

Distribution and Ecology of Freshwater Ichthyofauna of the Biga Peninsula, North-western Anatolia, Turkey

Hasan M. SARI, Süleyman BALIK, M. Ruşen USTAOĞLU, Ali İLHAN
Ege University, Fisheries Faculty, Hydrobiology Department, 35100 Bornova, İzmir - TURKEY

Received: 04.11.2004

Abstract: This research was carried out at 35 stations in 16 different streams on the Biga Peninsula during the spring and summer of 2000 and 2001 to determine the freshwater ichthyofauna and community features. In addition, some physical and chemical parameters of the streams were determined in their natural environment.

Fourteen taxa belonging to 5 families were determined. *Leuciscus cephalus*, *Petroleuciscus borysthenticus*, *Rhodeus amarus*, *Phoxinus phoxinus*, *Chalcalburnus chalcoides*, *Barbus tauricus escherichi*, *Gobio gobio*, *Capoeta capoeta bergamae*, *Vimba vimba*, *Cobitis fahirae* and *Neogobius fluviatilis* are recorded for the first time from the Biga Peninsula. The most abundant species in the study area was *L. cephalus*. Fish communities in the streams were analysed, where 3 different groups were formed at a level of 50% similarity. Larger streams are determined to be the richest habitats in terms of species diversity.

Key Words: biological diversity, ecology, taxonomy, abundance, similarity

Biga Yarımadasının Tatlısu İhtiyofaunasının Dağılımı ve Ekolojisi, Kuzey-Batı Anadolu, Türkiye

Özet: Bu araştırma Biga yarımadası akarsularının tatlısu ihtiyofaunasını ve komünite özelliklerini belirlemek amacıyla 2000-2001 yılları ilkbahar ve yazın 16 farklı akarsuda 35 istasyonda yapıldı. Ayrıca, akarsulara ait bazı fiziksel ve kimyasal parametreler de yerinde saptandı.

Bölgede 5 familyaya ait 14 taksa belirlendi. Bunlardan *Leuciscus cephalus*, *Petroleuciscus borysthenticus*, *Rhodeus amarus*, *Phoxinus phoxinus*, *Chalcalburnus chalcoides*, *Barbus tauricus escherichi*, *Gobio gobio*, *Capoeta capoeta bergamae*, *Vimba vimba*, *Cobitis fahirae* ve *Neogobius fluviatilis* Biga yarımadasından ilk kez kaydedildi. Çalışma alanında en yaygın tür *L. cephalus* olduğu belirlendi. Akarsulardaki balık komüniteleri analiz edildiğinde, %50 benzerlik seviyesinde üç farklı grup olduğu saptandı. Büyük akarsuların tür çeşitliliği açısından en zengin habitatları oluşturduğu belirlendi.

Anahtar Sözcükler: Biyolojik çeşitlilik, ekoloji, taksonomi, bolluk, benzerlik

Introduction

It has been reported that the first studies concerning the fish fauna of the inland waters of Turkey were started in the mid-1800s (Geldiay and Balık, 1999). The fish fauna of the inland waters of Anatolia and Eastern Thrace has been examined in several studies (i.e. Kuru, 1975; Balık, 1975, 1985, 1988; Kelle, 1978; Erk'akan, 1983). However, there are only a few studies on the fish fauna of the Biga Peninsula, which is located in western Turkey (Tortonese, 1954; Geldiay, 1972; Balık, 1975). In the first 2 studies, various information was reported about the species, distribution, abundance and ecology of trout in the region. On the other hand, studies on lakes

Manyas and Apolyont and the streams in the east of this region have provided some information about the freshwater fish fauna of the peninsula (Balık, 1975, 1985, 1987; Ongan, 1982). When the literature is reviewed, it is seen that no other species of fish have been reported except for *S. trutta macrostigma*.

The aim of this study was to determine the freshwater ichthyofauna of the Gönen, Kocabaş, Karamenderes and Tuzla streams, and the brooks in the region, and to compare them with regard to the relative abundance, similarity and species diversity in their ichthyofauna.

Materials and Methods

Four different field studies were performed on the Biga Peninsula in the late spring and summer of 2000 and 2001. The study was carried out at 35 different stations in 16 streams (Figure 1). The upper part of the Kocabaş Stream was not studied because of the failure of the generator. A single sampling was conducted at each station, except for at stations 1 and 4. Some physico-chemical properties of these streams were determined in the region. The water temperatures and conductivity were measured with a YSI 30 model SCT meter, pH levels were measured with a WTW pH 330 model pH meter and the dissolved oxygen and oxygen saturation were measured with a WTW Oxi 330 model oxygenometer.

Fish were sampled by electric fishing, fixed with 4% buffered formalin, and kept in the freshwater fish collection of the Ege University Museum of the Faculty of Fisheries (ESFM-PISI).

Studies by Tortonese (1954), Berg (1962, 1964, 1965), Balık (1985), Miller (1986), Almaça (1986), Bogutskaya (1997, 2002), Reshetnikov et al. (1997), Geldiay and Balık (1999) and Erkakan et al. (1999) were used in the taxonomic evaluation of the specimens.

A total of 3893 specimens were caught during the study. Depending on the habitat characters of the study

stations in the streams, electric fishing was performed in areas ranging from 140 to 2400 m². Because of the high numbers of fishing attempts and variations in the size of study areas, the data were expressed per 100 m² area.

The rates of species of fish in the streams were shown by relative abundance (Krebs, 1989).

$$\text{Relative abundance \%} = (n_i / N) * 100$$

where n_i refers to the number of individuals of the species in the sample, and N refers to the total number of individuals of fish caught in the stream.

For the evaluation of similarities between the fish communities in the streams, Jaccard's similarity coefficient (Krebs, 1989) was used.

$$\text{Jaccard's similarity coefficient, } S_j = (a / a + b + c) * 100$$

where a refers to the number of species in samples A and B , b refers to the number of species only in sample B (not in A) and c refers to the number of species only in sample A (not in B). Cluster analysis was performed with the software BiodiversityPro, based on binary data (species absence vs. presence within sampling stations), using a single linkage clustering method for determining the most similar stations in terms of species diversity. The groups formed were evaluated considering a 50% similarity level.

