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Subrecent Ostracoda Associations and the Environmental Conditions of Karstic Travertine Bridges on the Zamantı River, Southern Turkey

Zamantı Irmağı Üzerinde Yer Alan Karstic Travertenlerde Yarı-Güncel Ostrakod Topluluğu ve Ortamsal Özellikleri, Güney Türkiye

Cemal TUNOĞLU, İbrahim Kadri ERTEKİN

Hacettepe University, Engineering Faculty, Geological Engineering Department, 06800 Beytepe-Ankara/Turkey
(e-mail: tunay@hacettepe.edu.tr)

ABSTRACT

Subrecent Ostracoda associations have been identified in karstic travertine deposits of the Zamantı River. In this study, seven species and three taxa left in open nomenclature (mainly of freshwater origin) were investigated: ***Limnocythere inopinata, Eucyprinotus rostratus, Psychodromus olivaceus, Scottia pseudobrowniana, Potomocypris fallax, Candona neglecta, Heterocypris barbara, Psychodromus*** sp.**,** ***Trajancypris*** sp. and ***Cypridopsis*** sp. Recent climatic and hydrochemical conditions were also determined in detail in order to provide a picture of the environmental conditions dominating over the fauna (Ostracoda) and flora (Bacillariophyceae/diatomeae, Chlorophyceae/green algae, Cyanophyceae/blue-green algae). The results suggest that spring waters with a high carbon-dioxide content support the algale population growth.
Key words: Karstic travertine bridges, Ostracoda, subrecent, Turkey.

ÖZ

Zamantı Irmağı üzeride yer alan karstik traverten çökellerinde yarı güncel ostrakod topluluğu tespit edilmiştir ve 7 bilinen tür ve isimlendirmeye açık 3 taxon (başlıca tatlısu kökenli) tanınımlanmıştır. ***Limnocythere inopinata, Eucyprinotus rostratus, Psychodromus olivaceous, Scottia pseudobrowniana, Potomocypris fallax, Candona neglecta, Heterocypris barbara, Psychodromus*** *sp.,* ***Trajancypris*** *sp. ve* ***Cypridopsis*** *sp. Ayrıntılı güncel iklimsel ve hidrokimyasal koşullar ortaya konulduğunda ortamsal şartların ifade bulduğu koşullar içinde Ostrakod faunası ile diatom (Bacillariophyceae), yeşil alg (Chlorophyceae) ve mavi-yeşil alg (Cyanophyceae) flora topluluğu baskın durumdadır. Sonuçlar, yüksek karbondioksit içeriğine sahip kaynak sularının alg topluluğunun gelişimini desteklediğini göstermektedir.*
Anahtar Sözcükler: Karstik traverten köprüsü, Ostrakod, yarı-güncel, Türkiye.

INTRODUCTION

Travertines are terrestrial freshwater carbonate formations and their faunal-floral associations have recently started to attract interest (Diebel and Pietrzeniuk, 1975, 1978, Pietrzeniuk, 1977; Chafetz and Folk, 1984; Emeis et al., 1987; Delorme, 1989, 1990; Pentecost, 1990; Viles and Goudie, 1990; Griffiths and Evans, 1991; Griffiths et al., 1993; Griffiths et al., 1995; Horne and Martens, 1999; Horne et al., 2002), as they are usually good indicators of environmental conditions. The morphology and geology of the three travertine bridges, and a detailed hydrochemistry, geochemistry, algal biology and formation hypothesis have been given by Bayarı (2002).

Study of fauna and flora associations, together with climatic and hydrochemical conditions, and the correlation of Holocene ostracode associations with fossils are believed to be helpful in reconstructing paleoenvironmental conditions elsewhere. Since the life forms depend strongly on the hydrochemical characteristics and climatic conditions dominating in a travertine site, a comparison of recent/subrecent species with those of the fossil record may provide information on past changes in environmental conditions.

Previous studies (Diebel & Pietrzeniuk, 1975, 1978, Meisch, 2000) indicate that travertines can develop chiefly via two distinct types of groundwater discharges, namely thermal and cool-karstic. Travertine formations associated with thermal springs usually include limited faunal and floral remains, probably because of harsh environmental conditions including high temperatures and the trace element content of the water. Compared to the cool-karstic travertines, most of the present day travertine-forming thermal springs exhibit a limited plant and animal diversity unless they have not been polluted by chemical species which may provoke life. Due to the limited number of life forms contained in them, the thermal spring associated carbonate deposits are called ‘abiogenic travertines’, while those formed by cold-karstic waters, containing a wide variety of faunal and floral species, are classified as ‘biogenic’(Weijermars et al., 1986).

The distribution of ostracode and algale species, as well as the climatic and hydrochemical conditions in three closely located travertine formations that developed in the Eastern Taurides, Turkey are described in some detail (Figure 1).

