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Monthly Variation in Stock Density and Growth Performance of Juvenile Gilthead Seabream (*Sparus aurata* L., 1758) in Beymelek Lagoon, Antalya, Turkey

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Abstract.- This study carried out in Beymelek Lagoon from June 2006 to May 2007, to investigate monthly variations of stock density and growth performance of juvenile gilthead seabream (*Sparus aurata* L., 1758). Juvenile individuals of gilthead seabream were sampled monthly using gillnets with 40, 44 and 50 mm stretched mesh sizes and trammel nets with 56, 60, 70 and 80 mm stretched mesh sizes at three different areas of Beymelek Lagoon. During the study, a total of 1798 juvenile gilthead seabream were sampled by these nets. Juvenile gilthead seabream samples were first caught in June. Number of samples caught in this month was only 10 individuals, while reached to 140 individuals in July and 494 individuals in August. The smallest gilthead seabream caught in June was 18 g weight and 10.6 cm in length. It was determined that average weight and length of samples collected in this month were 29.2 g and 12.5 cm, respectively. Their average weight and length reached to 93.4 g and 18.2 cm until at the beginning of September being free commercial fishing for this species. In this period, specific growth rate also increased 116.3%. This increase lasted gradually until October.

Key words: Beymelek Lagoon, juvenile gilthead seabream, *Sparus aurata*, stock density, growth performance.

INTRODUCTION

Estuaries and coastal lagoons are used by large number of fish as nursery sites, migration routes, feeding and/or breeding areas. For these reasons, they represent important environments, which support high levels of fish production (McHugh, 1967; Elliott, 2002). The gilthead sea bream (*Sparus aurata* L., 1758) is an inshore species which inhabits sea grass beds as well as sand and rocky bottoms (Bauchot and Hureau, 1986). During its first months of life, this species is known to enter coastal lagoons and estuaries in early spring, seeking shelter and food (Arias, 1976, 1980; Suau and Lopez, 1976). Although most juveniles leave the nursery before reaching one year old, some individuals may stay for a second year (Arias, 1980). Beymelek Lagoon is used by gilthead seabream as a nursery ground, with juveniles arriving in the spring and usually leaving in autumn and winter periods.

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S. aurata as well as *Diplodus sargus, Lithognathus mormyrus, Sarpa salpa, Boops boops, Oblada melanura, Liza saliens, Chelon labrosus, Liza aurata, Mugil cephalus, Trachinotus ovatus, Alepes djedaba, Caranx rhonchus, Sardinella maderensis, Sardinella aurita, Dicentrarchus labrax, Siganus rivulatus, Anguilla anguilla, Engraulis encrasicolus, Solea solea, Sphyraena chrysotaenia* and *Echeneis naucrates* inhabit Beymelek Lagoon (Balık *et al.*, 2011a). Many of these fish species are not important for commercial fishing in the lagoon because of the low economic value or low stock density. Balık *et al*. (2011a) reported that during this study *S. aurata, D. sargus* and *L. mormyrus* contributed 38.0, 7.2 and 4.6% to the total catch. The ratio of gilthead seabream in the total catch shows that this species is the most important fish species for fisheries in this lagoon. However, there were few studies on this species in Beymelek Lagoon.

Previous studies on the ichthyofauna of Beymelek Lagoon focused largely on growth and biological characteristics of gilthead seabream (Kocakaya, 1999; Küçükkara, 1999; Emre *et al.*, 2009), striped seabream (*L. mormyrus*) (Emre *et al.*, 2010) and leaping grey mullet (*L. saliens*) (Balık *et*

al., 2011b) and on temporal and spatial changes in species composition (Balık *et al.*, 2011a). As one of the most important commercial species for fisheries in Turkey, information on movements and habitat use of gilthead seabream is of considerable importance for management and conservation.

Juvenile gilthead seabream migrate into Beymelek Lagoon, and most of which are caught by fishermen using trammel nets and in fish traps in barriers on the channel between the lagoon and the sea from the beginning of September to the end of winter. Although it is the most important commercial fish species for lagoon fisheries, little is known on its biology, spatial distribution, spawning grounds and behavior, and eventual migration. Especially entering time into the lagoon area, monthly stock density and growth performance of this species should be known well for a management strategy. Our study investigated monthly variation in stock density and growth of gilthead seabream in Beymelek Lagoon from June to May 2007.

