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Distribution Pattern and Morphological Differences between the Sexes of River Blenny, *Salaria fluviatilis* (Asso, 1801), in the Ceyhan River Basin, Turkey

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Abstract: The distribution of the river blenny (*Salaria fluviatilis*) in the Ceyhan River basin and the morphological differences between the sexes were investigated. Occurrence of the river blenny in the Ceyhan River basin depended on altitude of the habitats, and specimens were obtained at altitudes < 750 m. Samples were strongly female biased, which may have been due to the egg-guarding behavior of the males. There was also sexual dimorphism in that male blennies were larger than females ($P < 0.05$); however, there were no differences in the meristic counts between the sexes ($P > 0.05$). Analysis of variance showed that all of the standardized morphometric measurements were significantly different among the samples. In discriminant function analysis, morphological differentiation was determined between the sexes. Plotting discriminant function 1 to 2 separated the sexes from each other. Proportions of correctly classified individuals into their original groups were 71.9% for juveniles, 79.0% for females, and 65.7% for males. According to principal component analysis, the differences between the sexes resulted mainly from the measurements related to dorsal fin depth, head depth, body depth, and caudal peduncle depth.

Key Words: Ceyhan River, river blenny, *Salaria fluviatilis*, distribution, morphology

Ceyhan Havzası'ndaki Nehir Horozbina Balığının (*Salaria fluviatilis* (Asso, 1801)) Eşey Grupları Arasındaki Morfolojik Farklılıklar ve Dağılımı

Özet: Horozbina balığının (*Salaria fluviatilis*) Ceyhan Nehir Havzası'daki dağılımı ve eşey grupları arasındaki morfolojik farklılıkları incelenmiştir. Nehir horozbina balığının Ceyhan Nehir Havzası'nda bulunuşu habitatların rakımına bağlı olarak değişmiş ve örnekler 750 m rakımın altındaki istasyonlardan elde edilmiştir. Örneklerin büyük çoğunluğunun dişi oluşu erkeklerin bekçilik görevinden kaynaklanmış olabileceğine; erkek bireylerin dişilerden büyük oluşu ise eşeysel dimorfizmin olduğuna yorumlanmıştır ($P < 0,05$). Eşey grupları arasındaki meristik özelliklerde herhangi bir farklılık görülmemiştir ($P > 0,05$). Varyans Analizi, standardize edilmiş morfometrik karakterlerin tamamının eşey grupları arasında önemli derecede farklılıklar olduğunu göstermiştir. Kümelerarası Korelasyon Analizinde eşey grupları arasında morfolojik farklılıklar tespit edilmiştir. Birinci ve ikinci varyasyonlar grafik üzerinde kümeleştirildiğinde, eşey gruplarının birbirlerinden ayrı kümeler oluşturduğu tespit edilmiştir. Kümelerarası Korelasyon Analizinde bireylerin kendi grubuna doğru olarak sınıflandırılması, ergin olmayanlarda % 71,9, dişilerde % 79,0 ve erkeklerde ise % 65,7 olarak bulunmuştur. Ana Bileşenler Analizine göre, eşey grupları arasında gözlenen farklılıkların genelde dorsal yüzgeç yüksekliği, baş yüksekliği, vücut yüksekliği ve kuyruk sapı yüksekliğinden kaynaklandığı tespit edilmiştir.

Anahtar Sözcükler: Ceyhan Nehri, nehir horozbina balığı, *Salaria fluviatilis*, dağılım, morfoloji

Introduction

The river blenny, *Salaria fluviatilis,* is the only freshwater representative of the marine family Blenniidae. It is thought that this species evolved from *Salaria pavo* around the time of the formation of the Mediterranean some 5 million years ago, and that it first adapted from marine to brackish waters and then to freshwaters (Perdices et al., 2000; Neat et al., 2003). Both *S. pavo* and *S. fluviatilis* can tolerate a wide range of salinity, but *S. pavo* is more often found in brackish lagoons and river estuaries (Neat et al., 2003).