MATERIAL AND METHODS

Ostracode samples were collected mainly from an unlithified or semi-lithified location along the Yerköprü I, II and III creeks running over the travertine (Figure 2A, B and C). Approximately 10 cm^3 of material was used to extract fossils. These samples were treated with 5% hydrogen peroxide for 5 hours; then sieved and washed with distilled water. After drying, the digested residues were sieved through a set of 1 mm, 0.5 mm and 0.25 mm sieves. Ostracode valves and carapaces were hand-picked from the residues under binocular microscope and transferred onto micropaleontological single slides, where each individual valve or carapace collected was attached in a different position (e.g. internal, external, dorsal, ventral etc.) on the multi-slides. After taxonomical classification, the valves and carapaces wereheated over an alcohol flame to remove impurities so that both the external and the internal parts could be seen in detail. The features of the valves and carapaces were studied with a Leitz binocular microscope having a 25x or 50x magnification, and some other details (e.g., muscle scars, marginal pore canals, hinge area etc.) were observed with a 150x or higher magnification. All of the photographs were taken with a Scanning Electron Microscpe (JEOL, JSM-5410 Type), having 70 and 140 magnifications (Plate 1-2).

The hydrochemical data used in this study were collected via field measurements and laboratory analysis of water samples. The travertine sites were visited both in dry and wet periods to discover any physical and chemical variations that may occur in the travertine depositing waters. Measurements of physical and chemical variables were carried out at different locations along the travertine depositing creeks (Bayarı et al., 1995; Bayarı 2002). The pH measurements were taken by means of a calibrated digital pH meter (Table 1). Parallel measurements of dissolved oxygen, temperature and electrical conductivity were also made in situ. The alkalinity of the water samples was determined on-site by means of Gran's potentiometric titration method (Appelo and Postma, 1992). Water samples collected for laboratory analysis were filtered through 0.45 µm cellulose-acetate filter when cation samples were preserved by adding laboratory grade HNO_3 until the sample pH lowered to pH< 2. The water samples were analyzed in the laboratory according to the standard methods. Atomic absorbtion spectrometric techniques were used in the analysis of cations, while the chloride and sulfate were analyzed according to Argentometric and Barium Chloride spectrometric methods, respectively. All analyses were checked for electro-neutrality and found to be within the 5% error limit (Bayarı et al., 1995; Bayarı, 2002).

DESCRIPTION OF TRAVERTINE SITES

The The travertines subject to this study are located along the lower part of the Zamantı River Basin in the Eastern Taurides, Turkey (Figure 1). Interestingly, these travertine deposits form natural bridges over the stream bed, with an average height of 15 m. To the authors' knowledge, the only other travertine formations of a similar size are in Mandalay, Burma (La Touche, 1906; Weijermars et al., 1986). Travertines which are currently being formed have been built up as a result of calcite precipitation from karstic springs discharging from the facing steep limestone walls of the stream bed. It is obvious that the travertine depositions have developed mostly in a horizontal direction, and since the karstic springs are located at the facing sides of gorge, the deposits that developed at each side have joined each other at some time in the past. Possibly, timbers which were squeezed in this part of the stream bed provided a basement for the first evolution of these bridge-like travertine formations.

Travertine forming springs discharge groundwater from the regional flow system, where it had been in contact with the aquifer for a long period of time and become super-saturated with calcite. Therefore, as soon as the groundwater with high carbon-dioxide content (log P_{CO2} = $10^{-1.5}$ atm) emerges and comes in contact with atmosphere (log P_{CO2} = $10^{-3.5}$ atm), in which the carbon-dioxide content is substantially lower, the hydrochemical system equilibrates with the atmosphere which causes travertine to precipitate, mostly in the form of calcite and/or low magnesian calcite (Bayarı et al., 1995; Bayarı, 2002). Because the travertines form natural bridges, they have been named Yerköprü (Turkish: earthen bridge), and numbered I, II and, III starting from the one located most upstream. Yerköprü I, Yerköprü II and Yerköprü III travertine sites are located at elevations of 750 m, 700 m and 450 m respectively.

