact that the substantial as many fish under this lenght limit was encountered revealed the unconscious fishing of mullets and more stringent precautions to be taken in this subject should be thought. The fisherman should use the more open-area fishing nets and release the fish under the lenght limit caught incidentally, to the sea by according to fishing bans. It is tought that the needed training and awareness-raising work by the authorities will be good to make for chance of continuing mullet generations. If the mullets are persisted to catch unconsciously, economically important fishes will be endangered.

Starting from this idea, long-term precautions should be taken for mullet populations. Therefore, as a priority, water quality, micro and macro studies of flora and fauna should be carried out. Planning for the future will be done, taking account of the scientific data obtained from these studies by experts.

References

[1] Papa, R., Marzano, F.N., Rossi, V., Gandolfi, G., Genetic diversity and adaptability of two species of Mugilidae (Teleostei: Perciformes) of the Po river delta coastal lagoons , **Oceanologica Acta,** 26, 121-128, (2003).

[2] Keith, P., Le Bail, P.Y. and Planquette, P., Atlas des poissons d'eau douce de Guyane (tome 2, fascicule I). **Publications Scientifiques du Muséum National d'Histoire Naturelle**, 286 p, Paris, (2000).

[3] Karataş, M., Investigation of reproduction characteristics and meat yields of chub (*Leuciscus cephalus* L.) and Italian barbel (*Barbus plebejus* L.) living in Almus Dam Lake, A. Ü. Institue of Science and Technology, **PhD thesis (unpublished),** 127 pp, Erzurum, (1995).

[4] Ergene, S., Reproduction characteristic of Thinlip Grey mullet, *Liza ramada* (Risso, 1826) inhabiting Akgöl-Paradeniz lagoons (Göksű Delta). **Turkish Journal of Zoology,** 24, 159–164, (2000).

[5] Hoşsucu, B., Some growth parameters of mullet species (Mugil spp.) living in Güllük Lagoon (Aegean Sea). E. U. **Journal of Fisheries, Aquatic Sciences**, 18, 421–435, (2001).

[6] Minos GC (1996) Biology and dynamics of *Liza ramada* (Pisces: Mugilidae) of the Mesolongi-Etoliko lagoon. Doctorate dissertation, University of Patra, Greece

[7] Sinovčić,G., Zorica, B. and Franičević, M., Population dynamics of grey mullet, Liza (Liza) ramada (Risso, 1826) from the Middle Adriatic (Šibenik Bay), **Proceedings, 8th Croatian Biological Congress /** Besendorfer, Višnja ; Kopjar, Nevenka (ur.), Croatian Biological Society , 2003. 299-300, Zagreb (2003).

[8] Torricelli, P., Tongiorgi, P. and Almansi, P., Migration of grey mullet fry into the Arno river: Seasonal appearance, daily activity, and feeding rhythms, **Fisheries Research**, 1, 219-234, (1981-1982).

[9] Almeida, PR, Moreira F, Costa JL, Assis CA, Costa MJ., The feeding strategies of *Liza ramada* (Risso, 1826) in fresh and brackish water in the River Tagus, Portugal. **Journal of Fish Biology**, 42, 95, (1993).

[10] Dzikowski, R., Paperna, I. and Diamant, A., Use of fish parasite species richness indices in analyzing anthropogenically impacted coastal marine ecosystems**,** **Helgol Marine Research,** 57, 220–227, (2003)

[11] Mureno, M., Olita, A., Sabatini, A., Follesa, M.C. and Cau, A., Dystrophy effects on the Liza ramada (Risso, 1826) (Pisces, Mugilidae) population in the Cabras lagoon (Central-Western Sardinia), **Chemistry and Ecology**, http://www.informaworld.com/smpp/title~db=all~content=t713455114~tab=issueslist~branches=20 - v2020(S1), 425 – 433, (2004).

[12] Matić-Skoko, S., Peharda, M., Pallaora, A., Franicevic, M., Species composition, seasonal fluctuations, and residency of inshore fish assemblages in the pantan estuary of the eastern middle Adriatic, **Acta Adriatica**, 46, 201–212, (2005).

[13] El-Halfawy, M., Ramadan, A.M., Mahmoud, W.F., Reproductive Biology and Histological Studies of The Grey Mullet, *Liza ramada*, (Risso, 1826) In Lake Timsah, Suez Canal, **Egyptian Journal of Aquatic Research**, 33, 434-454, (2007).

[14] Ergene, S., Growth properties of thin-lipped mullet, *Liza ramada* (Risso., 1826) inhabiting in Akgöl-Paradeniz Lagoon of Göksu Delta. **Turkish Journal of Zoology,** 23, (supplement. 2): 647–655, (1999).

[15] Göçer, M. and Ekingen, G., Growth parameters of *Liza ramada* (Risso, 1826) population in Mersin Bay, E.U. **Journal of Fisheries and Aquatic Sciences**, 20, 27 – 34, (2003).

