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The Age, Growth and Reproduction of Gray Triggerfish (*Balistes capriscus*, Gmelin, 1789) in İskenderun Bay

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Abstract: The length-weight relationship, age, growth parameters, spawning, sex ratio, first maturity length and fecundity of gray triggerfish (*Balistes capriscus* G. 1789) were studied using 195 specimens from the İskenderun Bay. Females made up 43% and males 57% of the individuals. The total length of females ranged from 8.0 to 24.5 cm and of males from 7.9 to 25.5 cm. The length-weight relationships for male and female were $W=0.0386*L^{2.76}$ and $W=0.0352*L^{2.78}$, respectively. The age data, derived from dorsal spin readings, were used to estimate the growth parameters of the von Bertalanffy equation. L_∞=39.0 cm, K=0.257, t_o=-0.79. The maximum age group determined was 3 for both sexes. The monthly values of gonadosomatic index (GSI) indicated that the spawning of gray triggerfish occurred mainly between May and July. Gray triggerfish attained first sexual maturity after 1 age (13 cm total length).

Key words: Mediterranean sea, İskenderun bay, *Balistes capriscus*, growth, reproduction

INTRODUCTION

Gray triggerfish is a commercially important benthopelagic species, living individually or in small groups in the stony and rocky sections of the coastlines extending 100 m in depth of the subtropical waters. It is a species, distributed along the Eastern Atlantic Ocean from Mediterranean Sea to the Moçamedes, Angola and the Western Atlantic Ocean from Nova Scotia (Canada), Bermuda, northern Gulf of Mexico to Argentina coast. It lives generally in bays, gulfs, lagoons and mossy reefs[1]. Its lengths is maximum 60 cm (1300 g), this scale reaches up to 45 cm in the Mediterranean Sea[2,3]. This carnivorous fish, which does not swim far away from its habitat, feeds on invertebrates, such as crustacea and mollusc[4]. The gray triggerfish is abundant because it cannot be caught easily and competes with the other species for food[5]. In the Mediterranean Sea, it reproduces among the plants in stony and rocky areas of the coastline between April and June. It attaches its demersal eggs on the plants[3].

Published information on the comprehensive biology and ecology of this species is scarce. Most of the work deals primarily with its systematic, distribution and bioecology. Robins and Ray[1], Harmelin-Vivien and Quero[2], Akşıray[3], Tortonese[4] provided some information distribution, reproduction and bioecology of the species. Johnson and Saloman[6] and Ofori-Danson [7] studied age, growth and mortality parameters of *Balistes capriscus*.

The present study is a contribution to our knowledge of the age and size distribution, growth, spawning, first maturity length and fecundity of the gray triggerfish in the Bay of İskenderun, in the Eastern Mediterranean.

MATERIALS AND METHODS

A total of 195 gray triggerfish specimens were collected from the R/V Mustafa Kemal-1 between December 1998 and January 1999 in the Bay of İskenderun. Monthly trawl surveys were carried out during daytime at depths ranging from 0 to 50 m. The trawl was equipped with an 18 mm mesh size net at the cod-end. Hauling lasted about 2, 5 h at a speed of 1.5 knots.

Total length was measured to the nearest millimetre and whole body and gonad weights were measured to the nearest gram, all in the laboratory. The age data, derived from dorsal spin readings, by using a stereomicroskop[8]. The length-weight relationships were determined according to the allometric equation[9]:

$$W = aL^b,$$

where, W is the total body weight (g), L the total length (cm) and a and b are constants. Growth was expressed in terms of the von Bertalanffy equation[10]:

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$$L_t = L_\infty (1 - \exp^{(-k(t-t_0))})$$

where, L_∞ is the asymptotic total length, L_t the total length at age t, K the growth curvature parameter and t_o is the theoretical age when fish would have been at zero total length. Growth parameters were estimated according to the non-linear method by using the FiSAT package program. The stages of sex and maturity were classified according to Holden and Raitt's[8] scale. The Gonadosomatic Index (GSI) was calculated the following formula:

$$GSI = \frac{\text{Gonad weight}}{\text{fish weight without gonad}} \times 100$$

The length at first maturity was obtained by using the method described by Ismen[11]. The percentage of mature in relation to immature and maturing individuals was calculated for each 1 cm size group and the length at which 50% (L_{50}) are mature was taken as length at first maturity. The egg numbers (fecundity) were estimated using gravimetric method Bagenal[12].