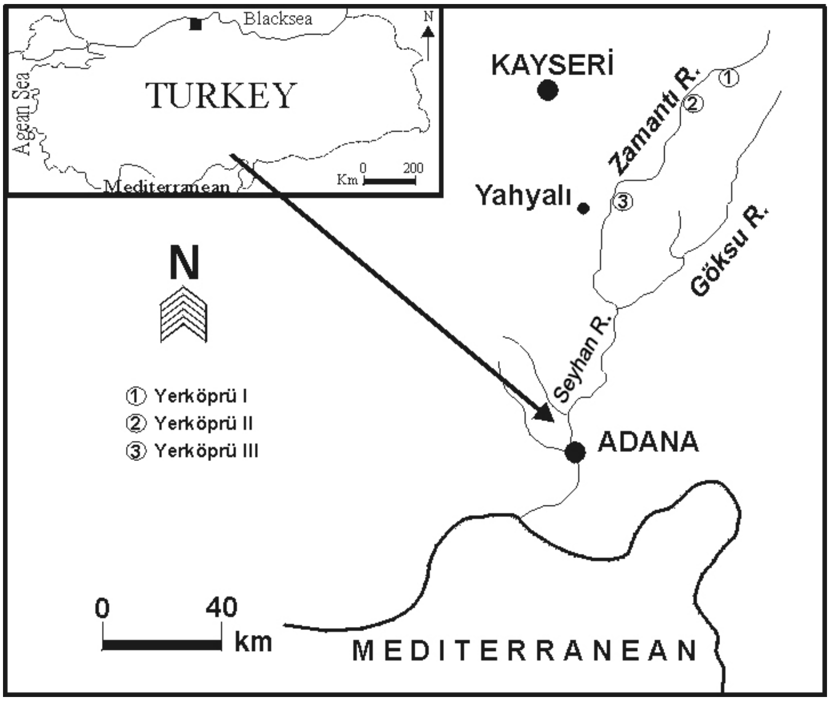

Figure 1. Location map of the study area.

Şekil 1. *Çalışma alanının yer bulduru haritası.*

CLIMATE

The climate in the study area is Mediterranean, characterized by hot and dry summers and mild and rainy winters. The climate is mainly affected by air masses originating from the Mediterranean Sea and moving inland. The Zamantı River, which joins the Mediterranean Sea through the Göksu and Seyhan Rivers about 50 km to the south, provides an excellent air corridor through which warm coastal winds breeze over the travertine sites. The dominant type of precipitation is rainfall, with a long-term average of 800 mm/year. Snow, amounting to several centimeters, is rare and usually melts within one day. The mean annual temperature is about 18^{o}C, whereas typical summer and winter temperatures are around 10^{o}C and 25^{o}C, respectively. The length of daily insolation in summer time is about 14 hours, reducing to 10 hours in winter. Humidity does not show a substantial variation during the year and averages 85% during hot summer days, but humidities may reach 95%; intensive spring and autumn rainfalls occur frequently, and these cause overland flows which bring slope-wash material over the travertine sites. During the snow melt season, intensive rainfall over the mountainous part causes huge flood flows to occur. The Yerköprü II travertine site is covered with flood flows for several tens of hours every 26 to 30 years (Bayarı et al., 1995; Bayarı, 2002).

Table 1. Physical and chemical data from travertine-forming springs (after Bayarı, 2002).

Çizelge 1. *Traverten oluşturan kaynaklara ait fiziksel ve kimyasal veriler (Bayarı, 2002'den).*

Travertine Site	pH	T(°C)	EC	DO	Ca	Mg	Na	K	Cl	SO_4	ALK	TDS	SICc	SIDo	SIGy
Yerköprü-1	7.549	13.8	320.0	8.5	2.078	0.511	0.749	0.257	1.000	0.369	4.800	479.1	+0.29	-0.05	-1.93
Yerköprü-2	7.594	13.6	335.0	8.0	2.133	0.527	0.570	0.247	0.740	0.337	4.959	481.3	+0.35	+0.08	-1.96
Yerköprü-3	7.670	15.0	455.0	7.4	2.838	0.416	1.109	0.060	1.320	0.489	5.370	573.1	+0.58	+0.33	-1.73

Note: Concentrations are in mmol/l unit. DO and TDS are in mg/l. EC is in µS/cm. DO: Dissolved oxygen; SI: Saturation index = log (ion activity product / solubility product); Cc: Calcite, Do: Dolomite, Gy: Gypsum

HYDROCHEMISTRY OF TRAVERTINE FORMING SPRINGS AND CREEKS

The physical and chemical properties (Table 1) of karstic springs and the streams originating from them have also been determined (Bayarı and Denizman, 1993; Bayarı et al., 1995; Bayarı, 2002).

SYSTEMATICS OF OSTRACODA COMMUNITIES AND PALEO-ENVIRONMENTAL EVALUATION

Besides many other aquatic environments, ostracode species also occur in the flowing waters from which, usually, the tufas and travertines are formed as a result of biogenic and/or inorganic processes (Pedley, 1987, 1990; Pentecost and Lord, 1988). Furthermore, travertines and tufas provide an excellent medium in which fossils are well preserved. As travertine forming waters are supersaturated with respect to calcite, the hydrochemical conditions favor the preservation by preventing secondary dissolution of valves by acidic waters.

