BIHAREAN BIOLOGIST 6 (2): pp.99-107
Article No.: 121115

http://biozoojournals.3x.ro/bihbiol/index.html

Age, growth, reproduction and feeding habits of brown comber, *Serranus hepatus* (L., 1758) in eastern Aegean Sea

Sercan YAPICI[1,*], Halit FILIZ[1] and Ozde OZKAN[1]

1. Mugla Sitki Kocman University Faculty of Fisheries, Mugla /Turkey.
* Corresponding author, S. Yapici, E-mail: sercanyapici@mu.edu.tr
Phone: +90 252 2115082 / Fax: +90 252 2111887

Received: 11. June 2012 / Accepted: 15. October 2012 / Available online: 18. October 2012 / Printed: December 2012

Abstract. Age, growth, reproduction and feeding habits of brown comber in the eastern Aegean Sea were analysed. Total length and weight of population varied between 6.50 - 11.70 cm and 3.53 – 25.80 g respectively. Age was determined by otolith readings and maximum age was observed as 4 years. Including both sexes von Bertalanffy growth equation parameters were expressed as L_∞= 12.50 cm, k= 0.54 yr^{-1}, t_0= -1.08. Monthly values of the gonadosomatic index indicated that reproduction starts in March and lasts during July, with a maximum in May. Stomach contents were mainly Crustacea (%IRI= 97.51) and Pisces (%IRI= 2.49).

Key words: Age, growth and reproduction; feeding; brown comber; *Serranus hepatus*; Aegean Sea.

Introduction

The brown comber, *Serranus hepatus* (L., 1758), is a small, demersal subtropical serranids species distributed along the coasts of the eastern Atlantic from Portugal and Canary Islands south to Senegal and in the Mediterranean (Tortonese 1986, Fricke et al. 2007). Concerning the Turkish Seas, it was distributed in Sea of Marmara, Aegean Sea and Mediterranean Sea coasts of Turkey (Fricke et al. 2007). It is common in *Posidonia* beds, sandy and muddy bottoms down to 100 m depths (Tortonese 1986). It has been caught in relatively high densities over the Aegean coasts (pers. obs.) and it is considered to be among the most common fish species in the Izmir Bay, where the study was conducted (Gokcen & Cirik 1988).

Studies on age and growth (Bouain 1983, Wagué & Papaconstantinou 1997, Labropoulou et al. 1998, Dulčic et al. 2007, Bilecenoglu 2009), reproductive traits (Bruslé, 1983), mortality (Dulčic et al. 2007), and diet (Bell & Harmelin-Vivien 1983, Labropoulou & Eleftheriou 1997, Labropoulou et al. 1998, Bilecenoglu 2009) of brown comber are available from different parts of Mediterranean. The length-weight relationship of the species was given from several localities throughout the Mediterranean, i.e. Portuguese coasts (Gonçalves et al. 1997), Balearic islands (Merella et al. 1997), Greek coasts (Stergiou & Moutopoulos 2001, Lamprakis et al. 2003), Spanish coasts (Valle et al. 2003) and Egyptian coasts (Abdallah 2002).

S. hepatus is mainly caught in the eastern Aegean Sea by bottom trawls as a by-catch species throughout the year. Total landings of *S. hepatus* in Turkey are unknown, as the Turkish Statistical Institute does not include the capture of this species. Despite its widespread occurrence along Turkish coasts, *S. hepatus* has no commercial value unlike its two other congeneric species (*S. scriba* and *S. cabrilla*; Bilecenoglu 2009), probably due to its small size. Very little is known about the species biology and ecology. The small size species is not consumed as food, yet due to its high proportion in the bottom trawl discard, habitat loss and pollution, the brown comber population has been evaluated as near threatened in Turkey (Fricke et al. 2007), thus making any biological data that we could possess of great importance. In this study, information on the age, growth, reproduction and feeding habits of *S. hepatus* are presented from Turkish coasts, based on material collected in Izmir Bay, Aegean Sea.

Materials and methods

Samples were monthly obtained from three stations (station I, 38° 28′N-26° 46′E; station II, 38° 33′N - 26° 43′E; and station III, 38° 32′N - 26° 40′E) by R/V EGESÜF (27 m LOA, 500 hp) between January 2005 and December 2005 around Uzunada Island, western part of Izmir Bay (Fig. 1). In the samplings, a traditional bottom trawl net was used to capture small sized fishes by a 24 mm stretched mesh size codend. Sampling depth strata varies between 12.8-63.1 meters. Ground was muddy bottom in station I-II; and *Posidonia* meadows in station III. Monthly bottom trawl surveys were carried out during daytime and the towing duration was 30 minutes for all the hauls and the average towing speed was 2.4 knots (ranging between 2.0 and 2.8 knots).

A total of 5222 specimens (844 males, 4294 females, and 84 unidentified) were collected during thirty-six trawl hauling. Specimens were separated and identified to the species level on board and then stored on ice until returned to the laboratory. In order to perform the stomach content analysis, sub-samples were taken and preserved with 10% buffered formaldehyde. Total length (TL, cm) was measured to the nearest 0.01 cm and wet weight (W, g) to the nearest 0.01 gram in the laboratory. Morphometric features were measured by digital calipers precision 0.01 mm. During this study, values of 17 morphometric and 5 meristic characters were determined on all subsamples.