[16] Cihangir, B., Benli, H.A., Cirik, Ş., Ünlüoğlu, A. and Sayın, E., Bio-ecological properties of Gökova Bay, **Proceedings of Symposium on Bodrum Peninsula Enviromental Problems**, Bodrum, 15-19 Şubat 1995, 647-662, (1998).

[17] Akyol, 0., Ceyhan, T., İlkyaz, A. and M.Erdem., et al., Gökova Körfezi (Ege Denizi) Uzatma Ağları Balıkçılığı Üzerine Araştırmalar**,** Anadolu University, **Journal of Science and Technology,** 8, 139-144, (2007).

[18] Bagliniere, J. L. and Louarn H. L., Caracteristiques scalimetriques des principales especes de poissons deau douce de France. **Bulletin France Peche Piscis**, 306, 1–39, (1987).

[19] Chugunov, N.I., Age and Growth Studies in Fish. Translation from Russian. **Israel Program for Scientific Translations**. 132 p. Jerusalem (1963).

[20] Lagler, K. F., Freshwater Fishery Biology. **W. M. C. Brown Company**. Dubuque, Iowa, 421 p., (1966).

[21] Hotos, G.N. A study on the scales and age estimation of the grey golden mullet, *Liza aurata* (Risso, 1810), in the lagoon of Messolonghi (W. Greece). **Journal of Applied Ichtyology**, 19, 220-228, (2003).

[22] Ricker, W. E., Computation and interpretation of biological statistics of fish populations. **Bulletin. Fish Research. Board Canadian,** 191, 382 pp, (1975).

[23] Sparre, P and Venema, S.C., Introduction to tropical Fish Stock Assessment. Part 1. *Manual.* **FAO Fishery Technical Paper**, 306/1, Rev. 1, 376 p. Rome (1992).

[24] Bolger, T and Connolly, P.L., The selection of suitable indices for the measurements and analysis of fish condition, **Journal of Fish Biology,** 34, 171–182, (1989).

[25] Avsar, D., Fishery biology and population dynamics, University of Cukurova **Handbook 5**. **Nobel Publ**., Adana, 332 pp, (2005).

[26] Nikolsky, G. V., The ecology of fishes (translated by L. Birkett). **Academic Press**, London, 352 p, (1963).

[27] Bruslé, S., Contribution à la connaissance de la sexualité de Poissons Téléostéens Marins Gonochoriques (Mugilidés) et Hermaphrodites (Serranidés). **Thèse Doct., Univ. Perpignan**, 360 pp., (1982).

[28] Erdogan,O., TürkmenM. and YildirimA., Studiesontheage,growthand reproduction characteristics of the Chub, *Leuciscus cephalus orientalis*,(Nordmann, 1840) in Karasu River, Turkey. **Turk Journal of Veterinary Animal Science**, 26, 983–991 (2002).

[29] Koc¸H. T.,Z. Erdogan, Z., Tinkci, M.and Treer, T., Age, growth and reproductive characteristics of chub, Leuciscus cephalus (L., 1758) in the _Ikizcetepeler Dam Lake (Balikesir), Turkey, **Journal of Applied Ichthyology,** 23, 19–24,(2007).

[30] Lorenzoni, M., Carosi, A., Pedicillo, G., Pompei, L. and Rocchini, M., Reproductive properties of the chub *Squalius squalus* (Bonaparte, 1837) in the Assino Creek (Umbria, Italy), Knowledge and Management of Aquatic Ecosystems, 403, 09, (2011).

[31**]** Wootton, R. J., Fish ecology. **Blackwell**, Glasgow, 203 p, (1992).

[32] Bilgin, S., Bircan, R., Sümer, Ç., Özdemir, S., Çelik, E.Ş., Ak, O., Satılmış, H.H., and Bayraklı, B., Population Features and Reproduction Biology of Golden Grey Mullet *Lizaaurata* (Risso, 1810) (Pisces: Mugilidae), in the Middle Black Sea (Sinop-Samsun Regions**), Science and Engineering Journal of Fırat University,** 18**,** 49-62, (2006).

[33] Farrugio H (1975) Les Muges (Poissons, Téléostéens) de Tunisie**. Répartition et pêche, contribution à leur étude systématique et biologique**. **Thèse Doct. Univ. USTL**, 201 pp, Montpellier, (1975).

[34] Yerli, S. V., Investigations on stocks of thin-lipped mullet, *L. ramada* (Risso, 1826) in Köycegiz Lagoon System, **Turkish Journal of Veterinary and Animal Sciences**, 16, 103–120, (1991).

[35] Kalay, M., Sangün, M.K., Ayas, D., Göçer, M., et al., Chemical Composition and Some Trace Element Levels of Thinlip Mullet, *Liza ramada* Caught from Mersin Gulf, **Ekoloji,** 17, 68, 11-16, (2008)

[36] Glamuzina, B., Dulčić, J., Conides, A., Bartulović, V., Matić-Skoko, S., Papaconstantinou, C. Some biological parameters of the thin-lipped mullet, *Liza ramada* (Pisces, Mugilidae) in the Neretva River delta (Eastern Adriatic, Croatian coast). **Vie et Millieu**, 3, 131-136, (2007).