Ten species of Ostracoda belonging to nine genera have been identified from the Yerköprü II and Yerköprü III travertine sites. Samples from Yerköprü I were found to be sterile (Figure 2). All identified Ostracoda are characteristic of freshwater habitats. The classifications according to Harthmann and Puri (1974) and Meisch (2000) are given below:

Subphylum Crustacea Pennant, 1777
Class Ostracoda Latreille, 1806
Subclass Podocopa Mueller, 1894
Order Podocopida Sars, 1866
Suborder Podocopina, Sars, 1866
Superfamily Cypridoidea s. str. Baird, 1845
Family Candonidae Kaufmann, 1900
Subfamily Candoninae Kaufmann, 1900

PLATE 1

Figure 1, 2. ***Limnocythere inopinata*** (Baird, 1843)

1. Left valve, external view. x120
2. Left valve, internal view. x95

Figure 3-7. ***Eucyprinotus rostratus*** (Sywula, 1965)

3. Left valve, external view. x80
4. Right valve, external view. x80
5. Left valve, internal view. x80
6. Right valve, internal view. x80
7. Left valve, dorsal view. x80

Figure 8-12. ***Psychrodromus olivaceus*** (Brady & Norman, 1889)

8. Left valve, external view. x70
9. Right valve, external view. x75
10. Left valve, internal view. x70
11. Left valve, dorsal view. x80
12. Right valve, internal view. x75

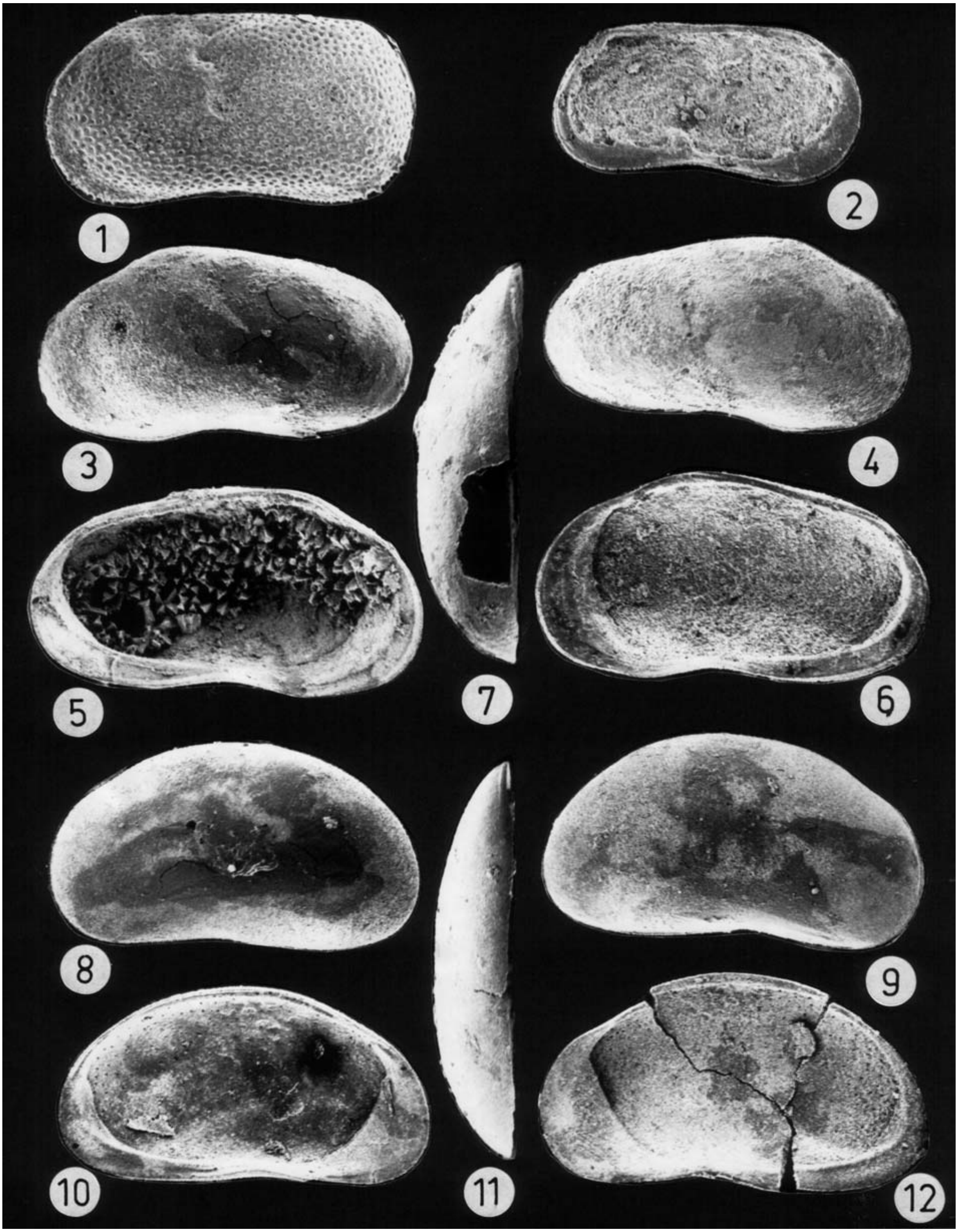
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PLATE 2

Figure 1-4. ***Psychrodromus*** sp. 1
1. Left valve, internal view. x120
2. Left valve, external view. x120
3. Right valve, internal view. x120
4. Right valve, external view. x70

Figure 5, 6. ***Scottia pseudobrowniana*** Kempf, 1971
5. Right valve, external view. x130
6. Left valve, external view. x120