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S. fluviatilis occurs both in rivers with a direct connection to the Mediterranean and in lakes in the Mediterranean region (Changeux and Pont, 1995; Cote et al., 1999; Neat et al., 2003). This species occurs as small and localized populations in waters with a mixture of gravel and small stones, and in moderate to fast-flowing streams (Freeman et al., 1990; Bianco, 1995; Elvira, 1995; Cote et al., 1999). *S. fluviatilis* is of considerable biogeographical interest because it is the only freshwater representative of a large cosmopolitan marine family, Blenniidae (Cote et al., 1999). This species is also of conservation interest because its distribution is circum-Mediterranean, but populations are generally small and highly localized (Cote et al., 1999).

Conservation status (Elvira 1995), distribution (Hernandez et al., 2000), ecological demands (Cote et al., 1999; Freeman et al., 1999), reproduction, and nest orientation patterns (Vinyoles et al., 2002) of *S. fluviatilis* populations in Spain, conservation status and distribution (Changeux and Pont, 1995) in France, distribution and conservation status (Bianca, 1995) in Italy, and behavioral and morphological characteristics in Greece (Neat et al., 2003) have been investigated. There is no information about ecology, morphology, and detailed distribution of *S. fluviatilis* populations in rivers in Turkey. While Turkey has about 2000 km of Mediterranean coastline from İskenderun Bay to İstanbul and there may be considerable habitats for *S. fluviatilis*, Geldiay and Balık (1988) reported that this species inhabits the rivers opening to the Mediterranean Sea and İznik Lake, but there is no further knowledge about its distribution in Turkey.

The Ceyhan River begins in mountains 2200 m high to the north of the regional center of Kahramanmaraş and flows south to the Mediterranean Sea. The river basin covers 20,670 km^2 and annual flow of the river is about 7.18 billion m^3 (Agrin Co. Ltd., 1999). The Ceyhan River has 15 main tributaries, the Söğütlü, Hurman, Nergele, Kömür, Terbüzek, Tekir, Fırnız, Aksu, Zeytin, Körsulu, Sabun, Hamus, Yarpuz, Karasu, and Savrun.

The aims of this study were to investigate the distribution of *S. fluviatilis* in the Ceyhan River basin in southeastern Turkey and to determine the morphological differences among the sexes.