RESULTS AND DISCUSSION

Age-length distribution: Out of the 195 specimens measured, 84 were female (43%) and 111 male (57%). The total length of the gray triggerfish in the İskenderun Bay ranged from 7.9 to 25.5 cm. The overall mean total length and total weight were estimated as 16.1 cm and 91.4 g, respectively. Males total length ranged from 7.9 to 25.5 cm, females total length from 8.0 to 24.5 cm (Fig. 1). The overall female to male ratio was 1: 1.35.

The length-weight relationships were separately evaluated for females and males (Fig. 2). The exponent b demonstrated on negative allometric growth. Comparing the length-weight relationships of the sexes using covariance analysis, no significant difference was found.

Table 1: Total length, weight at age values of gray triggerfish

Age	Length (cm)	N	%	S.D.	Weight	S.D.
I	14.4 (8.0-18.4)	138	70.7	2.28	63.2	25.2
II	19.9 (17.5-24.3)	52	26.7	2.02	149.1	42.6
III	24.9 (24.0-26.1)	5	2.6	0.82	270.9	33.2
Mean	16.2	195	100.0	-	91.4	-

Table 2: The von Bertalanffy growth parameters of *Balistes capriscus*

	Parameter	Estimates	Asymptotic S.E.	C.V.
(T)	L_∞ (cm)	39.000	2.074E+01	0.5318
	K (yıl^{-1})	0.257	2.551E-01	0.9918
	t_o	-0.790	5.790E-01	-0.7333
	L_∞ (cm)	36.700	4.274E+02	1.1631
(F)	K (yıl^{-1})	0.274	6.043E-01	2.2072
	t_o	-0.749	1.268E+00	-1.6924
	L_∞ (cm)	39.000	2.348E+02	0.6021
(M)	K (yıl^{-1})	0.256	2.922E-01	1.1399
	t_o	-0.832	6.989E-01	-0.8396

The equations for the relationship were $W=0.0352*L^{2.78}$ (r=0.99) for females, $W=0.0386*L^{2.76}$ (r=0.98) for males, $W=0.0361*L^{2.78}$ (r = 0.99) for pooled data.

The maximum age determined was 3 for females and males. Age group 1 (70.7%) was dominant. Age group 1 was followed by age groups 2 (26.7%) and 3 (2.6%) (Table 1).

Growth: The estimated von Bertalanffy growth parameters are shown in Table 2. Growth of *B. capriscus* is rapid for the first year and the mean length at the end of the year is 14 cm. After the first year, growth declined gradually. While growth rate is 14.1% between the age groups 1 and 2, this rate is decrease 12.8%, between the groups 2 and 3 (Fig. 3).

Reproduction: The sea and maturity stage of each specimen were determined by visual and microscopic examination of the gonads. The gonadosomatic index (GSI) was calculated monthly. The GSI results revealed that spawning occurred after May, when the GSI reached its highest level (Fig. 4). However, the presence of mature individuals in August showed that reproduction may continue at a reduced rate during summer.