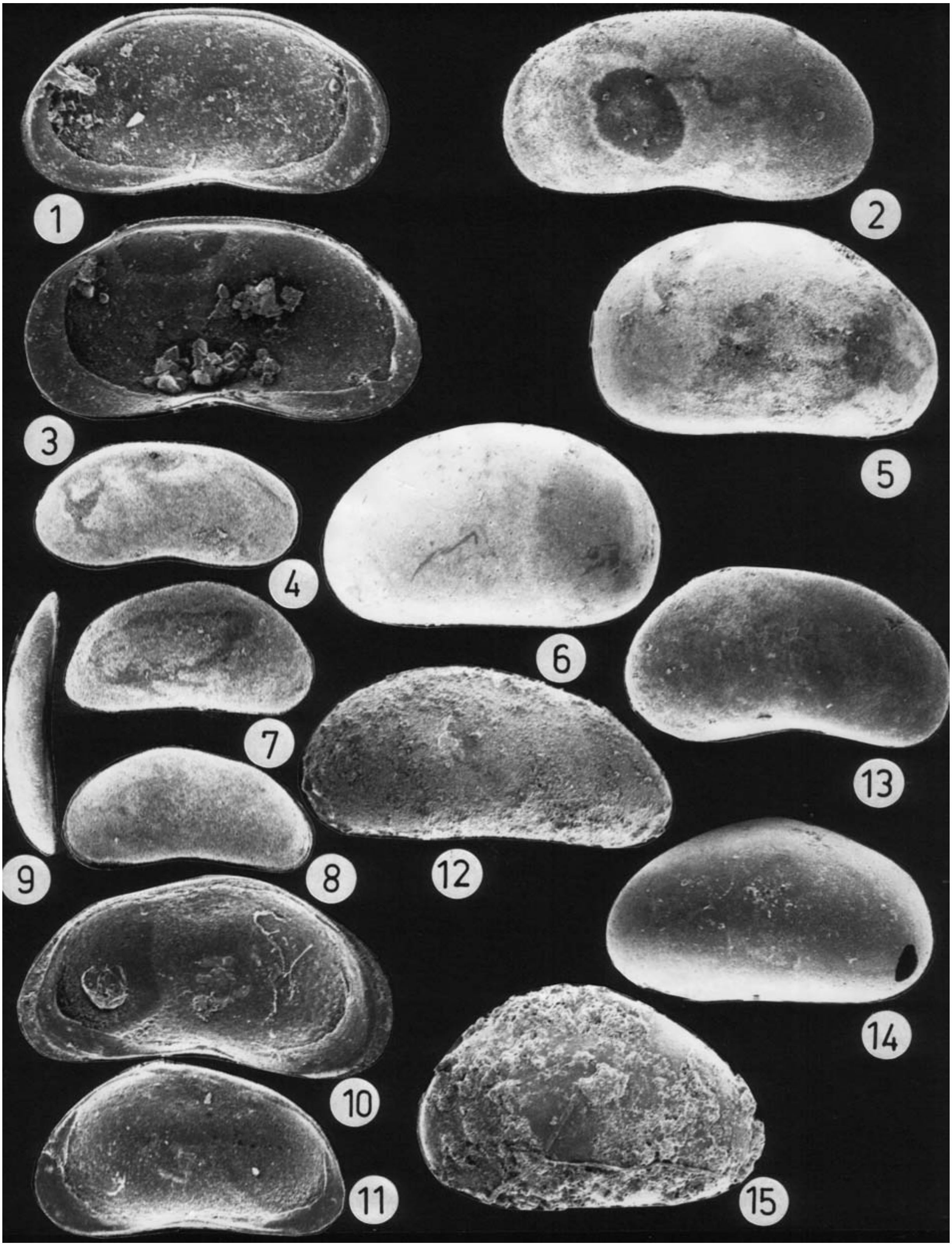
Figure 7-11. ***Potamocypris fallax*** Fox, 1967
7. Right valve, external view. x85
8. Left valve, external view. x85
9. Left valve, dorsal view. x85
10. Left valve, internal view. x120
11. Right valve, internal view. x110

Figure 12. ***Trajancypris*** sp. 1
Left valve, external view. x95

Figure 13. ***Candona neglecta*** Sars, 1887
Right valve, external view. x95

Figure 14. ***Heterocypris barbara*** (Gauthier & Brehm, 1928)
Left valve, external view. x140