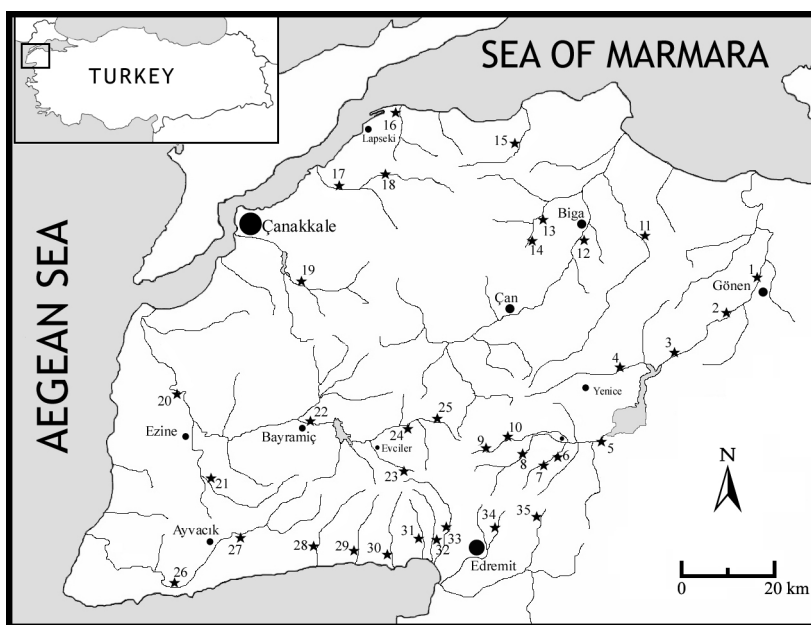


Figure 1. View of the Biga Peninsula and sampling stations.

The diversity of species in the streams was shown with the Shannon-Wiener diversity index (Krebs, 1989; Clarke and Warwick, 1994).

$$H' = - \sum p_i \log_2 p_i$$

where p_i is the proportion of the total sample belonging to the i^{th} species.

An evenness index was used for the analysis of the distribution of species in the streams (Krebs, 1989; Clarke and Warwick, 1994).

$$J' = H' / H_{max}$$

in which H' is the Shannon-Wiener function, H_{max} is the probable maximum diversity in equal abundance of all species ($= \log S$) and S refers to the number of species.

Abbreviations: D- dorsal fin rays; D1- 1st dorsal fin rays; D2- 2nd dorsal fin rays; A- anal fin rays; P- pectoral fin rays; V- ventral fin rays; L. lat.- number of lateral line scales; L. tran.- number of transversal scales; Ngr- number of gill rakers of the external row of the first left arch.

Results

The Biga Peninsula includes several streams and brooks, most of originated in the Kaz Mountains. There are many streams around these mountains, flowing in different directions, such as the Gönen Stream to the north-east, the Kocabaş Stream to the north, the Karamenderes Stream and the Tuzla Stream to the west, and numerous brooks to the south (Figure 1).

Some physico-chemical properties of the streams determined are given in Table 1. The stream lengths on the Biga Peninsula ranged between 12 and 134 km, and the altitude from 5 to 590 m.

Ichthyofauna

The fish specimens 14 taxa belonging to 13 genera in 5 families, are given below:

Family: Anguillidae

Anguilla anguilla (Linnaeus, 1758)

Materials: ESFM-PISI/2001-079 (3 specimens), Mihli Brook (Küçükkuşu-Ayvacak), 17.05.2001; ESFM-PISI/2001-097 (1 specimen), Zeytinli Brook (Zeytinli-Edremit), 09.07.2001; ESFM-PISI/2001-101 (7 specimens), Manastır Brook (Kavaklar-Edremit), 09.07.2001; ESFM-PISI/2001-103 (3 specimens), Kazan

Brook (Güre-Edremit), 10.07.2001; ESFM-PISI/2001-105 (6 specimens), Şahin Brook (Altınoluk-Edremit) 10.07.2001.

Only a single species of this family inhabits Anatolia; thus, diagnostic characters of the species are not given.

Family: Salmonidae

Salmo trutta macrostigma Dumeril, 1858

Materials: ESFM-PISI/2000-037 (40 specimens), Ayazma Brook (Evciler-Bayramiç), 13.06.2000; ESFM-PISI/2000-038 (45 specimens), Adaçay Brook (Karaköy-Bayramiç), 13.06.2000; ESFM-PISI/2000-055 (8 specimens), Handere Brook (Kalkım-Yenice), 14.06.2000; ESFM-PISI/2001-031 (10 specimens), Çelebi Brook (Aşağı Çavuş köyü-Yenice), 14.05.2001; ESFM-PISI/2001-078 (1 specimen), Mihli Brook (Küçükkuşu-Ayvacak), 17.05.2001.

Diagnosis: D III 9-10; A III 8-9; P I 11-12; V I 7-8; L. lat. 108-112.

Oncorhynchus mykiss (Walbaum, 1792)

Materials: ESFM-PISI/2001-104 (6 specimens), Kazan Brook (Güre-Edremit), 10.07.2001.

Diagnosis: D III 11; A III 10-11; P I 12-14; V II 8-9; L. lat. 112-116

Family: Cyprinidae

Leuciscus cephalus (Linnaeus, 1758)

Materials: ESFM-PISI/2000-030 (226 specimens), Tuzla Stream (Behramkale-Ayvacak), 12.06.2000; ESFM-PISI/2000-036 (109 specimens), Karamenderes Stream (Bayramiç), 13.06.2000; ESFM-PISI/2000-039 (61 specimens), Adaçay Brook (Çırpılar köyü-Bayramiç), 13.06.2000; ESFM-PISI/2000-060 (5 specimens), Gönen Stream (Yalıoba köyü-Yenice), 14.06.2000; ESFM-PISI/2000-058 (3 specimens), Handere Brook (Kalkım-Yenice), 14.06.2000; ESFM-PISI/2000-051 (28 specimens), Kocaçay Brook (Kayatepe köyü-Yenice), 14.06.2000; ESFM-PISI/2000-045 (30 specimens), Çakırköy Brook (Çakırköy-Yenice), 14.06.2000; ESFM-PISI/2000-065 (14 specimens), Gönen Stream (Gönen-Balıkesir), 15.06.2000; ESFM-PISI/2000-070 (4 specimens), Biga Stream (Biga-Çanakale), 15.06.2000; ESFM-PISI/2000-077 (51 specimens), Kocaçay Brook (Taşoluk köyü-Biga), 15.06.2000; ESFM-PISI/2000-080 (156 specimens), Çınar Brook (Çınardere-Biga), 15.06.2000; ESFM-PISI/2001-034 (4 specimens), Çelebi

Table 1. Physico-chemical parameters of the streams on the peninsula (Flow, F: Fast, M: Moderate, S: Slow).