Sagittal otoliths were removed, cleaned and stored dry in u-plates. Age was determined following the procedure described by Holden and Raitt (1974). Otoliths were placed in a black dish with glycerin (30%) and alcohol (70%) to improve reading and were examined under a stereoscope microscope with a reflected light (x10 magnification). Otoliths were read twice by two different readers at an interval of one week and when there was no agreement between the readings, the otolith was excluded. Date of birth of samples was set at June because the highest concentrations of the brown comber larvae and eggs in northeast Mediterranean have been reported during this month (Orek 2004). Such concentrations in June have also been reported for the other Mediterranean areas (Labropoulou et al. 1998).

To examine fish growth, a von Bertalanffy growth equation (VBGE) was calculated using the iterated least square method (Beverton & Holt 1957):

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

where, L_∞ is the asymptotic total length, L_t the total length at age t, k the growth curvature parameter and t_0 is the theoretical age

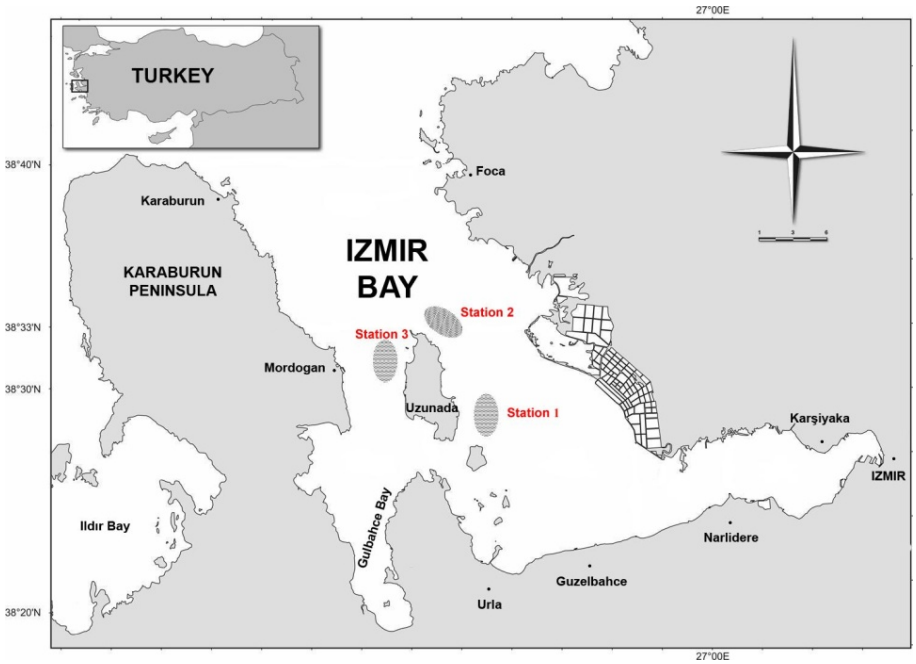

Figure 1. Map showing the location of the sampling stations.

when fish would have been at zero total length (Sparre & Venema 1992).

Growth performance index was used to compare growth rates with the formula (Pauly & Munro 1984),

$\varphi' = \log_{10} k + 2 \log_{10} L_\infty$

The relationship between weight and length, $W = aL^b$ (Sparre & Venema 1992), was converted into logarithmic expression: $ln\ W = ln\ a + b\ ln\ L$. Parameters a and b were calculated by least-squares regression, as was the coefficient of determination (r^2). Significant difference of b values from 3, which represent isometric growth, was tested with the t-test (Pauly 1993).

The stage of gonad maturation was determined by Holden & Raitt's (1974) scale and sexual identification was made macroscopically. Sex ratio (males/females) was calculated. The gonadosomatic index (GSI) was calculated monthly with the equation below:

GSI = Gonad Weight / (Total Body Weight – Gonad Weight) x 100 (Wooton, 1991)

Prey items in each stomach were identified to group level, measured, counted and weighed on an electronic balance (precision 0.01 g). Diet composition was evaluated using three measures described by Hyslop (1980): the numerical index (%N); the gravimetric index (%W), and frequency of occurrence (%F). The index of relative importance (IRI; Pinkas et al 1971) was calculated and expressed as a percentage (%IRI; Cortes 1997).

Results

Age and growth

Table 1 shows the descriptive statistics regarding length, weight and sex data of all individuals. Morphometric and metric characters are shown in Table 2 and Table 3, respectively.

Among the 1850 brown comber from which the otoliths were taken, 238 individuals could not be aged since there was no agreement between readers. Thus, 1612 otoliths were used for direct reading (Table 4). As a result of the 1612 otolith readings, it has been concluded that 2 and 3 year old fishes were dominated in the population. Maximum age determined from otoliths was 4 years. Specimens younger than 1 year were poorly observed in the examined samples (Table 4).

The estimated von Bertalanffy growth parameters were as follows: L_∞= 12.50 cm, k= 0.54 and t_0= -1.08 for combined sexes. The asymptotic length, 12.50 cm, is realistic since the largest specimen sampled was 11.7 cm. The growth performance index (φ′) was estimated as 1.93.

The length-weight relationships were calculated for each sex (Table 5). No significant difference was found between L-W relationships incidating negative allometry growth type (t-test, $p>0.05$).

Reproduction

Monthly changes in gonadosomatic index (GSI) for females are shown in Figure 2. According to GSI, *S. hepatus* reproduces between March and July and it is possible to reach maximum levels in May.

Comparing the GSI values attained by females it can be noticed that, during the reproduction period, females reach GSI values of about 8.9%.

Of collected 5222 specimens, 844 were males, 4294 females, and 84 unidentified individuals. The sex ratio was found as 1:5.