Figure 15. ***Cypridopsis*** sp. 1
Left valve, external view. x80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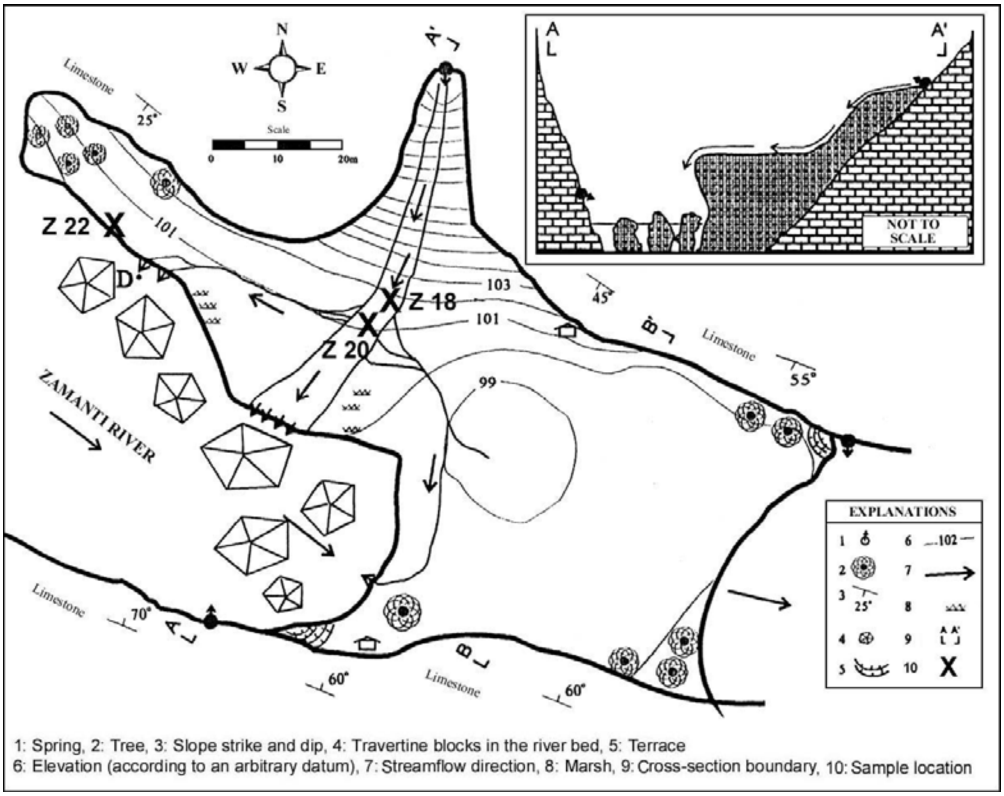
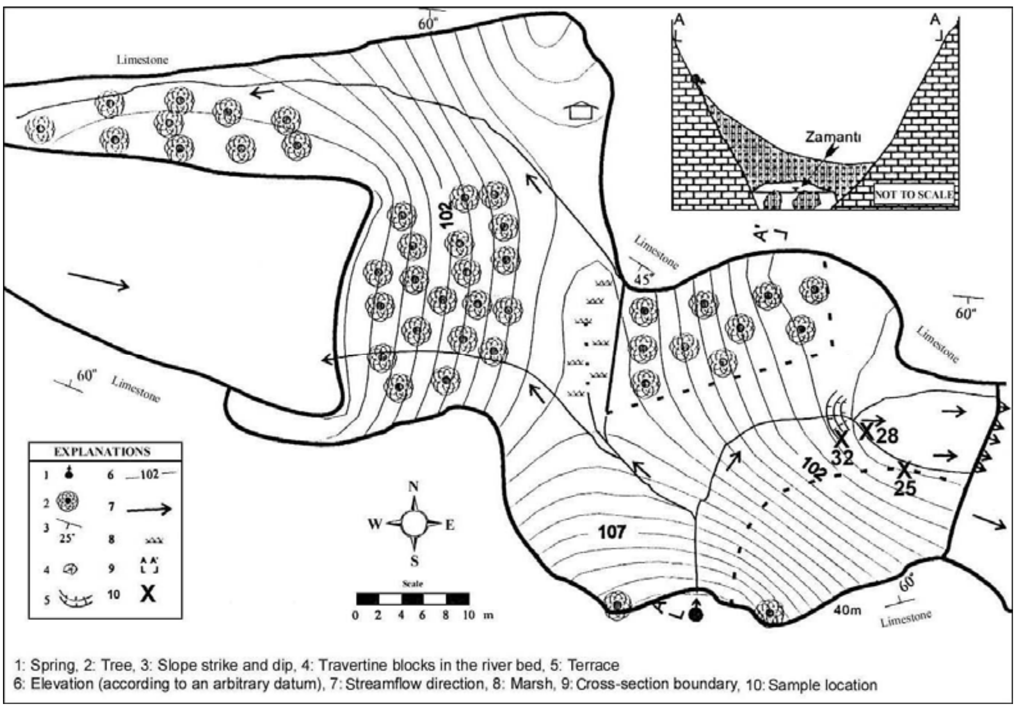


1: Spring, 2: Tree, 3: Slope strike and dip, 4: Travertine blocks in the river bed, 5: Terrace
6: Elevation (according to an arbitrary datum), 7: Streamflow direction, 8: Marsh, 9: Cross-section boundary, 10: Sample location