Stream (Stations)	Substrate	Flow	L	Co	D	A	T	pH	DO	OS	C	
Gönen Stream	1. Gönen Stream	Silt to pebble	M	134	40°06' N 27°38' E	15.06.2000 15.05.2001	10 10	19.1 17.0	7.55 8.68	5.7 11.5	61 115	290 336
	2. Gönen Stream	Cobble to boulder	F		40°02' N 27°33' E	15.05.2001	40	14.5	-	-	-	-
	3. Gönen Stream	Cobble to boulder	F		39°58' N 27°27' E	14.06.2000	60	13.0	-	-	-	-
	4. Çakırköy Brook	Pebble to cobble	M		39°56' N 27°20' E	14.06.2000 15.05.2001	140 140	18.6 11.0	8.70 7.44	10.5 7.7	110 69	335 433
	5. Kocaçay Brook	Pebble to cobble	M		39°50' N 27°19' E	14.06.2000	120	19.0	7.70	7.3	77	278
	6. Handere Brook	Pebble to cobble	M		39°46' N 27°13' E	14.06.2000	220	16.5	7.97	6.9	66	-
	7. Handere Brook	Pebble to boulder	F		39°43' N 27°11' E	14.06.2000	340	16.0	-	-	-	-
	8. Döşeme Brook	Pebble to cobble	M		39°46' N 27°11' E	14.05.2001	240	12.0	7.59	7.4	76	269
	9. Çelebi Brook	Pebble to cobble	M		39°48' N 27°04' E	14.05.2001	320	11.0	7.70	7.3	75	261
	10. Çelebi Brook	Pebble to cobble	F		39°49' N 27°08' E	14.05.2001	240	12.0	-	-	-	-
Kocabaş Stream	11. Kocaçay Brook	Silt to gravel	S	90	40°11' N 27°21' E	15.06.2000	70	27.9	7.86	5.8	73	324
	12. Biga Stream	Silt to gravel	S		40°10' N 27°12' E	15.06.2000	10	23.7	7.85	6.1	69	572
	13. Bakacak Brook	Gravel to pebble	S		40°12' N 27°03' E	15.05.2001	30	20.0	7.91	8.0	89	576
	14. Harmanlı Brook	Gravel to pebble	S		40°09' N 27°03' E	15.05.2001	40	14.5	8.11	7.10	73	715
15. Çınar Brook	Clay to silt	S	20	40°19' N 27°02' E	15.06.2000	30	20.4	7.60	6.4	71	442	
16. Bayram Brook	Gravel to cobble	S	10	40°23' N 26°46' E	16.05.2001	10	13.0	7.80	7.8	72	648	
Umurbey B.	17. Umurbey Brook	Pebble to boulder	S	30	40°14' N 26°40' E	16.05.2001	20	16.0	7.60	7.2	73	407
	18. Uludere Brook	Pebble to boulder	S		40°16' N 26°45' E	16.05.2001	90	19.0	8.30	7.1	79	392
19. Sarı Brook	Sand to cobble	M	45	40°04' N 26°32' E	16.05.2001	60	23.0	8.28	8.4	96	503	

Table 1. (Continued).

Karamenderes Stream	20. Karamenderes Stream	Sand to boulder	F	124	39°51' N 26°19' E	17.05.2001	20	18.0	7.18	4.5	42	450
	21. Bahçeli Brook	Gravel to pebble	S		39°41' N 26°23' E	17.05.2001	30	17.0	8.08	7.8	82	749
	22. Karamenderes Stream	Silt to gravel	F		39°49' N 26°37' E	13.06.2000	50	17.7	8.26	8.3	85	346
	23. Ayazma Brook	Pebble to boulder	F		39°44' N 26°50' E	13.06.2000	300	9.6	8.02	8.7	79	289
	24. Adaçay Brook	Sand to pebble	M		39°48' N 26°46' E	13.06.2000	140	-	-	-	-	-
	25. Adaçay Brook	Pebble to boulder	F		39°47' N 26°57' E	13.06.2000	590	12.7	7.76	8.1	83	173
Tuzla Stream	26. Tuzla Stream	Sand to cobble	S	55	39°30' N 26°19' E	12.06.2000	40	28.4	8.77	6.3	80	261
	27 Geme Brook	Sand to cobble	M		39°35' N 26°26' E	17.05.2001	180	19.0	8.27	8.4	90	470
	28. Mihli Brook	Sand to cobble	M	25	39°34' N 26°39' E	17.05.2001	10	16.0	7.62	7.0	76	271
	29. Şahin Brook	Sand to cobble	M	15	39°34' N 26°45' E	10.07.2001	5	17.2	8.14	8.8	92	314
	30. Manastır Brook	Sand to cobble	M	18	39°35' N 26°49' E	10.07.2001	5	16.7	7.92	7.6	80	383
	31. Kazan Brook	Sand to cobble.	M	12	39°37' N 26°52' E	10.07.2001	70	12.1	7.86	8.7	83	224
	32. Sütüven Brook	Sand to cobble	M	12	39°37' N 26°55' E	10.07.2001	5	16.1	7.84	7.8	79	269
	33. Zeytinli Brook	Sand to cobble	M	26	39°36' N 26°57' E	09.07.2001	5	22.7	8.20	7.4	83	207
	34. Yaşyer Brook	Sand to cobble	M	20	39°37' N 27°03' E	09.07.2001	50	26.7	8.45	8.8	101	455
	35. Eybek Brook	Sand to boulder	M	40	39°40' N 27°06' E	09.07.2001	300	20.7	7.85	7.0	77	283