MATERIALS AND METHODS

Beymelek Lagoon is located along the south-western coast of Turkey at the Mediterranean Sea (30° 04' E, 36° 16' N). The lagoon covers about 255 ha surface area with a depth range between 0.5 and 2.5 m. The bottom is generally a mixture of sand and mud, and approximately 60% of the lagoon surface area is covered with macroalgae, especially during the summer period. Lake Kaynak (about 5 ha surface area and 2-5 m depth) is located in the north-west of the lagoon lake. There is water connection from this lake via channel of about 270 m in length. From this lake, freshwater of about 1 $m^3 s^{-1}$ flows into the lagoon (TOKB, 1984). On the other hand, there are water connections from Mediterranean Sea via channel of about 200 m in length and 30-35 m in wide. Salinity thus varies seasonally, mainly as the result of winter rains, evaporation, and brackish water inflow, with salinity levels between 10 and 17 psu. The annual water temperature fluctuates from 15 to 23 C. Juvenile gilthead seabream were collected at the three sampling sites (1, 2 and 3) from Beymelek Lagoon in the third week of each month from February 2006 to May 2007. Site 1 is located at the mouth opening of the lagoon, influenced by its proximity to a deep marine inlet. The sampling site bottom is mainly muddy-sandy with macroalgae surface coverage during summer. Site 2 is located in the north-western part of the lagoon near the water inlet from Lake Kaynak. The bottom is muddy and the surface is covered with vegetation especially during summer months. Site 3 is located in the north-eastern part of the lagoon near an island with a surface area of 500 m^2 (Fig. 1). The subrate at this sampling site is generally characterized by a soft bottom and the presence of macroalgae. During the study, a fishing operation was conducted on every month at each sampling site using gillnets with 40, 44 and 50 mm stretched mesh sizes and trammel nets with 56, 60, 70 and 80 mm stretched mesh sizes (stretched mesh of inner wall). Length of each net was 100 m. All nets were fastened and deployed in circles between 20.00 and 01.00 hours, using a small boat at each sampling site. After several minutes, the nets were hauled in and the captured fish removed.

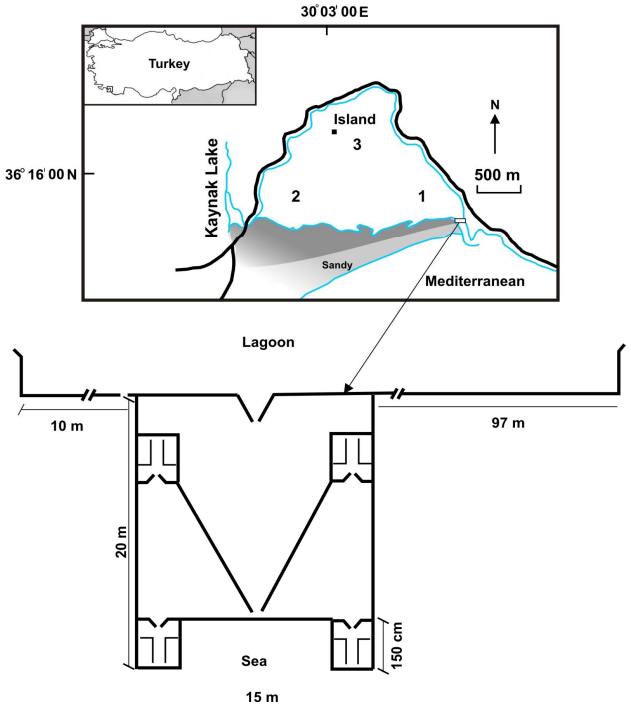

Fig. 1. Map of Beymelek Lagoon in Turkey showing sampling sites and fish traps in barrier.

For each fish, the total length (TL) was

measured to the nearest mm and the total weight (W) to 0.1 g. Monthly variations in number, average weight, absolute growth and relative growth, specific growth rate and length-frequency distributions were determined.

Growth of gilthead seabream in weight was analyzed as absolute growth, relative growth and specific growth rate. Absolute Growth [ΔG (g)], Relative Growth [RG], Specific Growth Rate [SGR (g/month)] were calculated using equations as follows (Adewolu *et al.*, 2008; Abbas, 2009; Benetti *et al.*, 2010):

$\Delta G=W_2-W_1$
$RG=(W_2-W_1)/W_1$
$SGR=100*[\ln (W_2)-\ln (W_1)]/(t_2-t_1)$

W_1, average weight of fish samples at time t_1 (g); W_2, average weight of fish samples at time t_2 (g); t_2-t_1: time duration (month).