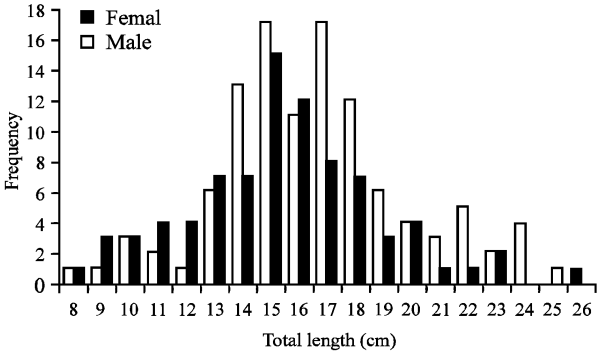


Fig. 1: Length-frequency distribution of gray triggerfish

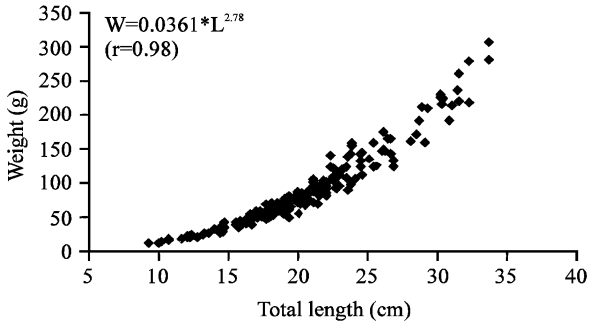


Fig. 2: Total length-weight relationship of *B. capriscus*

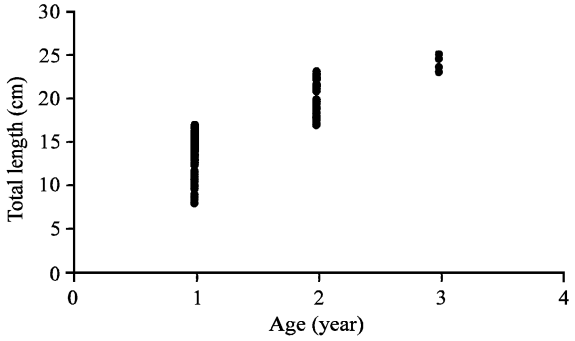


Fig. 3: The von Bertalanffy growth curve of gray triggerfish in the İskenderun bay

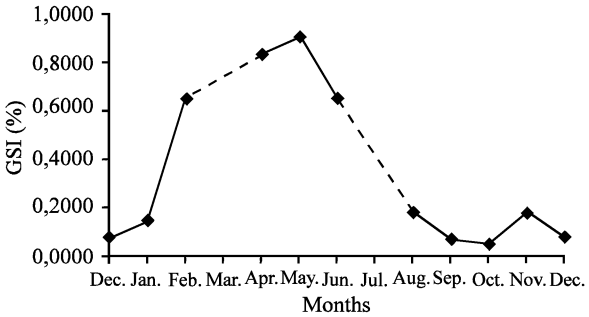


Fig. 4: Gonadosomatic index (GSI) values of gray triggerfish

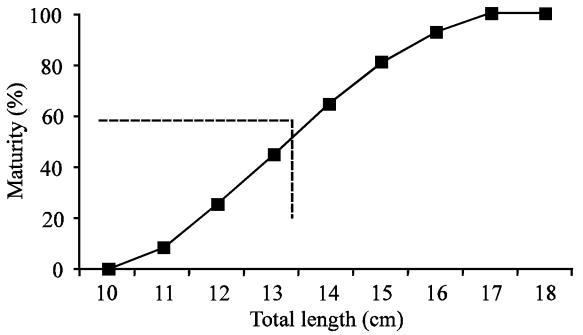


Fig. 5: Length at first sexual maturity of *B. capriscus* (L_{50})

Table 3: The von Bertalanffy length-growth constants and

Researcher	Region	L_∞	K	t_0	ǿ
Ofori-Danson[7]	Ghana	40.8	0.430	-	6.56
Johnson and Saloman[6]	The Gulf of Mexico (F)	43.8	0.383	-0.150	6.60
	The Gulf of Mexico (M)	49.2	0.382	-0.227	6.84
Işmen *et al.*[11]	The Bay of İskenderun (T)	39.0	0.257	-0.790	5.96
	The Bay of İskenderun (M)	39.0	0.256	-0.832	5.96
	The Bay of İskenderun (F)	36.7	0.274	-0.749	5.91

Maturity length: The transition from immaturity to maturity usually occurs over a range of length and is not abrupt, and this is reflected by the data presented in Fig. 5. From the percentages of mature individuals, the mean length at 50% maturity was calculated with 1 cm length intervals. The gray triggerfish attained first sexual maturity at total length of 13 cm. All individuals (L_{100}) attained sexual maturity at lengths of 16 cm. In the İskenderun Bay, mean fecundity for the examined specimens (its length range from 12 cm to 13.3 cm) was determined as 103833 (63802 and 144887).