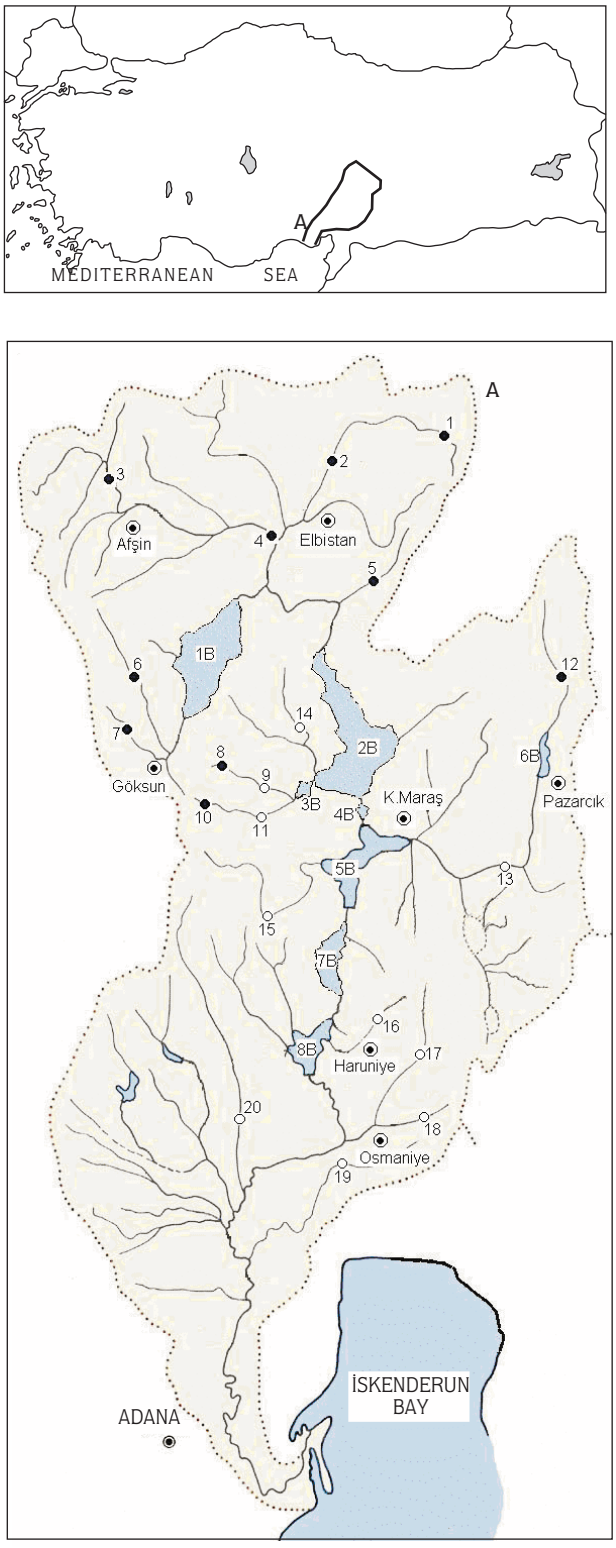
Materials and Methods

In this study 20 stations on 15 streams in the Ceyhan River basin were selected and fishing was carried out at these stations (Figure 1). Altitudes of the working stations varied from 126 to 1475 m.

In all, 275 *S. fluviatilis* specimens were collected by electrofishing in the streams of the Ceyhan River. Then, the specimens were fixed in 4% formaldehyde solution. In the laboratory, 11 morphometric characters (Figure 2) were measured to the nearest 0.1 mm with a digital compass. These characters included the following: total length (TL), from the maxilla to the end of caudal lobe; standard length (SL), from the maxilla to the end of the caudal peduncle; pre-dorsal distance (PD), from the maxilla to the origin of the dorsal fin; dorsal fin length (DFL), from the origin of the dorsal fin to the end of the dorsal fin; snout length (NL), from the maxilla to the orbit margin; eye diameter (ED), horizontal diameter of the eye; head length (HL), horizontal distance from the maxilla to the most posterior point of the opercula on the ventral side; head depth (HD), depth of the posterior to the orbit; body depth (BD), at level of the origin of the anal fin; caudal peduncle depth (CPD), the distance between the dorsal and ventral sides of the base of the caudal fin; dorsal fin depth (DFD), distance from the base to tip of the longest ray of the dorsal fin. Total lengths were not used in this study for morphometric evaluation. Meristic characteristics were counted from the number of dorsal, anal, pectoral, caudal, and ventral fin rays, and the number of vertebrae and teeth.

Standard lengths are given as original values of average, while other morphometric characters are given as a percent of standard length. Differences in morphometric characters among the sexes were analyzed by Tukey's test in SPSS v13.

The data for morphometric characters were in transformed and then subjected to principal component analysis (PCA) in SYSTAT v10.0. Data reduction was carried out by PCA to reduce the initial morphometric variation to uncorrelated principal components. Therefore, morphometric characters were used in the analysis. Three components were produced in PCA. In the morphometric data set, the first principal component (PC1) represents size, whereas the second and third principal components (PC2 and PC3) most often lack correlation to size and they are the most informative (Delling et al., 2000) and, therefore, the highest character loadings in PC2 and PC3 should be taken into consideration to indicate the differences.