The length-weight relationship was calculated by the equation $W=a*TL^b$, where W is the total body weight (g), L is the total length (cm), a is a coefficient related to the body form and b is exponent indicating isometric growth when equal to 3 (Anderson and Neumann, 1996; Wootton, 1990).

RESULTS

During the study, a total of 1798 juvenile gilthead seabream hatched in the 2006-2007 reproduction season were collected. The number of the monthly variations of juvenile gilthead seabream captured from the lagoon and water temperature are shown in Figure 2. Juvenile gilthead seabream was first sampled in early June having about 30ºC water temperature. Number of juvenile gilthead seabream sampled was only 10 in this month, while it increased to 140 in July and 494 in August. As seen in Figure 2, the number of juvenile gilthead seabream was decreased in September and then did not change from September to January. Therefore, the number of samples collected in this month was lower than other months.

Monthly average weights, absolute growth, relative growth and specific growth rates in weight and in length of juvenile gilthead seabreams collected from June 2006 to May 2007 in Beymelek Lagoon are given in Table I. The smallest specimen in June was 18 g in weight and 10.6 cm in length in this month, average weight and length were determined as 29.2 g and 12.5 cm. Their average weight and length increased 80% and 16.8% from June to July, respectively (Figs. 3, 4). Monthly variations of weight and length (Figs. 3, 4) and length-frequency distributions showed (Fig. 5) that weights and lengths of juvenile gilthead seabream entering to Beymelek Lagoon increased gradually from June 2006 to May 2007.

Length-weight relationship of gilthead seabream was calculated as $W=0.0204*L^{2.904}$ (R^2=0.9506. 95% CI of b=2.866-3.134) (Fig. 6). The

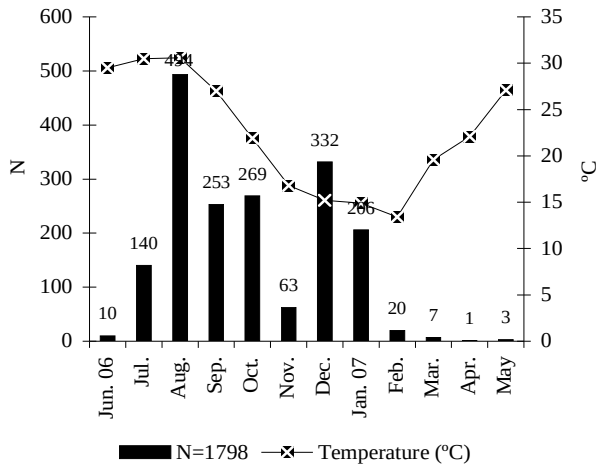

Fig. 2. Monthly variation in the number of juvenile giltheas seabream caught from Beymelek Lagoon from June 2006 to May 2007 and water temperature.

Table I.- Monthly increase in weight (g) of juvenile gilthead seabream in Beymelek Lagoon.

t_1	W_1	t_2	W_2	ΔG	RG	SGR
June 06	29.2	July	52.6	23.40	0.80	58.86
July	52.6	August	81.3	28.70	0.55	43.54
August	81.3	Sept.	93.4	12.10	0.15	13.88
Sept.	93.4	Oct.	127.6	34.2	0.37	31.20
Oct.	127.6	Nov.	115.6	-12.0	-0.09	-9.88
Nov.	115.6	Dec.	138.8	23.2	0.20	18.29
Dec.	138.8	Jan. 07	136.7	-2.1	-0.02	-1.53
Jan. 07	136.7	Feb.	172.0	35.3	0.26	22.97
Feb.	172.0	March	163.3	-8.7	-0.05	-5.19
March	163.3	April	194.1	30.8	0.19	17.28
April	194.1	May	266.7	72.6	0.37	31.78

b values and t-test result indicated an isometric growth for juvenile gilthead seabream in Beymelek Lagoon.

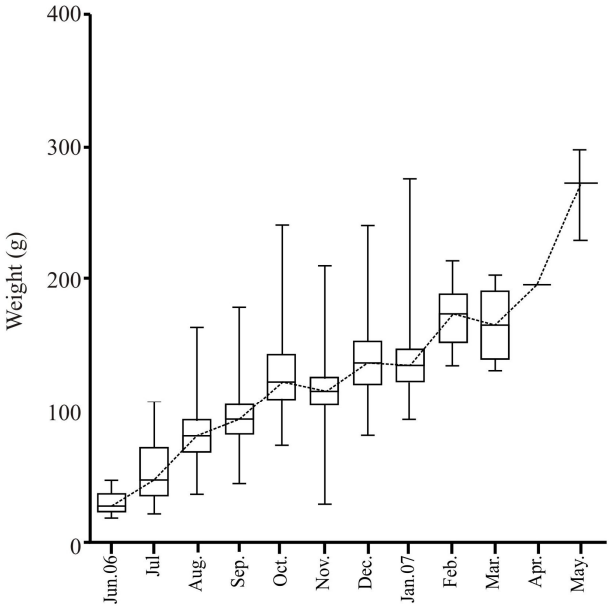

Fig. 3. Monthly weights (Mean±SD) of juvenile gilthead seabream collected in Beymelek Lagoon from June 2006 to May 2007.