[37] Modrusan, Z., Teskeredzic, E., and Jukic, S., Biology and ecology of Mullidae species on the eastern Adriatic coast (Sibenic Bay). **Report of fifth technical consultation of the general fisheries concil fort he Mediterranean on stock assesment in the Adriatic and Ionian Seas, Barry, Italy, FAO, Fish Rapp**., (394), 159-167, (1988).

[38] Sinovčić,G., Allegria-Hernandez, V., Jug-Duyakovic, J., Jukic, S., Kacic, I., Regner, S., Tonkovic, M., Contribution to the knowledge of ecology of grey mullet, Liza (Liza) ramada (Risso, 1826) from the Middle Adriatic (Šibenik Bay), **Acta Adriatica**, 27, 147-162, (1986).

[39] Arruda, L.M., Azevedo, J.N., and Neto, A.I., Age and growth of grey mullet, *Liza* (*Liza*) *ramada* (Risso, 1826) (Pisces: Mugilidae) in Ria de Aveiro (Portugal), **Scientia Marina**, 55, 497-504, (1991).

[40] Katselis, G., Koukou, K., and Moutopoulos, D., Yield per recruit and spawning stock biomass models for the management of four Mugilidae species in Mesolonghi –Aitoliko lagoon (W. Greece), **International Aquatic Research (Special Issue of AquaMedit 2010 Conference, Greece),** 2, 155-162, (2010).

[41] Bagenal, T. B. And Tesch, F. W., 1978: Age and growth. In: Methods for assessment of fish production in fresh waters. **IBP Handbook No. 3. T. Bagenal (Ed.). Blackwell Scientific Publications, Oxford**, pp.101–136 (1978).

[42] Temelli, B., Mullet species which can be cultured and natural breeding properties of the fishes in İzmir Bay, **Journal of Fisheries, 4**, 13-16, 93–105, (1987).

[43] Sarı, H. M., Investigation of biology of thin-lipped mullet population (*Liza ramada* Risso, 1826) in Bafa Lake, **MSc. Thesis, E. Ü. Institute of Science and Technology**, 1–67, (1988).

[44] Yerli, S., Investigations on economic fish populations in Köyceğiz Lagoon System, **H. U. PhD. thesis, Institute of Science and Technology**, 1–267, (1989).

[45] Akyol, O., Demecology of mullet (mullidae) species of Homa Lagoon (İzmir Körfezi) kefal (Mugilidae). **E.Ü. Institute of Science and Technology**, **PhD. Thesis**, Bornova-İzmir, 1–123, (1999).

[46] El-Zaeem, S.Y., Phenotype and genotype differentiation between flathead grey mullet [*Mugil cephalus*] and thinlip grey mullet [*Liza ramada* (Pisces: *Mugilidae*)], **African Journal of Biotechnology,** 10, 9485-9492, (2011).

[47] Frost, W. E., The age and growth of eels (*Anguilla anguilla*) from The Windemere catchment area: Part 2. **Journal of Animal Ecology,** 14, 106–124 (1945).

[48] Treer, T.; Habekovic, D.; Safner, R.; Kolak, A., Length-mass relationship in chub (Leuciscus cephalus) from five Croatian rivers. **Agricultural Conspectus Science,** 64, 137–142, (1999).

[49] Sagi, G. and Abraham, M., Photoperiod and ovarian activity in the gray mullet *L. ramada* (Pisces. Mugilidae), **Israel Journal of Zoology,** 33, 1–9, (1985).

[50] Slastenenko, E., Karadeniz Havzasi baliklan: (Çeviri. H. Altan) **Et ve Balık Kurumu Umum Müdürlüğü Yayını**. 711p, (1956).

[51] Katavic, I., Temporal distribution of young mugilids (Mugilidae) in the coastal waters of the Central Eastern Adriatic**, Acta Adriatica,** 21, 137-150, (1980).

[52] Salem, S.A.and Mohammed, S.Z., Studies on *Mugil seheli* and *Mugil capito* in Lake Timsah II. Reproduction, **Bulletin of Institute Oceaography and Fishery**, 8, 95–100, (1982).

[55] Eisawy, A. M.; Hashem, M. T. and ELSedfy, H. M., Sexual maturity, spawning migration and fecundity of *Mugil capito* in lake Borollus. **Bulletin Institute of Oceaography and Fishery, ARE**, 4, 34–56, (1974).

[56] Buhan, E., Development of Lagoon management through researches of mullet populations in Köyceğiz Lagoon System, Ministry of Rural Affairs, **Fisheries Research Institute**, Bodrum, **serie B,** 3, 1-347, (1998).

[57] Zaki , M.L., Salem, S. B.; EL-Gharabawy, M. M.., EL-Shorbagy, I. K and EL-Boray, K.F., Seasonal histological changes in the testes of *Mugil seheli* in Suez Bay. **Buletin of Natural Institute of Oceanography and Fish., ARE**, 20, 211-223, (1994).

[58] Anonymus, Ministry of Rural Affairs, **26675th number, 1/2 no.notifications**, Ankara, (2007).