Food

Of the 278 examined brown comber stomachs, five different prey items belonging to two major prey groups were found. Crustacea constituted 97.51% of the diet, while fishes only 2.49%. Among the Crustaceans, Natantia was the principal prey (%IRI: 63.36), followed by Brachyura (%IRI= 30.38). As a different prey group from crustaceans, juvenile specimens of *Gobius* sp. were observed (Table 6). These demersal fishes are commonly observed over sandy and muddy bottoms of Izmir Bay (Bilecenoglu 2003, Filiz & Togulga 2009).

Table 1. Descriptive statistics of length and weight data of specimens obtained in Izmir Bay (Values given are the mean ± SD and range in parenthesis).

Sex	n	Total Length (cm)	Total Weight (g)
♂+♀	5222	9.50±0.75 [6.50 – 11.70]	13.72±3.27 [3.53 – 25.80]
♂	844	9.70±0.84 [7.70 – 11.70]	15.14±3.75 [7.41 – 25.80]
♀	4294	9.65±0.83 [6.50 – 11.70]	15.23±3.74 [3.53 – 25.40]
Undetermined	84	7.72±2.00 [4.40 – 10.40]	8.59±5.47 [1.16 – 17.32]

Table 2. Values of some morphometric measurements of *S.hepatus*.

Morphometric Characters	Formula	Mean (±SE)	Std. Deviation	Total Length (%)	r^2
Standart Length	y = 0.8387 TL – 0.2201	7.11 ± 0.185	1.43	81.35	0.99
Pre-opercular Distance	y = 0.3073 TL + 0.0246	2.71 ± 0.068	0.53	31.01	0.96
Pre-orbital Distance	y = 0.0957 TL − 0.0210	0.81 ± 0.024	0.19	9.33	0.77
Eye Diameter	y = 0.0722 TL + 0.0700	0.70 ± 0.017	0.13	8.02	0.84
Inter-orbital Distance	y = 0.0459 TL + 0.1188	0.52 ± 0.012	0.09	5.95	0.71
Pre-pectoral Length	y = 0.2905 TL + 0.0923	2.63 ± 0.065	0.50	30.11	0.95
Pectoral Fin Length	y = 0.2280 TL − 0.0551	1.94 ± 0.052	0.41	22.17	0.90
Pre-pelvic Length	y = 0.2867 TL + 0.0964	2.60 ± 0.065	0.51	29.78	0.91
Pelvic Fin Length	y = 0.0331 TL − 0.0193	2.70 ± 0.009	0.07	3.09	0.64
Body Height	y = 0.2968 TL – 0.2628	2.33 ± 0.069	0.53	26.67	0.90
Pre-dorsal Length	y = 0.2811 TL + 0.2439	2.70 ± 0.066	0.51	30.90	0.87
Dorsal Fin Length	y = 0.4051 TL – 0.0745	3.46 ± 0.099	0.76	39.67	0.81
Pre-anal Length	y = 0.4976 TL + 0.1698	4.51 ± 0.112	0.87	51.71	0.94
Anal Fin Length	y = 0.1197 TL − 0.0284	1.01 ± 0.030	0.23	11.65	0.78
Podencul Height	y = 0.0819 TL + 0.0355	0.75 ± 0.019	0.15	8.59	0.84
Max. Mouth Height	y = 0.1886 TL + 0.1069	1.75 ± 0.043	0.33	20.07	0.93
Max. Mouth Width	y = 0.1485 TL − 0.0022	1.29 ± 0.034	0.26	14.82	0.90

Table 3. Meristic counts of *S.hepatus*

Numbers of Pectoral Fin Ray	14
Numbers of Pelvic Fin Ray	I-15
Numbers of Dorsal Fin Ray	X-13
Numbers of Anal Fin Ray	III-7
Numbers of Scale in Lateral Line	46

Discussion

Age and growth

There are various studies providing information about maximum lengths of the species in Mediterranean. These studies give us a chance to make a comparison (Table 7). According to Tortonese (1986), the species usually have sizes of 5-12 cm, attaining a maximum of 15 cm (Golani et al. 2006). Bauchot (1987) mentions a higher maximum length of 25 cm. As it is seen, maximum length in Izmir Bay is a little higher than those of the obtained individuals in other parts of Mediterranean (Bouain et al., 1983; Merella et al., 1997; Lamprakis et al., 2003; Valle et al., 2003; Cicek et al., 2006) and quite lower than those obtained by Wagué and Papaconstantinou (1997), Gonçalvez et al. (1997), Labropoulou et al. (1998), Abdallah (2002), Borges et al. (2003), Lamprakis et al. (2003), Dulcic and Glamuzina (2006), and Dulcic et al. (2007). The largest fish obtained in the present study (11.7 cm) is somewhat smaller than previous records, but appears to be within the reported range. Additionally, if we consider that the reported biggest length study (in Adriatic as 18.9 cm) are made in lagoon areas, where temperature and food availability can affect this outcome.

Age determination from direct observations on the otoliths resulted in the establishment of five age groups (0+, I, 2, 3, and 4) for the population. Age group 2 and 3 included 67.75% of the population (Table 4). The dominance of small and younger individuals in the samples implies that there may be a fisheries pressure, predator pressure or pollution effect on the population. All kind of fisheries' activity is prohibited in inner part of Izmir Bay because it has been highly polluted by both domestic and industrial wastes. Also, the southeast part of the line combined Ardıç Burnu (38° 31' 58"

Table 4. Results from direct reading on the otoliths of *S. hepatus* from Izmir Bay. Age expressed in years.