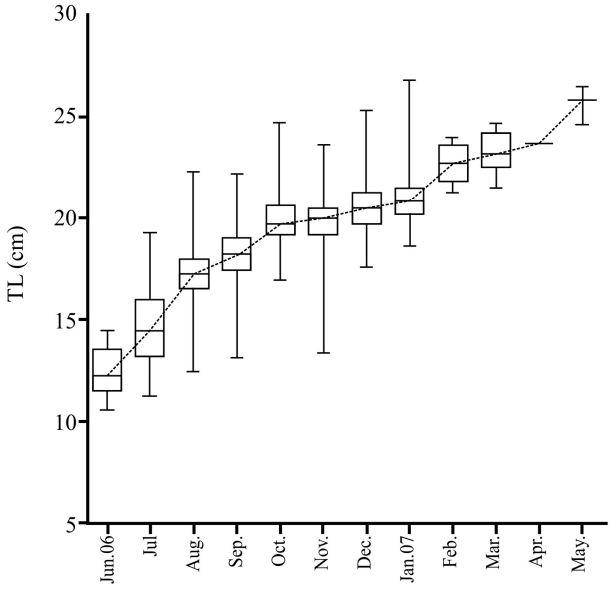

Fig. 4. Monthly length (Mean±SD) of juvenile gilthead seabream collected in Beymelek Lagoon from June 2006 to May 2007.

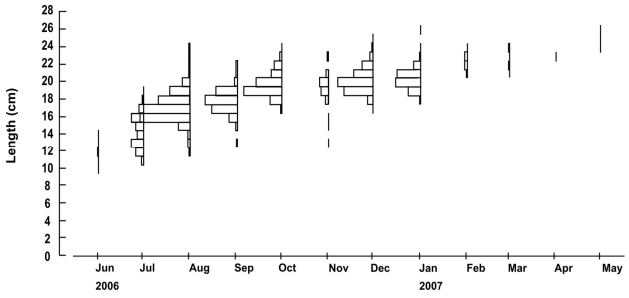

Fig. 5. Monthly length-frequency distributions of juvenile gilthead seabream collected in Beymelek Lagoon from June 2006 to May 2007.

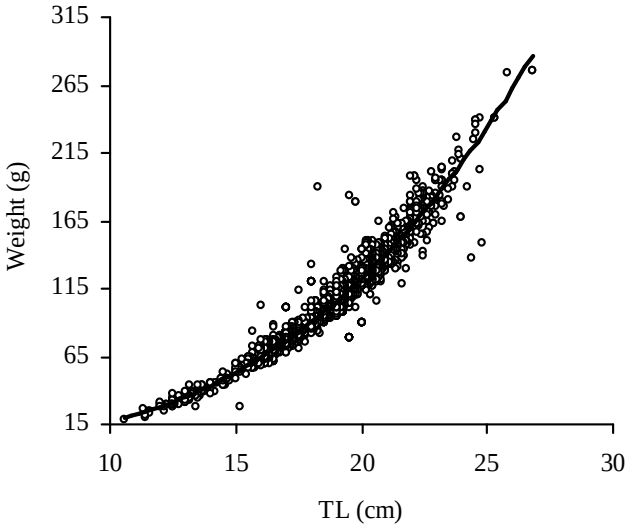

Fig. 6. Length-weight relationship of juvenile gilthead seabream collected in Beymelek Lagoon from June 2006 to May 2007.