Working stations:

1. Söğütlü Station I (1475 m)
2. Söğütlü Station II (1350 m)
3. Hurman Station I (1258 m)
4. Hurman Station II (1145 m)
5. Nergele Station (1213 m)
6. Kömür Station (1417 m)
7. Terbüzek Station (1390 m)
8. Tekir Station I (1125 m)
9. Tekir Station II (750 m)
10. Fırnız Station I (920 m)
11. Fırnız Station II (690 m)
12. Aksu Station I (1125 m)
13. Aksu Station II (464 m)
14. Zeytin Station (698 m)
15. Körsulu Station (560 m)
16. Sabun Station (223 m)
17. Hamus Station (264 m)
18. Yarpuz Station (126 m)
19. Karasu Station (127 m)
20. Savrun Station (295 m)

Reservoirs:

1B. Adatepe Reservoir
2B. Menzelet Reservoir
3B. Suçatı Reservoir
4B. Kılavuzlu Reservoir
5B. Sır Reservoir
6B. Kartalkaya Reservoir
7B. Berke Reservoir
8B. Aslantaş Reservoir

Figure 1. The Ceyhan River basin and stations.
(Open circles indicate the stations inhabited by *S. fluviatilis*. The numbers at the end of station names indicate altitude.)

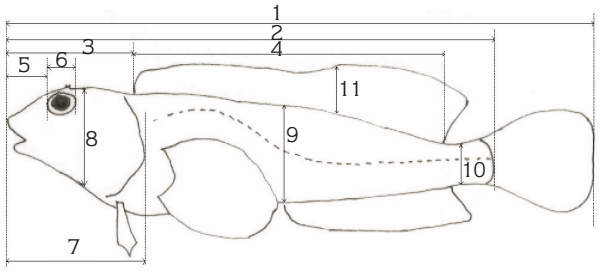


Figure 2. Morphometric measurements of *S. fluviatilis* specimens. 1. Total length (TL); 2. standard length (SL); 3. pre-dorsal length (PD); 4. dorsal fin length (DFL); 5. snout length (NL); 6. eye diameter (ED); 7. head length (HL); 8. head depth (HD); 9. body depth (BD); 10. caudal peduncle depth (CPD); 11. dorsal fin depth (DFD).

Discriminant function analysis (DFA) was also used to assess the maximum variation in morphometric traits among the sexes. Prior to DFA it is necessary to remove any size effect in the morphologic data set; therefore, an allometric formula should be used to correct length effects (Turan et al., 2004):

$$M_{adj} = M * (L_s/L_o)^b$$

where M is the original measurement, M_{adj} is the size adjusted measurement, L_o is the SL, and L_s is the mean SL of all fish. Parameter b was estimated for each character from the observed data as the slope of the regression of log M on log L_o, using all fish in all groups (Turan et al., 2004). The adjusted new results were tested by the correlation of SL and adjusted character. The correlation between SL and 9 transformed morphometric characters were not significant. Size-adjusted data were submitted to DFA in SPSS v13, and graphs were generated in SYSTAT v10.0.

Results

Distribution and sex ratio

Freshwater blennies were obtained at altitudes < 750 m in the middle and lower parts of the Ceyhan River basin. They were not found in streams above 750 m. *S. fluviatilis* was recorded in the streams of Tekir, Fırnız, Aksu, Zeytin, Sabun, Hamus, Yarpuz, Körsulu, and Savrun (Figure 1). Its occurrence in the Ceyhan River basin depended on altitude, but altitude had no effect on abundance. Although the Tekir station II is at an altitude of 750 m, it had greater *S. fluviatilis* abundance than Aksu II, Zeytin, Körsulu, Sabun, Hamus, Karasu, and Savrun.

Of the 275 *S. fluviatilis* specimens, there were 32 juveniles, 144 females, and 99 males. Samples were strongly female biased ($P < 0.05$).

Morphological differences

Meristic

Based on the specimens examined, spines, fin rays, vertebrae, and teeth counts are given for females and males in Table 1. The body of *S. fluviatilis* is naked and it has a single, long dorsal fin from the operculum side to the caudal peduncle. Pelvic fins are jugular and formed by a spine and 2 rays. *S. fluviatilis* has 32 vertebrae and 2 canine teeth on the upper and lower jaws, 15-20 small teeth on the upper jaw, and 14-16 teeth on the lower jaw (Table 1). These teeth are in a single curved row. The differences in the meristic scores between females and males were not significant ($P > 0.05$).