L: Length (km), Co: Coordinates; D: Date; A: Altitude (m), T: Temperature (°C), DO: Dissolved Oxygen (mg/l), OS: Oxygen saturation (%); C: Conductivity ($\mu\text{S}25^\circ\text{C}$)

Brook (Örencik-Yenice), 14.05.2001; ESFM-PISI/2001-039 (49 specimens), Gönen Stream (Ilıcaoba köyü-Gönen), 15.05.2001; ESFM-PISI/2001-043 (76 specimens), Bakacak Brook (Bakacak-Biga), 15.05.2001; ESFM-PISI/2001-049 (79 specimens), Harmanlı Brook (Harmanlı-Biga), 15.05.2001; ESFM-PISI/2001-054

(101 specimens), Çakırköy Brook (Çakırköy-Yenice), 15.05.2001; ESFM-PISI/2001-058 (71 specimens), Gönen Stream (Gönen-Balıkesir), 15.05.2001; ESFM-PISI/2001-065 (64 specimens), Uludere Brook (Karaömerler-Lapseki), 16.05.2001; ESFM-PISI/2001-066 (59 specimens), Bayram Brook (Adatepe-Lapseki),

16.05.2001; ESFM-PISI/2001-067 (9 specimens), Umurbey Brook (Sindal-Lapseki), 16.05.2001; ESFM-PISI/2001-068 (2 specimens), Sarı Brook (Terziler-Çanakkale), 16.05.2001; ESFM-PISI/2001-069 (16 specimens), Karamenderes Stream (Çamköy-Ezine), 17.05.2001; ESFM-PISI/2001-071 (152 specimens), Bahçeli Brook (Bahçeli-Ezine), 17.05.2001; ESFM-PISI/2001-077 (42 specimens), Mihli Brook (Küçükkuyu-Ayvacık), 17.05.2001; ESFM-PISI/2001-080 (73 specimens), Geme Brook (Ayvacık-Edremit), 17.05.2001; ESFM-PISI/2001-095 (5 specimens), Eybek Brook (Haciosmanlar-Edremit), 09.07.2001; ESFM-PISI/2001-096 (43 specimens), Zeytinli Brook (Zeytinli-Edremit), 09.07.2001; ESFM-PISI/2001-099 (100 specimens), Yaşyer Brook (Çamcı-Edremit), 09.07.2001; ESFM-PISI/2001-102 (8 specimens), Manastır Brook (Kavaklar-Edremit), 09.07.2001; ESFM-PISI/2001-106 (37 specimens), Şahin Brook (Altınoluk-Edremit), 10.07.2001; ESFM-PISI/2001-107 (10 specimens), Sütüven Brook (Kızılköçüli-Edremit), 10.07.2001.

Diagnosis: D III 7-9; A III 7-9; P I 13-19; V II 7-9; L. lat. 41-48; L. tran. 8-9/4-5; Ngr. 8-10.

Petroleuciscus borysthenicus (Kessler, 1859)

Materials: ESFM-PISI/2001-045 (10 specimens), Bakacak Brook (Bakacak-Biga), 15.05.2001.

Diagnosis: D III 8-9; A III 8-9; P I 11-13; V II 6-7; L. lat. 35-37; L. tran. 6-7/3-4; Ngr. 7-8.

Rhodeus amarus (Bloch, 1782)

Materials: ESFM-PISI/2000-026 (58 specimens), Tuzla Stream (Behram-Ayvacık), 12.06.2000; ESFM-PISI/2000-031 (8 specimens), Karamenderes Stream (Bayramiç), 13.06.2000; ESFM-PISI/2000-052 (9 specimens), Kocaçay Brook (Kayatepe köyü-Yenice), 14.06.2000; ESFM-PISI/2000-062 (3 specimens), Gönen Stream (Yalıoba köyü-Yenice), 14.06.2000; ESFM-PISI/2000-069 (1 specimen), Gönen Stream (Gönen-Balıkesir), 15.06.2000; ESFM-PISI/2000-073 (8 specimens), Kocaçay Brook (Taşoluk köyü-Biga), 15.06.2000; ESFM-PISI/2000-082 (5 specimens), Çınar Brook (Çınardere-Biga), 15.06.2000; ESFM-PISI/2001-062 (31 specimens), Gönen Stream (Gönen-Balıkesir), 15.05.2001; ESFM-PISI/2001-076 (2 specimens), Bahçeli Brook (Bahçeli-Ezine), 17.05.2001.

Diagnosis: D III 9-10; A III 9-10; P I 12-13; V II 6-7; L. lat. 4-6.

Phoxinus phoxinus (Linnaeus, 1758)

Materials: ESFM-PISI/2000-057 (25 specimens), Handere Brook (Kalkım-Yenice), 14.06.2000; ESFM-PISI/2001-032 (10 specimens), Çelebi Brook (Aşağıçavuş köyü-Yenice), 14.05.2001; ESFM-PISI/2001-033 (27 specimens), Döşeme Brook (Karaaydın-Yenice), 14.05.2001; ESFM-PISI/2001-035 (121 specimens), Çelebi Brook (Örencik-Yenice), 14.05.2001.

Diagnosis: D III 7; A III 7; P I 15-16; V II 7; Ngr. 7-8.

Vimba vimba (Linnaeus, 1758)

Materials: ESFM-PISI/2001-042 (9 specimens), Gönen Stream (Ilıcaoba köyü-Gönen), 15.05.2001; ESFM-PISI/2001-057 (9 specimens), Çakırköy Brook (Çakırköy-Yenice), 15.05.2001.

Diagnosis: D III 8-9; A III 15-16; P I 15-17; V II 8; L. lat. 54-56; L. tran. 9-10/6; Ngr. 16-17.