A



1: Spring, 2: Tree, 3: Slope strike and dip, 4: Travertine blocks in the river bed, 5: Terrace
6: Elevation (according to an arbitrary datum), 7: Streamflow direction, 8: Marsh, 9: Cross-section boundary, 10: Sample location

B

Figure 2. Geological and morphological maps of the travertine sites and sample locations. **A.** Yerköprü I travertine sites, **B.** Yerköprü II travertine sites

***Şekil 2.** Traverten alanlarının jeolojik ve morfolojik haritası ve örnekleme noktaları. **A.** Yerköprü I traverten alanı **B.** Yerköprü II traverten alanı*

C

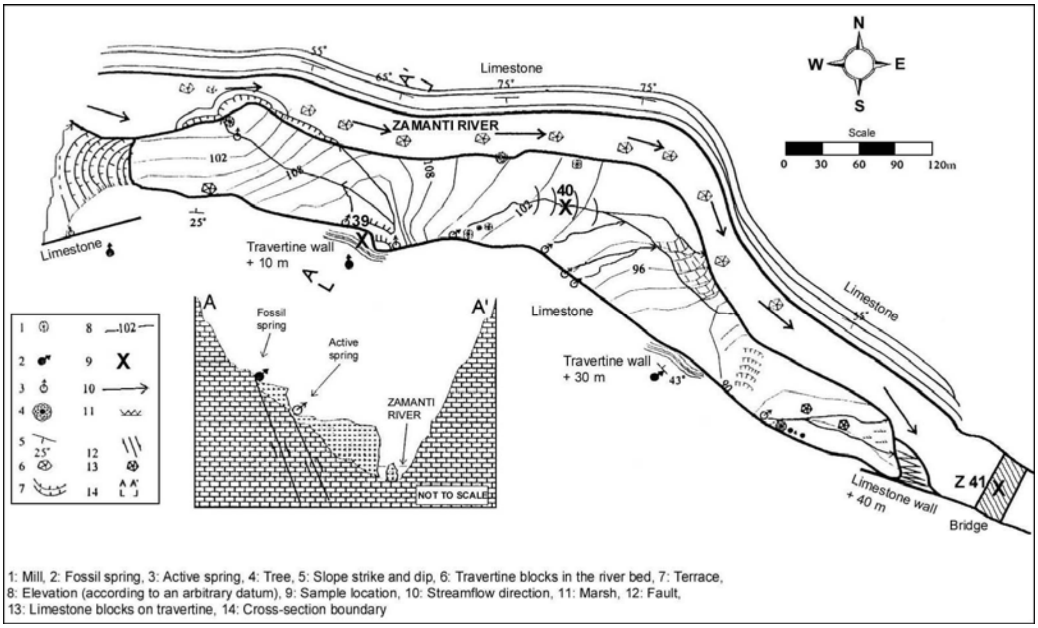


Figure 2. (Continued) **C.** Yerköprü III travertine sites.

Şekil 2. *(Devamı)* ***C.*** *Yerköprü III traverten alanı*

Genus **Limnocythere** Brady, 1868

Limnocythere inopinata (Baird, 1843)

Pl. 1 Figs. 1, 2

1843 *Limnocythere inopinata* Baird, Zoologist 1: 195.

1995 *Limnocythere inopinata* Baird, Griffiths, p. 15-17.

2000 *Limnocythere inopinata* Baird, Meisch, p. 427-432, figs. 175, 176.

2005 *Limnocythere inopinata* Baird, Scharf et al., pl. 2, figs. 29, 30.

Geographic and paleogeographic distribution: Austria, Croatia, the Czech Republic, Denmark, France, Germany, Hungary, Ireland, Italy, Netherland, Poland, the Slovak Republic, Sweden, Switzerland, Former Yugoslavia (Serbia) and the United Kingdom (cf. Meisch, 2000), Belarus (Nagorskaya & Keyser, 2005), Turkey (Külköylüoğlu, 2005; Külköylüoğlu and Dügel, 2004; Yılmaz and Külköylüoğu, 2006).

General stratigraphic level: Pleistocene-Holocene (cf. Meisch, 2000)

Locality and stratigraphic level in this study: Yerköprü II, sample number: 28, 25; Yerköprü III, sample number: 39, Holocene-Recent.

Family Cyprididae Baird, 1845

Subfamily Eucypridinae Bronshtein, 1947

Genus ***Trajancypris*** Martens, 1989

Trajancypris sp. 1

Pl. 2 Fig. 12

Definition: Carapace subclavate in lateral view, dorsal margin concave, ventral margin convex, anterior margin well rounded and slightly dropped to the ventral margin. Posterior margin narrow, well rounded and slightly dropped to the ventral margin. Valve surface smooth, muscle scars, hinge and marginal zone of genus character. Anterior end slightly beak-shaped in dorsal view.

Material: 2 valves

Dimensions: Length: 1.3 mm Height: 0.7 mm Width: 0.7 mm

Remarks: This species is similar to *Trajancypris clavata* (Baird, 1838), but the posterior margin of the *T. clavata* has not dropped to the ventral margin.