Morphometric

SL values and other morphometric characters as percent of SL are given in Table 2. Male blennies were significantly larger than females and the difference in SL between the sex groups was also significant ($P < 0.05$). All the morphometric characters as percent of SL were significantly different among the groups (Table 2) and *S. fluviatilis* is sexually dimorphic.

All the morphometric characters were significantly correlated to the SL (Table 3). Univariate statistics (ANOVA) shoved that all of the standardized morphometric measurements were significantly different among the samples (Table 4).

In DFA, the first discriminant function (DF1) accounted for 86.4% and the second discriminant function (DF2) accounted for 13.6% of the inter-group variability (Figure 3).

Pooled within-groups correlations between discriminating variables and discriminant functions showed that BD measurements (FD, ED, HD, and BD) contributed to DF1, whereas body length measurements (PD, NL, HL) contributed to DF2 (Table 5). DFA correctly

Table 1. Meristic counts of male and female *S. fluviatilis* samples (n: number of fish, X: mean value; Min and Max: minimum and maximum; SD: standard deviation).

		Male					Female				
		n	X	Min	Max	SD	N	X	Min	Max	SD
Dorsal fin	Spine	37	12	10	24	0.973	52	12	10	20	0.541
	Soft ray	37	16	13	24	0.786	52	16	13	20	0.489
Anal fin	Spine	41	2	2	2		58	2	2	2	
	Soft ray	41	16	13	24	0.296	58	15	12	17	0.149
Caudal fin	Soft ray	41	11	9	12	0.144	58	11	9	12	0.124
Ventral fin	Spine	41	1	1	1		58	1	1	1	
	Soft ray	41	2	2	2		58	2	2	2	
Pectoral fin	Soft ray	41	13	12	14	0.058	58	13	11	14	0.080
Vertebrae		25	32				17	32			
Teeth (upper jaw/lower jaw) (curved teeth:canine teeth)		25	(15-20):2/(14-16):2				17	(15-20):2/(14-16):2			

Table 2. Morphometric characters of *S. fluviatilis*. Measurements, except SL, are percentages of SL.

	Juvenile	Female	Male	d.f.	F	Significance
Standard length (mm)	33.43 [a]	57.80 [b]	72.55 [c]	2, 272	225.021	0.000
Pre-dorsal	26.46 [a]	27.57 [b]	29.34 [c]	2, 272	29.745	0.000
Dorsal fin length	63.45 [a]	68.99 [b]	67.81 [b]	2, 272	22.615	0.000
Snout length	5.05 [a]	7.70 [b]	8.29 [c]	2, 272	111.192	0.000
Eye diameter	6.74 [a]	6.66 [b]	5.66 [b]	2, 272	52.576	0.000
Head length	26.89 [a]	26.56 [a]	27.94 [b]	2, 272	11.975	0.000
Head depth	17.47 [a]	19.70 [b]	24.23 [c]	2, 77	48.186	0.000
Body depth	20.06 [a]	22.66 [b]	24.56 [c]	2, 272	38.999	0.000
Caudal peduncle depth	8.41 [a]	8.90 [b]	9.83 [c]	2, 272	49.570	0.000
Dorsal fin depth	7.17 [a]	6.83 [a]	8.36 [b]	2, 270	33.425	0.000

d.f.: degree of freedom in the ANOVA and Tukey's tests
Superscript letters indicate Tukey's test results.

Table 3. Linear relationships between SL and the morphometric characters PD, DFL, NL, ED, HL, BD, CPD, and DFD.