Chalcalburnus chalcoides (Güldenstädt, 1772)

Materials: ESFM-PISI/2000-028 (13 specimens), Tuzla Stream (Behramkale-Ayvacık), 12.06.2000; ESFM-PISI/2000-033 (6 specimens), Karamenderes Stream (Bayramiç), 13.06.2000; ESFM-PISI/2000-044 (7 specimens), Adaçay Brook (Çırpılar köyü-Bayramiç), 13.06.2000; ESFM-PISI/2000-048 and 49 (148 specimens), Çakırköy Brook (Çakırköy-Yenice), 14.06.2000; ESFM-PISI/2000-054 (54 specimens), Kocaçay Brook (Kayatepe köyü-Yenice), 14.06.2000; ESFM-PISI/2000-064 (4 specimens), Gönen Stream (Gönen-Balıkesir), 15.06.2000; ESFM-PISI/2000-071 (5 specimens), Biga Stream (Biga-Çanakkale) 15.06.2000; ESFM-PISI/2000-075 (41 specimens), Kocaçay Brook (Taşoluk köyü-Biga), 15.06.2000; ESFM-PISI/2001-040 (25 specimens), Gönen Stream (Ilıcaoba köyü-Gönen), 15.05.2001; ESFM-PISI/2001-060 (11 specimens), Gönen Stream (Gönen-Balıkesir), 15.05.2001; ESFM-PISI/2001-053 (120 specimens), Çakırköy Brook (Çakırköy-Yenice), 15.05.2001; ESFM-PISI/2001-048 (6 specimens), Bakacak Brook (Bakacak-Biga), 15.05.2001; ESFM-PISI/2001-070 (16 specimens), Karamenderes Stream (Çamköy-Ezine), 17.05.2001; ESFM-PISI/2001-075 (22 specimens), Bahçeli Brook (Bahçeli-Ezine), 17.05.2001; ESFM-PISI/2001-082 (117 specimens), Geme Brook (Ayvacık-Edremit), 17.05.2001.

Diagnosis: D III 8-9; A III 13-15; P I 13-15; V II 8-9; L. lat. 57-68; L. tran. 11-12/4-5; Ngr. 21-32.

Barbus tauricus escherichi Steindachner, 1897

Materials: ESFM-PISI/2000-025 (60 specimens), Tuzla Stream (Behram-Ayvacık), 12.06.2000; ESFM-PISI/2000-034 (98 specimens), Karamenderes Stream (Bayramiç), 13.06.2000; ESFM-PISI/2000-040 (27 specimens), Adaçay Brook (Çırpılar köyü-Bayramiç), 13.06.2000; ESFM-PISI/2000-047 (3 specimens), Çakırköy Brook (Çakırköy-Yenice), 14.06.2000; ESFM-PISI/2000-050 (41 specimens), Kocaçay Brook (Kayatepe köyü-Yenice), 14.06.2000; ESFM-PISI/2000-056 (34 specimens), Handere Brook (Kalkım-Yenice), 14.06.2000; ESFM-PISI/2000-059 (10 specimens), Gönen Stream (Yalıoba köyü-Yenice), 14.06.2000; ESFM-PISI/2000-066 (65 specimens), Gönen Stream (Gönen-Balıkesir), 15.06.2000; ESFM-PISI/2000-072 (2 specimens), Biga Stream (Biga-Çanakale), 15.06.2000; ESFM-PISI/2000-079 (74 specimens), Kocaçay Brook (Taşoluk köyü-Biga), 15.06.2000; ESFM-PISI/2001-036 (6 specimens), Çelebi Brook (Örencik-Yenice), 14.05.2001; ESFM-PISI/2001-037 (46 specimens), Gönen Stream (Ilicaoba köyü-Gönen), 15.05.2001; ESFM-PISI/2001-052 (19 specimens), Harmanlı Brook (Harmanlı-Biga), 15.05.2001; ESFM-PISI/2001-055 (35 specimens), Çakırköy Brook (Çakırköy-Yenice), 15.05.2001; ESFM-PISI/2001-064 (1 specimen), Gönen Stream (Gönen-Balıkesir), 15.05.2001; ESFM-PISI/2001-074 (23 specimens), Bahçeli Brook (Bahçeli-Ezine), 17.05.2001; ESFM-PISI/2001-081 (61 specimens), Geme Brook (Ayvacık-Edremit), 17.05.2001; ESFM-PISI/2001-098 (11 specimens), Zeytinli Brook (Zeytinli-Edremit), 09.07.2001; ESFM-PISI/2001-100 (16 specimens), Yaşyer Brook (Çamcı-Edremit), 09.07.2001; ESFM-PISI/2001-108 (3 specimens), Sütüven Brook (Kızılkçeili-Edremit), 10.07.2001.

Diagnosis: D IV 8-9; A III 5-6; P I 13-15; V II 7-8; L. lat. 50-64; L. tran. 11-13/7-9; Ngr. 8-14.

Capoeta capoeta bergamae Karaman, 1971

Materials: ESFM-PISI/2000-078 (186 specimens), Kocaçay Brook (Taşoluk köyü-Biga), 15.06.2000; ESFM-PISI/2000-081 (31 specimens), Çınar Brook (Çınardere-Biga), 15.06.2000; ESFM-PISI/2001-047 (13 specimens), Bakacak Brook (Bakacak-Biga), 15.05.2001; ESFM-PISI/2001-051 (16 specimens), Harmanlı Brook (Harmanlı-Biga), 15.05.2001.

Diagnosis: D III 8; A III 5; P I 13-15; V I 8; L.lat. 60-68; L.tran. 12-13/9-10; Ngr. 15-19.

Gobio gobio (Linnaeus, 1758)

Materials: ESFM-PISI/2000-027 (1 specimen), Tuzla Stream (Behramkale-Ayvacık), 12.06.2000; ESFM-PISI/2000-035 (8 specimens), Karamenderes Stream (Bayramiç), 13.06.2000; ESFM-PISI/2000-042 (5 specimens), Adaçay Brook (Çırpılar köyü-Bayramiç), 13.06.2000; ESFM-PISI/2001-046 (64 specimens), Bakacak Brook (Bakacak-Biga), 15.05.2001; ESFM-PISI/2001-050 (9 specimens), Harmanlı Brook (Harmanlı-Biga), 15.05.2001; ESFM-PISI/2001-073 (12 specimens), Bahçeli Brook (Bahçeli-Ezine) 17.05.2001.

Diagnosis: D III 7; A II 6; P I 12-14; V II 6-7; L.lat. 38-39; L.tran. 6/4-5; Ngr. 8-10.