The gray triggerfish, abundantly available in the warm and temperate seas, can be seen quite rarely in the Marmara Sea and Black Sea[3]. It is not a commercially important species in the Mediterranean Sea coast of Turkey. However, it is consumed mostly fresh, smoked and dried salted.

The length distribution of the 195 individuals collected from the Iskenderun Bay in the Eastern Mediterranean Sea varied from 7.9 to 25.5 cm. The maximum age was determined as 3 (24.9 cm) for the both sexes. The dominant age group was 1. Johnson and Saloman[6] reported that the maximum ages were 12 (56 cm) for the females, 13 (54 cm) for the males in the Northeast of the Mexican Gulf. Wilson *et al.*[13] stated that the maximum lifespan of gray triggerfish is 11 years and found length at age to be similar to those reported by Johnson and Saloman[6]. Lieske and Myers[14] reported that *B. capriscus* reaches to total length 60 cm in the Red Sea including Caribbean. Akşıray[3] and Bauchot[15] noted that the maximum scale of the gray triggerfish is 45 cm and the total length usually ranges from 15 to 35 cm.

The functional regression b value represents the body form and is directly related to the weight affected by ecological factors such as temperature, food supply, spawning conditions and the characteristics of habitat within a year Ricker[16]. The functional regression values (a and b) of the length-weight relationships of *B. capriscus* were calculated as 0.0361 and 2.78, respectively. Johnson and Saloman[6] found that the functional regression values were a=0.0067, b=3.19 for the male, a=0.0139, b=3.07 for the female in the northeastern Gulf of Mexico[17], as a=0.0192, b=2.36 in the Caribbean-Salamanca[18], as a=0.0206, b=2.65 on the southern coastline in Portuguese. The differences observed in the functional regression values of *B. capriscus* from different areas might be attributed to spatial and temporal changes in their different nutritional conditions.

Comparison of the length growth parameters obtained for the gray triggerfish applying Munro's phi prime test showed that there is no significant differences ($p>0.05$) between the overall growth performances of the gray triggerfish sampled from Gulf of Mexico, Ghana and Mediterranean Sea (Table 3).

The calculated value of the growth coefficient K in this study lies in the lower range of those calculated by Johnson and Saloman[6] and Ofori-Danson[7]. However in agreement with previous studies, no statistically significant differences have been detected among the growth performances of gray triggerfish from different areas may be result from the different bioecological conditions.

The ripe fish in samples taken at monthly intervals in İskenderun Bay and the GSI results revealed that the spawning of gray triggerfish occurred mainly May and July. These results are similar to those determined in other studies on gray triggerfish[3,13] reported that *B. capriscus* in the Mediterranean Sea reproduce in the period from April to the end of June. Wilson *et al.*[13] stated that the some species in the northeastern Gulf of Mexico spawn between March and August, mostly June. The total length and age at 50 % maturity for both sex in this study were 13 cm (age group 1). Manooch[19] stated that gray triggerfish attains first sexually maturity at age of 2 (30 cm), but also it may at the age of 1. Ofori-Danson[7] claimed that gray triggerfish mature at the age of 1 and 14.5 cm total length in the same area.

The number of eggs producted of the individuals with a scale of between 12 and 13.3 cm in the eastern Mediterranean Sea were 63802 and 144887. Since the egg productivity of this species isn't very well known and no sufficient data are available on fecundity, the results could not be compared with them. There is only one observation on the number of eggs produced in the Mexico Gulf. Manooch[19], indicated that the individuals at 30 cm produced 49000 eggs, 66000 for 41 cm, 90000 for 56 cm fish in the Mexico Gulf. The differences in the egg number probably results from batch spawning of this species habiting in the tropical and subtropical zones.

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