Juvenile		Female		Male	
Y = a + b * SL	R^2	Y = a + b * SL	R^2	Y = a + b * SL	R^2
PD = 0.230 * SL + 1.142	0.814	PD = 0.247 * SL + 1.572	0.773	PD = 0.271 * SL + 1.625	0.814
DFL = 0.822 * SL -6.170	0.819	DFL = 0.690 * SL - 0.017	0.906	DFL = 0.704 * SL - 1.852	0.890
NL = 0.042 * SL + 0.269	0.612	NL = 0.072 * SL + 0.266	0.524	NL = 0.073 * SL + 0.694	0.457
ED = 0.020 * SL + 1.552	0.497	ED = 0.045 * SL + 1.187	0.518	ED = 0.033 * SL + 1.717	0.361
HL = 0.236 * SL + 1.096	0.805	HL = 0.253 * SL + 0.689	0.780	HL = 0.253 * SL + 1.885	0.716
HD = 0.173 * SL + 0.059	0.785	BD = 0.276 * SL - 4.004	0.938	HD = 0.340 * SL - 5.824	0.936
BD = 0.156 * SL + 1.476	0.629	BD = 0.260 * SL - 1.864	0.714	BD = 0.257 * SL - 0.801	0.611
CPD = 0.093 * SL - 0.307	0.762	CPD = 0.085 * SL + 0.230	0.775	CPD = 0.097 * SL + 0.097	0.691
DFD = 0.114 * SL - 1.404	0.511	DFD = 0.075 * SL - 0.386	0.441	DFD = 0.085 * SL - 0.096	0.374

Table 4. Differences in all morphometric measurements between samples, based on univariate statistics (ANOVA).

	Wilks' lambda	F	d.f.	Significance
Pre-dorsal	0.887	17.151	2, 269	0.000
Dorsal fin length	0.912	12.994	2, 269	0.000
Snout length	0.863	21.428	2, 269	0.000
Eye diameter	0.783	37.171	2, 269	0.000
Head length	0.919	11.784	2, 269	0.000
Head depth	0.792	35.265	2, 269	0.000
Body depth	0.967	4.694	2, 269	0.010
Caudal peduncle depth	0.884	17.571	2, 269	0.000
Dorsal fin depth	0.870	20.067	2, 269	0.000

d.f.: degree of freedom in the ANOVA and Tukey's tests

classified, on average, 73% of the individuals (Table 6). The classification success rates were 71.9% for juveniles, 79.0% for females, and 65.7% for males (Table 6).

In PCA, 9 principal components were produced and 91.5% of the variance was presented in PC1 (Table 5). PC1 represents allometric size factor; therefore, PC2 and PC3 should be taken into consideration. HD, DFD, BD, and CPD had the highest loadings on PC2, but NL and ED received the highest loadings on PC3. The highest loadings in PC2 and PC3 indicated that the differences among the groups resulted mainly from BD, HD, and fin depths.

Discussion

S. fluviatilis occurs in rivers with relatively shallow water and in low altitude lakes in Israel, Albania, Croatia, France, Greece, Italy, Spain, Portugal, Turkey (Froese and Pauly, 2003), and Jordan (El-Absy and Mir, 1986). This species occurs in the rivers of Turkey's southern, western, and northwestern coastlines, and in İznik Lake

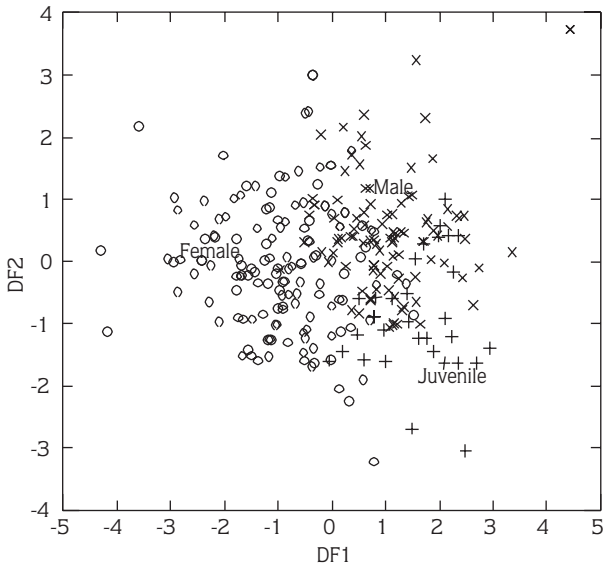


Figure 3. Plotting DF1 against DF2, illustrating morphometric differences among the sexes.