Length Classes (cm)	Age Classes (year)					
	0+	1	2	3	4	∑
4.0-4.9	6					6
5.0-5.9	36	3				39
6.0-6.9	12	39				51
7.0-7.9		43	2			45
8.0-8.9		77	167			244
9.0-9.9		20	343			363
10.0-10.9			153	382	224	759
11.0-11.9				13	92	105
N	54	182	665	395	316	1612
Mean (TL)	5.62	7.75	9.24	10.26	10.48	
Std. dev.	0.597	0.891	0.636	0.247	0.443	
%	3.35	11.30	41.25	24.50	19.60	100

Table 5. Length–weight relationship for *S. hepatus* collected from Izmir Bay, Turkey. C.I = confidence intervals; *a* = intercept of the relationship; *b* = slope of the relationship; r^2= coefficient of determination; n = sample size.

Sex	n	$W = aL^b$			Growth Type
		a	b ± 95%C.I.	r^2	
♂	844	0.0191	293 ± 0.04	0.95	A(-)
♀	4294	0.0213	2.86 ± 0.08	0.85	A(-)
♂ + ♀	5222	0.0200	2.89 ± 0.05	0.85	A(-)

Table 6. Prey groups in stomach content (diet composition) of *S.hepatus* %O: frequency of occurrence, %N: numerical composition, %W: weight of the stomach content and %IRI :percentage index of relative importance.

Prey Category	%O	%N	%W	%IRI
Crustacea				
Natantia	63.64	40.91	60.30	63.36
Brachyura	54.55	27.27	29.34	30.38
Mysidacea	9.09	13.64	0.73	1.28
Copepoda	18.18	9.09	4.78	2.48
Fish				
Gobius sp.	18.18	9.09	4.86	2.49

Table 7. Comparisons of the maximum lengths

Study	Locality	Length	Lmax.
Bouain *et al.*. (1983)	Tunisian waters	TL	10.0
Wagué and Papaconstantinou (1997)	Thermaikos Gulf	TL	13.1
Gonçalvez *et al.* (1997)	Portugal	TL	13.8
Merella *et al.* (1997)	Spain	TL	11.1
Labropoulou *et al.*. (1998)	Cretan Shelf	TL	14.0
Abdallah (2002)	Alexandria Coast	TL	12.5
Borges *et al.* (2003)	Portugal	TL	13.1
Lamprakis *et al.* (2003)	N.Aegean Sea	TL	12.1
Lamprakis *et al.* (2003)	N.Aegean Sea	TL	11.6
Valle *et al.* (2003)	Spain	SL	7.9
Cicek *et al.* (2006)	Babadillimani Bight	TL	10.5
Dulčić and Glamuzina (2006)	Adriatic	TL	18.9
Dulčic *et al.* (2007)	Adriatic	TL	13.0
Bilecenoglu (2009)	Izmir Bay	TL	11.7
This study	Izmir Bay	TL	11.7

Table 8. Comparisons of growth parameters.

Study	L_∞ (cm)	k (year^{-1})	t_0 (year)	t_{max}[A].	Φ' [B]	Locality
Bouain (1983)	10.60	0.25	-0.44	12.0	1.45	Tunisian waters
Wagué and Papaconstantinou (1997)	14.66	0.23	-2.56	13.1	1.69	Thermaikos Gulf
Labropoulou *et al.*. (1998)	15.30	0.36	-0.58	8.3	1.93	Cretan Shelf
Dulčic *et al.* (2007)	14.82	0.22	-1.67	13.6	1.68	Croatian coast
Bilecenoglu (2009)	11.90	0.56	-1.14	5.4	1.90	Izmir Bay
This study	12.50	0.54	-1.08	5.6	1.93	Izmir Bay

[A] t_{max}(life-span)= based on $3/k$ assumption (acoording to Froese and Binohlan 2000)
[B] $\Phi' = \log k + 2 \log L_\infty$

Table 9. Comparison of the LW relationships.

Study	Locality	n	W= aL^b		
			a	b	r^2
Bouain (1983)	Tunisian waters	-	0.0066	3.64	0.98
Wagué (1987)	Thermaikos Gulf	1290	0.1770	1.89	0.74
Gonçalvez *et al.* (1997)	Portugal	69	0.0345	2.72	0.90
Merella *et al.* (1997)	Balearic Islands	61	0.0091	3.24	0.99
Abdallah (2002)	Off Alexandria	153	0.0250	2.84	0.95
Borges *et al.* (2003)	Algarve	123	0.0177	2.98	0.92
Lamprakis *et al.* (2003)	N. Aegean Sea	2318	0.0121	3.12	0.95
Lamprakis *et al.* (2003)	N. Aegean Sea	1739	0.0113	3.16	0.96
Lamprakis *et al.* (2003)	N. Aegean Sea	579	0.0267	2.75	0.84
Valle *et al.* (2003)	Spain	87	0.0112	3.12	0.96
Cicek *et al.* (2006)	Babadillimani	584	0.0161	3.03	0.97
Dulčić and Glamuzina (2006)	Adriatic	87	0.0112	3.12	0.98
Dulčić *et al.* (2007)	Adriatic	1218	0.0100	3.19	-
Bilecenoglu (2009)	Izmir Bay	603	0.0157	2.99	0.97
This study	Izmir Bay	5222	0.0200	2.89	0.85

N - 26° 37' 22" E) and Deveboynu (38° 39' 24" N - 26° 43' 42" E) is prohibited to all kind of trawl by the Ministry of Agriculture and Rural Affairs (Anonymous 2007). Therefore, purse seine, hook-and-line and gill net are important fisheries methods in the Izmir Bay (Bilecenoğlu 2003). Because the presence of economically important demersal fish species, it is known that illegal fisheries can be occurred (Metin et al. 2000). On the other hand, fishes reported preying on *S. hepatus* such as *Merluccius merluccius* (Papaconstantinou & Stergiou 1995, Akalin 2004), *Scorpaena porcus* (Bradai & Bouain 1990), *S. scrofa* (Bradai & Bouain 1990), *Uranoscopus scaber* (Sanz 1985), and *Scyliorhinus canicula* (Filiz & Taskavak 2005) were abundant both in the area and in the trawl catch compositions.