Family: Cobitidae

Cobitis fahirae Erkakan, Atalay-Ekmekçi & Nalbant, 1998

Materials: ESFM-PISI/2000-029 (1 specimen), Tuzla Stream (Behram-Ayvacık), 12.06.2000; ESFM-PISI/2000-032 (10 specimens), Karamenderes Stream (Bayramiç), 13.06.2000; ESFM-PISI/2000-041 (2 specimens), Adaçay Brook (Çırpılar köyü-Bayramiç), 13.06.2000; ESFM-PISI/2000-046 (2 specimens), Çakırköy Brook (Çakırköy-Yenice), 14.06.2000; ESFM-PISI/2000-053 (3 specimens), Kocaçay Brook (Kayatepe köyü-Yenice), 14.06.2000; ESFM-PISI/2000-061 (4 specimens), Gönen Stream (Yalıoba köyü-Yenice), 14.06.2000; ESFM-PISI/2000-067 (7 specimens), Gönen Stream (Gönen-Balıkesir), 15.06.2000; ESFM-PISI/2000-074 (1 specimen), Kocaçay Brook (Taşoluk köyü-Biga), 15.06.2000; ESFM-PISI/2001-038 (10 specimens), Gönen Stream (Ilicaoba köyü-Gönen), 15.05.2001; ESFM-PISI/2001-044 (17 specimens), Bakacak Brook (Bakacak-Biga), 15.05.2001; ESFM-PISI/2001-056 (54 specimens), Çakırköy Brook (Çakırköy-Yenice), 15.05.2001; ESFM-PISI/2001-061 (41 specimens), Gönen Stream (Gönen-Balıkesir), 15.05.2001; ESFM-PISI/2001-072 (3 specimens), Bahçeli Brook (Bahçeli-Ezine), 17.05.2001.

Diagnosis: D III 7; A II 5; P I 6-7; V II 5.

Family: Gobiidae

Neogobius fluviatilis (Pallas, 1811)

Materials: ESFM-PISI/2000-068 (4 specimens), Gönen Stream (Gönen-Balıkesir), 15.06.2000; ESFM-PISI/2001-041 (6 specimens), Gönen Stream (Ilicaoba köyü-Gönen), 15.05.2001; ESFM-PISI/2001-063 (6 specimens), Gönen Stream (Gönen-Balıkesir),

15.05.2001.

Diagnosis: D1 VI; D2 I 14-16; A I 12-14; P 17-19; L.lat. 57-62.

Ichthyofaunal composition

Twelve of these taxa are autochthonic (native). *A. anguilla* is a catadromous species, and *O. mykiss* is an exotic species that entered the streams after escaping from nearby fish farms. Thus, it was not included in the faunistic analysis (Table 2).

The streams Gönen, Kocabaş and Çınar join the Sea of Marmara. The Gönen Stream is rich in fish species and contains 9 species of the fauna in the region. *L. cephalus* and *B. tauricus escherichi* of these species have been colonised in the whole stream systems. Eight species were identified in the Kocabaş Stream, and most of them were collected from the middle of the stream basin. The Çınar Brook, 1 of the 3 brooks running into the Sea of Marmara, is poorer in diversity as it is smaller than the others. Three species of fish identified in this brook were also found in the Kocabaş Stream, which is very close to it.

The fish fauna of the Bayram Brook, which runs into

the sea at the Marmara mouth of the Dardanelles, and of the Umurbey Brook and the Sarı Brook, which run into the Dardanelles, are very much alike. These 3 streams, which only *L. cephalus* inhabit, are quite different from the others on the peninsula in regard to species diversity.

Only *S. trutta macrostigma* was found in the upper part of the Karamenderes Stream, which runs into the sea at the Aegean mouth of the Dardanelles. *L. cephalus* and *C. chalcoides* were identified at the plain part of its basin after the valleys. Other species were seen in the middle of the stream basin.

The Tuzla Stream, emerging near Ayvacık, lies on the far west of the peninsula and runs into the Aegean Sea. The fish fauna of this stream is very like that of the Karamenderes Stream. However, there is no *S. trutta macrostigma* in this stream since it is warmer than the Karamenderes Stream. The fish species were found in various parts of the stream depending on their ecological requirements. While more species were encountered in the middle part, which runs through the plains, only *L. cephalus*, *C. chalcoides* and *B. tauricus escherichi* were encountered in the upper part of the stream.

Table 2. Fish composition of the streams and relative abundance.

Taxa	Gönen S.	Kocabaş S.	Çınar B.	Bayram B.	Umurbey B.	Sarı B.	Karamenderes S.	Tuzla S.	Mihli B.	Şahin B.	Manastır B.	Kazan B.	Sütüven B.	Zeytinli B.	Yaşyer B.	Eybek B.	Total
<i>A. anguilla</i>	--	--	--	--	--	--	--	--	10.0	13.3	50.0	100	--	4.2	--	--	1.1
<i>S. t. macrostigma</i>	2.0	--	--	--	--	--	19.9	--	10.0	--	--	--	--	--	--	--	3.6
<i>L. cephalus</i>	19.2	30.0	81.3	100	100	100	42.7	53.7	80.0	86.7	50.0	--	71.4	75.0	86.8	100	49.6
<i>P. borysthenicus</i>	--	1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.2
<i>R. amarus</i>	2.7	1.5	2.5	--	--	--	2.2	11.6	--	--	--	--	--	--	--	--	3.1
<i>P. phoxinus</i>	13.7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.3
<i>V. vimba</i>	1.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.2
<i>C. chalcoides</i>	33.6	7.7	--	--	--	--	6.6	14.1	--	--	--	--	--	--	--	--	10.5
<i>B. t. escherichi</i>	19.2	15.5	--	--	--	--	22.8	19.0	--	--	--	--	28.6	20.8	13.2	--	15.2
<i>C. c. bergamae</i>	--	34.0	16.2	--	--	--	--	--	--	--	--	--	--	--	--	--	9.2
<i>G. gobio</i>	--	8.2	--	--	--	--	2.9	0.8	--	--	--	--	--	--	--	--	2.5
<i>C. fahirae</i>	6.2	2.1	--	--	--	--	2.9	0.8	--	--	--	--	--	--	--	--	2.1
<i>N. fluviatilis</i>	2.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.4

There are various brooks that run into Edremit Bay in the southern part of the Biga Peninsula, whose fish faunas are alike. For example, *A. anguilla*, a catadromous fish, was identified in most of these brooks. While *L. cephalus*, an autochthonic species, was identified in almost all of these brooks, *S. trutta macrostigma* was identified only in those with cool water. On the other hand, *B. tauricus escherichi* was found in the middle part of the Sütüven Brook, the Yaşyer Brook and the Eybek Brook, which are on the south-easternmost part of the peninsula, and have warm water.