(Geldiay and Balık, 1988; Balık, 1995). It was also reported in Seyhan Dam Lake in Adana (Özyurt et al., 2003), but there is no detailed information about its Turkish population, and the record reported in this study is the first for the Ceyhan River.

S. fluviatilis is common in Corsica and its habitat preference was reported to be the lower course, a great distance from the source, with a lower mean gradient and lower altitude (Changeux and Pont, 1995). According to Hernandez et al. (2000), this species' habitats vary greatly in altitude, depth, stream velocity, and bottom composition. They searched altitudes < 650 m in the Jucar River basin of Spain, and only found specimens at altitudes ≥ 400 m. However, in the present study, this species was found at altitudes ≥ 750 m in the Ceyhan River basin. *S. fluviatilis* occurs in small populations in shallow waters 2-5 m deep, with low velocity, and bottoms of gravel and small stones (Bianco, 1995). In our

Table 5. Character loadings on PC1, PC2, and PC3, and pooled within-groups correlations between discriminating variables and discriminant functions. (*denotes the largest correlation between each variable and discriminant functions).

	Character loadings on principal components			Discriminant functions from discriminant analysis	
	PC1	PC2	PC3	DF1	DF2
Pre-dorsal	0.355	0.011	-0.000	0.205	0.675*
Dorsal fin length	0.392	-0.001	0.017	-0.290*	0.123
Snout length	0.527	-0.015	0.091	-0.210	0.790*
Eye diameter	0.242	0.028	0.031	-0.490*	0.214
Head length	0.336	0.013	0.001	0.243	0.351*
Head depth	0.464	0.140	-0.094	0.462*	0.360
Body depth	0.402	-0.028	0.023	0.383*	0.088
Caudal peduncle depth	0.367	0.035	0.005	0.265	0.543*
Dorsal fin depth	0.392	-0.188	-0.075	0.361*	0.145
Variance explained (%)	91.5	3.9	1.7		

Table 6. Correct classification of individuals (73%) into their original groups.

	Sample	Juvenile	Female	Male	Total
Original count	Juvenile	23	2	7	32
	Female	15	113	15	143
	Male	21	13	65	99
%	Juvenile	71.9	6.3	21.9	100
	Female	10.5	79.0	10.5	100
	Male	21.2	13.1	65.7	100

study, specimen abundance was greater in shallow water and stony habitats. Tekir and Zeytin streams, both located at high altitudes, had greater abundance due to shallow water and stony bottoms. Altitude affected the occurrence of the species, but not its abundance.

The sex ratio (male to female) of *S. fluviatilis* was reported as 0.73 in Lake Kournas, 0.58 in the Fango River, and 0.61 in Lake Garda (Neat et al., 2003). In the current study, the sex ratio of *S. fluviatilis* in the Ceyhan River was similar to that in these previous reports, and samples were strongly female biased. The differences in the sex ratio of *S. fluviatilis* may be due to the egg-guarding behavior of the males. Females deposit a layer of eggs on the underside of the nest stone and the eggs are guarded against predators by the males (Cote et al., 1999); therefore, predation of males may be higher than that of females.

The present results demonstrated significant differences in morphometric characters between the sexes of *S. fluviatilis*, but not in meristic characters. The male specimens had significantly larger bodies than females. SL in the current study was similar to the SL reported for the Fango River populations, but it was higher than that reported for the Lake Kournas and Lake Garda populations (Neat et al., 2003). Neat et al. (2003) reported that *S. fluviatilis* specimens inhabiting 2 lakes were smaller in body size than river populations and that their morphometric characteristics varied between the populations. In the current study, differences in morphology of *S. fluviatilis* between the habitats were not investigated, and so it is not possible to offer any interpretation about such differences.