The maximum age reached by specimens of brown comber (4 years) from the Izmir Bay is within the longevity limits observed over the biogeographical distribution area. Indeed, if brown comber longevity (4-5 years) is similar on the Aegean Sea (Labropoulou et al. 1998) and Tunisian waters (Bouain 1983), the life span seems to be longer (7 years) in the Adriatic lagoons and estuaries (Dulčić et al. 2007). From these results, it can be concluded that the populations living in the Adriatic Sea are the ones that will reach the maximum age (7) and will be close to the maximum length ever recorded (25.0 cm; Smith 1981).

In this study, growth rate of the population has been found quite high. Since the earlier ages fish has high somatic (body) growth, this finding being expected. However, the growth coefficient is highly variable among different studies (k= 0.22-0.56) (Table 8). The asymptotic length (L_∞) estimated in this study was within the observed total lengths. When making a comparison with the previous studies made in Mediterranean (Table 8), calculated growth performance index (Φ) value for the Izmir Bay was higher than the one found in other localities, except Cretan Shelf. Although differences were observed, no significant differences were found among our Φ value and the ones obtained for Mediterranean ($p > 0.05$). Just about any factor that might possibly influence growth has been shown to have an effect, including temperature, food availability, nutrient availability, light regime, oxygen, salinity, pollutants, current speed, predator density, intraspecific social interactions and genetics (Helfman et al. 1997). These factors, often working in combination, create large variations in size of fishes of the same and different ages (Helfman et al. 1997).

A comparison of published length–weight relationships for the species is given in Table 9. The values of the slope (b) ranged from 1.89 to 3.64 according to localities and our results remained within the ranges given. The length-weight relationship in fishes can be affected by a number of factors, including season, habitat, gonad maturity, sex, diet and stomach fullness, health and preservation techniques, and differences in the length ranges considering the caught specimen (Tesch 1971, Wootton 1991) and number of examined specimens (Bilecenoglu 2009), which were not accounted for in the present study. Thus, differences in length-

weight relationships between this and other studies could potentially be attributed to the combination of one or more of the factors given above. Concerning growth type, the length-weight relationships revealed negative allometry as also found by Wagué (1987), Gonçalvez et al. (1997), Abdallah (2002) and Lamprakis et al. (2003). Positive allometry was observed in Tunisian waters (Bouain, 1983), around Balearic Islands (Merella et al. 1997), along north Aegean Sea (Lamprakis et al. 2003) and Spanish coasts (Valle et al. 2003) and in Adriatic Sea (Dulčic & Glamuzina 2006, Dulčic et al. 2007). Algarve (Borges et al. 2003), Babadillimani (Cicek et al. 2006) and Izmir Bay (Bilecenoglu 2009) specimens had exponent *b* values close to 3, indicating that the fish grows almost isometrically.

Reproduction

Females were found as dominant since species is synchronous hermophrodite.

Monthly changes in gonadosomatic index for females are shown in Figure 2. A comparison between the spawning season of the brown comber population living in Izmir Bay with those from other areas (Table 10) shows that there is certain homogeneity in the spawning period.

Species of the genus *Serranus* are functional simultaneous hermaphrodites and this reproductive mode is considered to be the most primitive reproduction pattern within the Serranidae (Smith 1965). *S. hepatus* is littoral fish which exhibit an amphisexuality (Reinboth 1970) and are characterized by a synchronous hermaphroditism. The gonads are ovotestes in which the male and female portions are clearly separated (D'Ancona 1949, Reinboth 1962), the ovary being larger than the testis. The testis is a double, narrow band, located in the ventral posterior part of the ovary and projects into the ovarian cavity. There is no separation between ovary and testis and the same epithelium borders the testis and the ovarian lamellae.

The testis is covered $^{1}/_{10}$ of gonads and male zone is at first an undifferentiated single part of the ventral gonad. Although *S. hepatus* is a synchronous hermaphrodite, according to its ontogeny, as the female zone differenties first, so it begins to be female, then becomes a hermaphrodite (Bruslé 1983). Sex stage of samples was separated according to Bruslé (1983) with a macroscope and gonads were not investigated histologically. The ovotestes that accepted as a male according to literature was photographed and showed in Fig. 3.

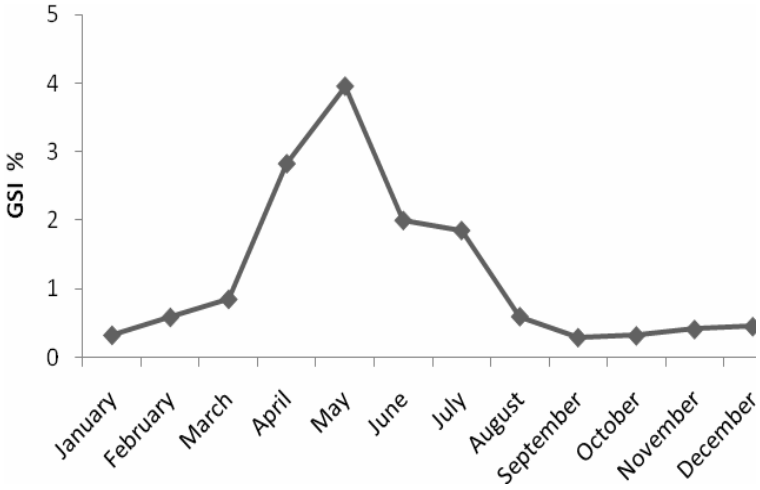

Figure 2. Variation in gonadosomatic index, GSI for female *S.hepatus* in the Izmir Bay.