Relative abundance

In total, 855 fish in 100 m² of 13 taxa were caught on the peninsula. *L. cephalus* and *B. tauricus escherichi* were the most common and the most widespread species, with 49.6% and 15.2% rates, respectively (Table 2), which is about 64.8% of the fish population of the peninsula. *A. anguilla* was encountered in some streams at a low rate (1.1%). Most of the taxa were identified in the larger streams. These small rivers are not good habitats for many small fish species, because they have stony beds and very little water in the summer months. Therefore, *A. anguilla* is seen to be more abundant than the taxa that are distributed in some larger streams.

Similarities between the Fish Communities

The streams on the Biga Peninsula were divided into 3 groups with regard to the similarities (at a level of

50%) between the fish communities (Figure 2). The Tuzla and Karamenderes streams form **Group 1**, with 85.71% similarity in their fish fauna. The Kocabaş Stream with 75% similarity and the Gönen Stream with 60% similarity can be included in this group. **Group 2** is formed only by the Çınar Brook and it has 37.50% similarity with those in Group 1. The small streams form **Group 3**, in which there is 100% similarity among the Bayram, Umurbey, Sarı and Eybek brooks; between the Şahin and Manastır brooks; and between the Sütüven and Yaşyer brooks. The similarity rate of the Mihli Brook to the Şahin and to the Manastır brooks, of the Zeytinli Brook to the Şahin, to the Manastır; to the Sütüven and to the Yaşyer brooks is 66.67%, and of the Kazan to the Şahin and to the Manastır brooks is 50.00%. In conclusion, the similarity of fish fauna of the streams in the region was found to be about 33.33%.

Species Diversity and Evenness

The Gönen Stream has the highest rate of species diversity (2.77) in the region (Table 3), followed by the other streams, the Kocabaş Stream (2.55), the Karamenderes Stream (2.18), and the Tuzla Stream (1.97). The Manastır Brook has the highest evenness value (1.00), followed by the Gönen Stream (0.87), the Sütüven Brook (0.86) and the Kocabaş Stream (0.85). The evenness among the main streams in the region (the Gönen, Kocabaş, Karamenderes and Tuzla Streams) ranged between 0.76 and 0.87.

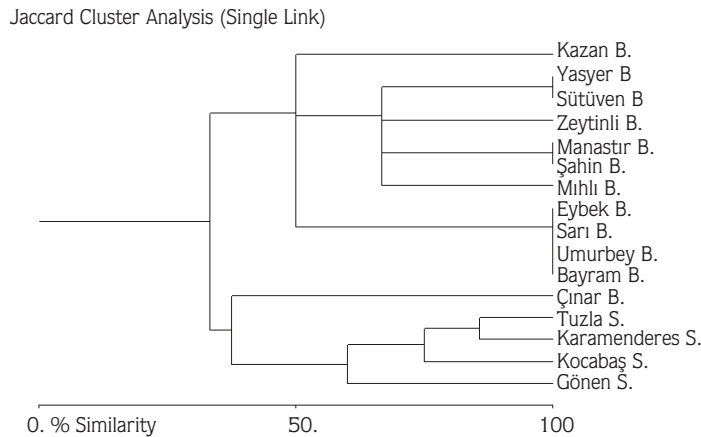


Figure 2. Similarity dendrogram among the streams on the Biga Peninsula.

Table 3. Values of species diversity and evenness in the streams on the peninsula.

Streams	Species richness	Shannon-Weiner (H') Species diversity	Evenness (J')
Gönen S.	9	2.77	0.87
Kocabaş S.	8	2.55	0.85
Çınar B.	3	0.80	0.51
Bayram B.	1	0.00	-
Umurbey B.	1	0.00	-
Sarı B.	1	0.00	-
Karamenderes S.	7	2.18	0.78
Tuzla S.	6	1.97	0.76
Mihli B.	3	0.92	0.58
Şahin B.	2	0.57	0.57
Manastır B.	2	1.00	1.00
Kazan B.	1	0.00	-
Sütüven B.	2	0.86	0.86
Zeytinli B.	3	0.97	0.61
Yaşyer B.	2	0.56	0.56
Eybek B.	1	0.00	-

Discussion

Related to the fish fauna of the region, there are a few studies on the occurrence and distribution of trout, a subspecies of *S. trutta macrostigma* (Tortonese, 1954; Geldiay, 1972; Balık, 1975).

Fourteen fish species and subspecies in 5 families were identified on the Biga Peninsula. Twelve of these are autochthonic: *S. trutta macrostigma*, *L. cephalus*, *P. borysthenicus*, *R. amarus*, *P. phoxinus*, *C. chalcoides*, *B. tauricus escherichi*, *G. gobio*, *C. capoeta bergamae*, *V. vimba*, *C. fahirae* and *N. fluviatilis*. As *A. anguilla* is a catadromous fish, it can be found in every stream running into the sea, and *O. mykiss*, which is bred in fish farms, is sometimes able to escape into the streams. Therefore, *A. anguilla*, which is a migratory fish, and *O. mykiss*, which is an accidentally introduced species, were not included in the autochthonic group of the region. Except for *S. trutta macrostigma*, *O. mykiss* and *A. anguilla*, the other species are newly identified in this study. *P. phoxinus*, which was previously reported in the Sakarya River in Anatolia (Erk'akan, 1983), was identified in the Gönen Stream and its branches (the Handere, the Döşeme, and the Çelebi Brook). *L. cephalus* and *B. tauricus escherichi* were the most common and the most abundant species on the peninsula.

The relative abundance of species differed according to various streams. *C. chalcoides* had the highest relative abundance in the Gönen Stream, *B. tauricus escherichi* in the Kocabaş Stream, *A. anguilla* in the Kazan Brook, *A. anguilla* and *L. cephalus* in the Manastır Brook and *L. cephalus* in rest of the streams. An overall evaluation of the sampling stations revealed the most abundant species to be *L. cephalus* (49.6%), followed by *B. tauricus escherichi* (15.2%), both of which are known to adapt easily to different stream flow conditions, and *C. chalcoides* (10.5%).