DISCUSSION

The sea bream is a protandrous hermaphrodite and it is a functional male in the first two years and at over 30 cm in length becomes female. In the Mediterranean, they reproduce between October and December (Sola *et al.*, 2006). The planktonic larval stage lasts about 50 days at 17-18°C (Sola *et al.*, 2006). Emre *et al.* (2009) reported that reproduction for gilthead seabream in Beymelek Lagoon occurred between December (2006) and February (2007). As indicated by Arias (1976) and Suau and Lopez (1976), following

hatched at sea juveniles of these species probably migrate into Beymelek Lagoon in the late spring and in the beginning of summer, seeking shelter and food. However, they were first sampled in June, with the smallest mesh-sized nets (40 mm stretched mesh) used in our study. Probably, juvenile individuals of this species were also present in the lagoon before June, but they were too small to catch with the gillnets and trammel nets used in the present study. Number of gilthead seabream sampled from the lagoon area increased from June to August, while decreased in September. Commercial fishing of gilthead seabream starts in September and lasts until March or April of the next year in Beymelek Lagoon. In this month, catching of this species started also by traps in barrier on the channel between the lagoon and the sea. But, it did not change from September to January 2007. During this period, the number of samples was lower only in November than those of December and January. Samples were collected each month evenings between 20.00 to 01.00 hours, while it was conducted in daylight in November because of inconvenient meteorological conditions. For this reason, the number of gilthead seabream sampled was lower in November than those of December and January. A few specimens were caught during February and later.

Juvenile of gilthead seabream were more abundant (94% in the 0+ age) than older individuals Beymelek Lagoon (Emre *et al*., 2009) as reported by Lasserre (1976) in the Arcachon Basin (France), by Kraljevic´ and Dulcˇic´ (1997) in Mirna estuary in the Adriatic Sea and by Chaoui *et al*. (2006) in Mellah Lagoon (north-eastern Algeria). The results of the present study confirm the importance of lagoons as nurseries for gilthead seabream. However, Küçükkara (1999) reported that the ages of gilthead seabream in the same lagoon ranged from 0+ to 4 years and only about 26.1% of the specimens were in the 0+ age and 40.5% in the age 1. During the study, it was observed that mesh size of trammel nets used in the commercial fishing was between 64 and 80 mm. Almost all of gilthead seabream caught by these nets were juvenile. In this lagoon, this species is caught by trammel nets as well as fish traps in barriers. In Beymelek Lagoon a barrier and fish traps in barriers on the channel between the lagoon and the sea are set each year at the beginning of September, to catch fishes as well as to prevent fishes from leaving the lagoon. They are removed each year in mid-April in order to implement entrance of fishes into the lagoon from the sea. Stock of gilthead seabream in the coastal sea was affected by these catching types. Therefore, juvenile gilthead seabream fishing must be prohibited both by trammel nets in the lagoon area and fish traps in barriers, for future of the species.

Smallest specimen in June was 18 g in weight and 10.6 cm in length. Average weight and length of individuals sampled in this month were calculated as 29.2 g and 12.5 cm, respectively. It was determined from June to July that absolute growth, relative growth and specific growth rate increased 23.4 g, 0.80 and 58.8%, respectively. Generally, average weight and length increased gradually from June to spring period of 2007. Results of this study showed that juvenile gilthead seabream was approximately 30 g in June, while they reached about 93 g weight until at the beginning of September being legal fishing season. In this period, specific growth rate also increased 116.3%. This growth may also be change year after year depending on especially food ability and stock density.

The relationship between length and weight shown that growth in weight is isometric ($b=2.904$) with a 95% confidence interval of $2.866 \leq CI \leq 3.134$. In the same lagoon b of length-weight relationship was reported as 2.9769 by Emre *et al.* (2009) for the same period and 3.0245 by Küçükkara (1999) about 10 years ago. In the same period b value calculated for only juvenile gilthead seabream was lower than that reported by Emre *et al.* (2009). The results showed that length-weight relationship of a fish population can change with fish size. It was reported that this species grows as isometric in Balearic Islands (Spain), Iberian coast (Morey *et al.*, 2003), Mellah Lagoon (Chaoui *et al.*, 2006) and southeast Mediterranean (Egypt); while allometric in Algarve coast of Portugal (Santos *et al.*, 2002), Iskenderun Bay (Can *et al.*, 2002) and northeast Mediterranean coast of Turkey (Sargun *et al.*, 2007). According to Bagenal and Tesh (1978) reason of this difference is probably

because of food, growth rate, gonad development and reproduction season etc.

In conclusion, in order to accurately determine entrance time of juvenile gilthead sea bream into Beymelek Lagoon, sampling must be done at frequent intervals by using a non-selective nets in the lagoon area. In addition, it was observed that mesh size of trammel nets used for commercial fishing was between 64 and 80 mm. Almost all individuals caught with these nets were juvenile. Fishing of gilthead seabream showed be prohibited by all methods or at least mesh size of trammel nets should be increased.

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