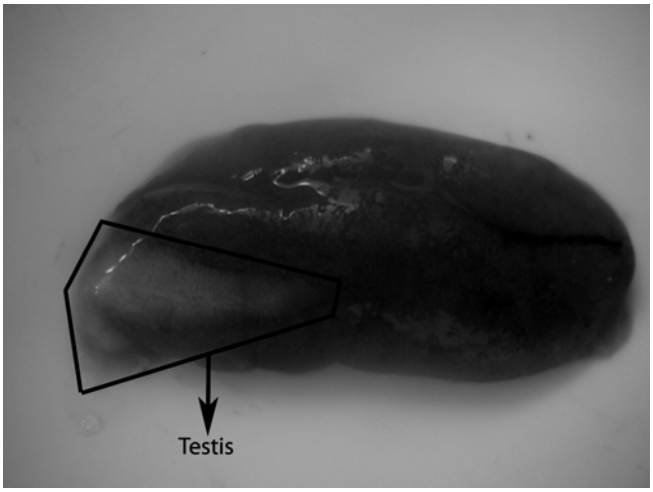

Figure 3. The outside view from ovotestes of *S.hepatus*
(Photographed by Sercan YAPICI)

Table 10. Comparison of the spawning season of *S.hepatus* obtained from different areas and according to several authors. + occurrence of spawning season.

Study	Locality	March	April	May	June	July	August	September	October
Risso (1810)*	Nice						+	+	
Dufusse (1856)*	Marseille	+	+	+	+	+			
Canestrini (1870-74)*	Italy						+	+	
Van Oordt (1929)*	Napoli		+	+	+				
Padoa (1939)*	Napoli							+	+
Marmorina (1969)*	Napoli		+	+	+				
D'Ancona (1949)	Adriatic				+	+	+	+	
Dieuzeide and Novella (1951)*	Algerie		+	+	+				
Piccinetti (1971)*	Adriatic						+	+	
Oven (1973)*	Adriatic	+	+	+	+	+	+	+	
Bruslé (1983)	Tunisia			+	+				
Tortonese (1986)	Mediterranean	+	+	+	+	+	+		
Wagué *et al*. (1997)	Thermaikos Gulf				+	+	+		
This study	Izmir Bay	+	+	+	+	+			

* indicates data taken from Wagué *et al*. (1997)

Table 11. Food items of different populations of *S.hepatus*.

Study	Locality	Method used	Food Items
Bell and Harmelin-Vivien (1983)	Marseille Gulf	%W	Crustacea
Labropoulou and Eleftheriou (1997)	Cretan waters	%N	Crustacea (71.6%), Pisces (28.4%)
Labropoulou *et al*. (1998)	Northern coast of Crete	%IRI	Crustacea (78.8%), Pisces (17.20%), Polychaeta (4.0%)
Bilecenoglu (2009)	Izmir Bay	%IRI	Crustacea (94.42%), Polychaeta (4.04%), Echinodermata (0.94%), Pisces (0.60%)
This study	Izmir Bay (M)	%IRI	Crustacea (97.51%), Pisces (2.49%)

Food

In the Izmir Bay, the diet of brown comber is based on crustaceans and fish, generally similar to that of other populations (Table 11). It is obvious that this carnivorous species is a specialist on crustaceans, especially benthic ones. In terms of %IRI, natantians and brachyurans made up almost 93.4% of the overall diet (Table 6).

Acknowledgements. This study was part of a project supported by Ege University, project number 2004/SUF/004. The authors would like to thank Prof.Dr. Zafer Tosunoglu, Prof.Dr. Okan Ozaydin for valuable comments and review, and R/V EGESUF captain and its crew for their sincere help in sampling, throughout the study. Also, thanks to Dr. Gokcen Bilge for providing some lacks literatures. Finally, thanks to Prof. Dr. Ertan TASKAVAK from Ege University for his comments and critical reading, especially English text revisions, of the manuscript.

References

Abdallah, M. (2002): Length-weight relationship of fishes caught by trawl off Alexandria, Egypt. NAGA, WorldFish Center Quarterly 25(1): 19–20.

Akalin, S. (2004): Investigation on the bio-ecological properties of European hake (*Merluccius merluccius*, Linnaeus, 1758) in Edremit Bay (Aegean Sea-Turkey), PhD Dissertation. Izmir: Ege University. 133 p.

Anonymous (2007): Republic of Turkey Ministry of Agriculture and Rural Affairs General Directorate of Protection And Control, "Notification 1/1 Regulating Commercial Fishing", Ankara, Published in the Official Gazette date: 19.10.2007- 26675 Notification Number: 2007-43.

Bauchot, M.L. (1987): Poissons osseux Fiches FAO d'identification pour les besoins de la pêche (Bony fish, Fao indetification for the rare fish). pp. 891–1421. In: Fischer, W., Bauchot, M.L., Schneider, M. (eds.), Rev.1., Méditerranée et mer Noire, Zone de pêche 37, Vol.II. Commission des Communautés Européennes and FAO. Rome, Italy.