It is thought that *S. fluviatilis* populations have been affected negatively because of physical changes to the Ceyhan River basin, as mentioned in the introduction section, because it is particularly sensitive to habitat changes (Changeux and Pont, 1995; Cote, 1999). Finally, *S. fluviatilis* may occur up to an altitude of 750 m and it is dimorphic because of the morphometric differences between females and males. Therefore, it is proposed that its Turkish populations should be investigated in detail to determine their conservation status.

References

Agrin Co. Ltd. 1999. Aslantaş Dam and related aspects of the Ceyhan River Basin, Turkey. A WCD case study prepared as an input to the World Commission on Dams, Cape Town, http://dams.org/kbase/studies/tr.

Balık, S. 1995. Freshwater fish in Anatolia, Turkey. Biological Conservation. 72: 213-223.

Bianca, P.G. 1995. Mediterranean endemic freshwater fishes of Italy. Biological Conservation. 72: 159-170.

Changeux, T. and Pont, D. 1995. Current status of the riverine fishes in the French Mediterranean basin. Biological Conservation. 72: 137-158.

Cote, I.M., Vinyoles, D., Reynolds, J.D., Doadrio, I. and Perdices, A. 1999. Potential impacts of gravel extraction on Spanish populations of river blennies *Salaria fluviatilis* (Pisces, Blenniidae). Biological Conservation. 87: 359-367.

Delling, B., Crivelli, A.J., Rubin, J.F. and Berrebi, P. 2000. Morphological variation in hybrids between *Salmo marmoratus* and alien Salmo species in the Volarja Stream, Soca River basin, Slovenia. Journal of Fish Biology. 57: 1199-1212.

El-Absy, A.H. and Mir, S. 1986. A new record of *Blennius fluviatilis* from Jordan. Zoology in the Middle East. 1: 114-116.

Elvira, B. 1995. Conservation status of endemic freshwater fish in Spain. Biological Conservation. 72: 129-136.

Freeman, M.C., Vinyoles, D., Grossman, G.D. and De Sostoa, A. 1990. Microhabitat use by *Salaria fluviatilis* in the Rio Matarrana, Spain. Freshwater Biology. 24: 335-345.

Froese, R. and Pauly, D. 2003. Fish Base–World Wide Web electronic publication. www.fishbase.org, version / 2003.

Geldiay, R. and Balık, S. 1988. Türkiye tatlı su balıkları, Ege Üniversitesi Fen Fak. Kitaplar Serisi, İzmir.

Hernandez, R., Lacomba, R.T., Uvinas, Y.N. and Oltra, R. 2000. Distribution of river blennies in the Jucar River basin (eastern Spain). Journal of Fish Biology. 57: 250-254.

Neat, F.C., Lengkeek, W., Westerbeek, E.P., Laarhoven, B. and Videler, J.J. 2003. Behavioural and morphological differences between lake and river populations of *Salaria fluviatilis.* Journal of Fish Biology. 63: 374-387.

Perdices, A., Doadrio, I., Cote, I.M., Machordom, A., Economidis, P. and Reynolds, J.D. 2000. Genetic divergence and origin of Mediterranean populations of the river blenny *Salaria fluviatilis* (Teleostei: Blenniidae). Copeia. 3: 723-731.

Özyurt, C.E., Sarıhan, E. and Akar, M. 2003. The possibilities of using longline at pike-perch (*Sander lucioperca* Bogustkaya and Naseka, 1996) fishing at Seyhan Dam Lake. E.U. Journal of Fisheries and Aquatic Sciences. 20: 43-50.

Turan, C., Ergüden, D., Gürlek, M. and Turan, F. 2004. Morphometric structuring of the anchovy (*Engraulis encrasicolus* L.) in the Black, Aegean and Northeastern Mediterranean seas. Turk. J. Vet. Anim. Sci. 28: 865-871.

Vinyoles, D., Cote, I. and De Sostoa, A. 2002. Nest orientation patterns in *Salaria fluviatilis*. Journal of Fish Biology. 61: 405-416.