The streams in the region were divided into 3 groups with regard to their similarities, using single linkage clustering at 50% similarity level. The fish fauna of the larger streams were 60% similar to each other. Similarity in the fish communities of the brooks forming **Group 3** was about 50%. The Çınar Brook is the only one forming **Group 2**. Although it is a small brook, it differs from the other small ones with the structure of its bed and water flow. Thus, its fish fauna has only 33% similarity with the others.

The Gönen Stream had the highest species diversity among the streams in the region. It is the longest stream on the peninsula, originating from an altitude of 400 m. The Gönen Stream has very different habitats within the range from higher altitudes to sea level (Gönen plate),

which explains its more diverse ichthyofauna in comparison with the other streams. Although the diversity is between 2 and 3 species in the large streams, it is below 1 in the small ones. The evenness index, which shows the presence probability of species in a habitat, was over 0.5 in general. The value of the evenness index of the Manastır Brook was 1.0, since it was not affected by environmental factors, which means that the species in it have a homogeneous distribution. Only one fish species was identified in some small brooks (the Bayram, Umurbey, Sarı, Kazan and Eybek Brooks) and thus the

evenness index was not calculated. Only a few stations in the Kocabaş Stream were studied because the generator failed. This negative unwanted event may have caused a relative deviation in the results of the statistical analysis.

Acknowledgements

This research was supported by Ege University (Project No. 2000/SUF/003). The authors thank E. Taşkavak and M. Bilecenoğlu for their suggestions on an earlier draft of the manuscript.

References

- Almaça, C. 1986. On Some *Barbus* Species from Western Asia (Cyprinidae, Pisces). Ann. Naturhist. Mus. Wien, 87B: 5-30.
- Balık, S. 1975. Taxonomical Position and Geographic Distribution of Freshwater Fishes of Western Anatolia. In: 5th Science Cong., İzmir, pp. 299-313.
- Balık, S. 1985. Taxonomical Revision and Present Situations of the Inland Water Fishes from Turkish Thrace. Tübitak Doğa Bilim Derg., Seri A₂, 9(2): 147-160.
- Balık, S. 1987. Fishes and Fisheries of Lake Kuş. 2nd Bandırma Bird Paradise and Kuş Lake Symposium, Bandırma, pp. 47-59.
- Balık, S. 1988. Systematic and Zoogeographic Investigations on Inland Water Fishes of the Mediterranean Region of Turkey. DOĞA TU Zooloji D., 12 (2): 156-179.
- Berg, L. S. 1962. Freshwater Fishes of the U.S.S.R. and Adjacent Countries. Vol. I (4th Ed.), Israel Program for Scientific Translations Ltd., Jerusalem.
- Berg, L. S. 1964. Freshwater Fishes of the U.S.S.R. and Adjacent Countries. Vol. II (4th Ed.), Israel Program for Scientific Translations Ltd., Jerusalem.
- Berg, L. S. 1965. Freshwater Fishes of the U.S.S.R. and Adjacent Countries. Vol. III (4th Ed.), Israel Program for Scientific Translations Ltd., Jerusalem.
- Bogutskaya, N. G. 1997. Contribution to the knowledge of Leuciscine fishes of Asia Minor, Part 2. An annotated check-list of leuciscine fishes (Leuciscinae, Cyprinidae) of Turkey with descriptions of a new species and two new subspecies. Mitt. Hamb. Zool. Mus. Inst. 94: 161-186.
- Bogutskaya, N. G. 2002. *Petroleuciscus*, a new genus for the *Leuciscus borysthenticus* species group (Teleostei: Cyprinidae). Zoosystematica Rossica, 11(1): 235-237.
- Clarke, K. R. and Warwick, R. M. 1994. Change in Marine Communities, an Approach to Statistical Analysis and Interpretation. Natural Environment Research Council, UK.
- Erk'akan, F. 1983. Investigations on Systematic and Bioecology of the Fish of Sakarya Basin. Tübitak Doğa Bilim Derg. (Veterinerlik ve Hayvancılık), 7: 141-154.
- Erkakan F., Atalay-Ekmekçi, F. G. and Nalbant, T. T. 1999. A review of the genus *Cobitis* in Turkey (Pisces: Ostariophysi: Cobitidae). Hidrobiologia, 403: 13-26.
- Geldiay, R. 1972. Trout (*Salmo trutta* L.) populations inhabiting the streams of Kazdağı Range. Verh. Internat. Verein. Limnol., 18: 1212-1221.
- Geldiay, R. and Balık, S. 1999. Inlandwater Fishes of Turkey (3rd ed.), Ege University Faculty of Fisheries, İzmir.
- Kelle, A. 1978. Investigations on fishes in Tigris (Dicle) River and its branches, Ph.D. thesis, Dicle University, Diyarbakır, 110 pp.
- Krebs, C. J. 1989. Ecological Methodology. Harper Collins Publishers, New York.
- Kuru, M. 1975. The Fish Fauna of Eastern Anatolia, Atatürk University Faculty of Science, Erzurum.
- Miller, P. J. 1986. Gobiidae. In: Fishes of the North-eastern Atlantic and the Mediterranean (Eds., Whitehead, P.J.P., Bauchot, M.L., Hureau, J.C., Nielsen, J., Tortonese, E.), UNESCO, Vol. III, Paris, pp. 1019-1085.
- Ongan, T. 1982. The project of improving inland water products and water resource inventory in South Marmara Region. İstanbul University Hydrobiology Research Institute, Sapanca.
- Reshetnikov Yu. S., Bogutskaya, N. G., Vasil'eva E. D., Dorofeeva, E. A., Naseka, A. M., Popova, O. A., Savvaitova, K. A., Sidelava, V. G. and Sokolov, L. I. 1997. An Annotated Check-List of the Freshwater Fishes of Russia. J. Ichthyology, 37(9): 687-736.
- Tortonese, E. 1954. The Trouts of Asiatic Turkey. İstanbul University Faculty of Science, Hidrobiologi, Series B, 2(1): 1-26.