Bell, J.D., Harmelin-Vivien, M.L. (1983): Fish fauna of French Mediterranean *Posidonia oceanica* seagrass meadows, Tethys 11: 1-14.

Beverton, R.J.H., Holt, S.J. (1957): On the Dynamics of Exploited Fish Populations, Fishery Investigations Series II Volume XIX, Ministry of Agriculture, Fisheries and Food.

Bilecenoglu, M. (2003) Modelling Trophic Relationships Among Fishes Inhabiting Izmir Bay. PhD Dissertation, Izmir: Ege University. 156 p.

Bilecenoglu, M. (2009): Growth and feeding habits of the brown comber, *Serranus hepatus* (Linnaeus, 1758) in Izmir Bay, Aegean Sea. Acta Adriatica 50(1): 105-110.

Borges, T.C., Olim, S., Erzini, K. (2003): Weight-length relationship for fish species discarded in commercial fisheries of the Algarve (southern Portugal). Journal of Applied Ichthyology 19(6): 394-396.

Bouain, A. (1983): Croissance lineaire des serrans des cotes sud-est de la tunisie. Commission Internationale Pour L'exploration De La Mer Mediterranee (CIESM) 28(5): 87-91.

Bradai, M.N., Bouain, A. (1990): Régime alimentaire de *Scorpaena porcus* et de *S. scrofa* (Teleostei, Scorpaenidae) du Golfe de Gabès, Tunisie. Cybium 14: 207-216.

Bruslé, S. (1983): Contribution to the sexuality of a hermaphroditic teleost, *Serranus hepatus* L. Journal of Fish Biology 22: 283–292.

Cicek, E., Avsar, D., Yeldan, H., Ozutok, M. (2006): Length-weight relationships for 31 teleost fishes caught by bottom trawl net in the Babadillimani Bight (northeastern Mediterranean. Journal of Applied Ichthyology 22: 290-292.

Cortés, E. (1997): A critical review of methods of studying fish feding based on analysis of stomach contents: application to elasmobranch fishes. Canadian Journal of Fisheries and Aquatic Sciences 54: 726–738.

D'Ancona, U. (1949): Osservazioni sull' organizzazione della gonade hermafrodita di alcuni Serranidi. Nova Thalassia 1: 1-15. [in Italian]

Dulčić, J. (1992): Istrazivanja sastava i brojnosti ihtioplanktona u srednjem Jadranu. Morsko Ribarstvo 3: 73-78. [in Croatian]

Dulčić, J., Fencil, M., Matić-Skoko, S., Kraljević, M., Glamuzina, B. (2004): Diel catch variations in a shallow-water fish assemblage at Duce Glava, eastern Adriatic (Croatian Coast). Journal of the Marine Biological Association of the United Kingdom 84(3): 659-664.

Dulčić, J., Glamuzina, B. (2006): Length-weight relationships for selected fish species from three eastern Adriatic estuarine systems (Croatia). Journal of Applied Ichthyology 22: 254-256.

Dulčić, J., Matić-Skoko, S., Paladi, A., Kraljević, M. (2007): Age, growth and mortality of brown comber, *Serranus hepatus* (Linnaeus, 1758) (Pisces: Serranidae), in the eastern Adriatic (Croatian coast). Journal of Applied Ichthyology 23(2): 195-197.

Filiz, H., Taskavak, E. (2005): Food of Lesser Spotted Dogfish, *Scyliorhinus canicula* (Linnaeus,. 1758), in Foca (The Northeast Aegean Sea, Turkey) in Autumn 2002. In Workshop on Mediterranean Cartilaginous Fish with Emphasis on Southern and Eastern Mediterranean, 14-16 October 2005, İstanbul Turkey. pp. 60-68.

Filiz, H., Togulga, M. (2009): Age and growth, reproduction and diet of the black goby, (*Gobius niger*) from Aegean Sea, Turkey. <www.fisheriesscience.com, accessed at: 2012.05.28 >

Fricke, R., Bilecenoglu, M., Sari, H.M. (2007): Annotated checklist of fish and lamprey species of Turkey, including a Red List of threatened and declining species. Stuttgarter Beitrage zur Naturkunde, Serie A (Biologie) 706: 1-169.

Froese, R., Binohlan, C. (2000): Empirical relationships to estimate asymptotic length, length at first maturity and length at maximum yield per recruit in fishes, with a simple method to evaluate length frequency data. Journal of Fish Biology 56: 758–773.

Gokcen, S.L., Cirik, S. (1988): Izmir Bay Marine Research Project, Report of year 1988 (in Turkish). DEU Institute of Marine Sciences and Technology, Project no: IMST-063, 141 p, Izmir.

Golani, D., Ozturk, B., Basusta, N. (2006): The Fishes of the Eastern Mediterranean. Turkish Marine Research Foundation, Istanbul, Turkey, 259p.

Gonçalves, J.M.S., Bentes, L., Lino, P.G., Ribeiro, J., Canário, A.V.M., Erzini, K. (1997): Weight-length relationships for selected fish species of the small-scale demersal fisheries of the south and south-west coast of Portugal. Fisheries Research 30: 253-256.

Helfman, G.S., Collette, B.B., Facey, D.E. (1997): The Diversity of Fishes. Blackwell Science, Malden, Massachusetts.

Holden, M.J., Raitt, D.F.S. (1974): Manual of Fisheries Science. Part 2. Methods of resource investigation and their application. FAO Fisheries Technical Paper 115: 1–255.

Hyslop, E.J. (1980): Stomach contents analysis: a review of methods and their application. Journal of Fish Biology 17: 411–429.

Labropoulou, M., Eleftheriou, A. (1997): The foraging ecology of two pairs of congeneric demersal fish species: importance of morphological characteristics in prey selection. Journal of Fish Biology 50: 324-340.

Labropoulou, M., Tserpes, G., Tsimenidis, N. (1998): Age, growth and feeding habits of the brown comber *Serranus hepatus* (L., 1758) on the Cretan shelf. Estuarine, Coastal and Shelf Science 46: 723–732.

Lamprakis, M.K., Kallianiotis, A.A., Moutopoulos, D.K., Stergiou, K.I. (2003): Weight-length relationships of fishes discarded by trawlers in the north Aegean Sea. Acta Ichthyologica et Piscatoria 33(2): 145-151.

Merella, P., Quetglas, A., Alemany, F., Carbonell, A. (1997): Length-weight relationship of fishes and cephalopods from the Balearic Islands (western Mediterranean). Naga WorldFish Center Quarterly 20(3/4): 66-68.

Metin, C., Tosunoglu, Z., Tokac, A., Lok, A., Aydin, C., Kaykac, H. (2000): Seasonal Variations of Demersal Fish Composition in Gulbahce Bay (Izmir Bay). Turkish Journal of Zoology 24: 437-446.

Orek, Y.A. (2004): The abudance and distribution of the pelagic eggs and larvae of some Teleost fishes in off Erdemli, Mersin. PhD Dissertation, Izmir, Ege University. 414p.

Papaconstantinou, C., Stergiou, K.I. (1995): Biology and fisheries of eastern Mediterranean hake (*Merluccius merluccius*). pp. 149-180. In: Alheit, J., Pitcher, T.J. (eds.), Hake: Biology, fisheries and markets. Chapman and Hall, London.

Pauly, D., Munro, J.L. (1984): Once more on the comparison of growth in fish and invertebrates. Fishbyte 2(1): 1-21.

Pauly, D. (1993): Fishbyte Section. Naga Worldfish Center Quarterly 16: 1-26.

Pinkas, L.M., Oliphant, S., Iverson, I.L.K. (1971): Food habits of albacore, bluefin tuna and bonito in Californian waters. California Department of Fish and Game 152: 1–105.

Reinboth, R. (1962): Morphologische und funktionelle Zweigeschlechtlichkeit bei marinen Teleostiern (Serranidae, Sparidae, Centracanthidae, Labridae) Zoologische Jahrbuecher Abteilung Fuer Allgemeine Zoologie und Physiologie Der Tiere 69: 409-480. [in German]

Reinboth, R. (1970): Intersexuality in fishes. Memoirs of the Society for Endocrinology 18: 515–543.

Sabatés, A. (1990): Distribution pattern of larval fish populations in the northwestern Mediterranean. Marine Ecology Progress Series 59: 75-82.

Sanz, A. (1985): Contribución al estudio de la biología de *Uranoscopus scaber* Linnaeus, 1758 (Osteichthyes, Uranoscopidae) del Mediterráneo occidental. Investigacion Pesquera 49: 35-46. [in Spanish]

Smith, C.L. (1965): The patterns of sexuality and classification of serranid fishes. American Museum Novitates 2207: 1-20.

Smith, C.L. (1981): Serranidae. *FAO* species identification sheets for fishery purposes. pp. 1-47. In: Fischer W., Bianchi G., Scott W.B. (eds.), Eastern Central Atlantic; fishing areas Department of Fisheries and Oceans Canada and FAO.

Sparre, P., Venema, S.C. (1992): Introduction to tropical fish stock assessment. Part 1. Manual. FAO Fisheries Technical Paper No: 306/1, Rev.1, Rome, 376 p.

Stergiou, K.I., Moutopoulos, D.K. (2001): A review of length-weight relationships of fishes from Greek marine waters. Naga Worldfish Center Quarterly 24: 23-39.

Tesch, F.W. (1971): In Methods for Assesment of Fish Production in Freshwater. pp. 101-113. In: Ricker, W.E. (eds.), Blackwell Scientific Publications Oxford and Edinburgh.

Tortonese, E. (1986): Serranidae. Fishes of the north-eastern Atlantic and the Mediterranean. pp.780–792. In: Whitehead, P.J.P., Bauchot, M.L., Hureau, J.C., Nielsen, J. (eds.), Vol.II, Unesco, Paris.

Valle, C., Bayle, J.T., Ramos, A.A. (2003): Weight-length relationships for selected fish species of the western Mediterannean Sea. Journal of Applied Ichthyology 19: 261-262.

Wagué, A. (1987): Biologie, écologie et dynamique de l'especè *Serranus hepatus* (L. 1758) (Poisson, Serranidae) dans le golfe de Thermaikos (Mer egèe, Greece). PhD. Diss. Aristotle University of Thessaloniki, Greece. 147 p.

Wagué, A., Economidis, P.S., Papaconstantinou, C. (1997): The reproduction of *Serranus hepatus* (Pisces, Serranidae) (L., 1758) in the Thermaikos Gulf (Aegean Sea, Greece). Oebalia 23: 61-73.

Wagué, A., Papaconstantinou, C. (1997): Age, growth and mortality of the brown comber *Serranus hepatus* (L. 1758) (Pisces, Serranidae) in the Thermaikos Gulf (Aegean Sea, Greece). Marine Life 7(1/2): 39–46.

Wootton, R.J. (1991): Ecology of Teleost Fishes. Chapman and Hall, London-New York.