Locality and stratigraphic level in this study: Yerköprü II travertine site, sample number: 28, Holocene.

Genus ***Eucyprinotus*** Sywula, 1972

Eucyprinotus rostratus (Sywula, 1965)

Pl. 1 Figs. 3-7

1965 *Eucyprinotus rostratus* Sywula, 647-649, figs. 1-5.

1992 *Eucyprinotus rostratus* Sywula, Martens, Ortal & Meisch, p. 102, fig. 5 A-I

Geographic and paleogeographic distribution: *E. rostratus* is known in Poland and Israel (Martens et al., 1992).

General stratigraphic level:

Locality and stratigraphic level in this study: Yerköprü II (sample number: 32) and Yerköprü III (sample number: 40) travertine sites, Holocene-Recent.

Subfamily Scottiinae Bronshtein, 1947

Genus ***Scottia*** Brady & Norman, 1889

Scottia pseudobrowniana Kempf, 1971

Pl. 2 Figs. 5, 6

1971 *Scottia pesudobrowniana* Kempf, Eisz. Gegenw. 22: 45, figs. 1: D-H; 2:A-H.

1975 *Scottia pesudobrowniana* Kempf, Diebel & Pietrzeniuk, p. 36, Taf. III, figs. 10,11.

1983 *Scottia pesudobrowniana* Kempf, Wouters, p. 7, pl. 1, fig. 6.

2000 *Scottia pesudobrowniana* Kempf, Meisch, p. 366-369, fig. 153.

Geographic and paleogeographic distribution: *S. pseudobrowniana* is known from Belgium, Croatia, the Czech Republic, Germany, Hungary, Ireland, Poland, the Slovak Republic, Sweden and the United Kingdom recently (Griffiths, 1995; cf. Meisch, 2000).

General stratigraphic level: Pleistocene-Holocene (cf. Meisch, 2000).

Locality and stratigraphic level in this study: Yerköprü II (sample number: 25, 32) and Yerköprü III (sample number: 39, 40) travertine sites, Holocene-Recent.

Subfamily Herpetocypridinae, Kaufmann, 1900

Genus ***Psychrodromus*** Danielopol & Mc Kenzie, 1977

Psychrodromus olivaceus (Brady & Norman, 1889)

Pl. 1 Figs. 8-12

1889 *Erpetocypris olivacea,* Brady & Norman, Sc. Trans. Roy. Dublin Soc. Ser. 2, 4 (2): 89; pl. 8: 3, 4.

1983 *Psychrodromus olivaceus,* Brady & Norman, Wouters, p. 5, pl. 1, fig. 3.

1995 *Psychrodromus olivaceus,* Brady & Norman, Griffiths, p. 76.

2000 *Psychrodromus olivaceus,* Brady & Norman, Meisch, p. 336-338, fig. 141.

Geographic and paleogeographic distribution: Belgium, the Czech Republic, France, Germany, Hungary, Ireland, Italy, Poland, Spain and the United Kingdom (cf. Meisch, 2000), Belarus (Nagorskaya and Keyser, 2005). *P. olivaceous* is also reported from Slovenia (Griffiths and Brancelj, 1996), and Turkey (Sarı-Karakaş and Külköylüoğlu, 2007).

General stratigraphic level: Middle Pleistocene-Holocene (cf. Meisch, 2000)

Locality and stratigraphic level in this study: Yerköprü II (sample number: 28) and Yerköprü III (sample number: 40, 41) travertine sites, Holocene-Recent.

Psychrodromus sp. 1

Pl. 2 Figs. 1-4

Definition: Valves kidney or bean shaped in lateral view, dorsal margin straight or slightly concave, ventral margin convex at the center, anterior margin well rounded and dropped towards ventral margin, posterior margin well rounded, marginal zone very thick, hinge, muscle scars and marginal zone are genus character, valve surface smooth

Material: 10 valves

Dimensions: Length: 1.0 mm Height: 0.5 mm Width: 0.5 mm

Remarks: *Psychrodromas* sp. 1 differs from *Psychrodromus olivaceous* (Brady & Norman, 1889) and *Psychrodromus fontinalis* (Wolf, 1920) by having a very wide and broad anterior and posterior margin.

Locality and stratigraphic level in this study: Yerköprü II (sample number: 25, 28) and Yerköprü III (sample number: Z 41) travertine sites, Holocene-Recent.

Genus ***Heterocypris*** Claus, 1893

Heterocypris barbara (Gauthier & Brehm 1928)

Pl. 2 Fig. 14

1928 *Heterocypris barbara* Gauthier & Brehm, Bull. Soc. Hist. Nat. Afr. Nord 19, 114, pl. 12-13.

1961 *Heterocypris barbara* Gauthier & Brehm, Beldescu, Com. Acad. Republ. Pop, Romine, 11, 8, 939, figs.1-3.

2000 *Heterocypris barbara* Gauthier & Brehm, Meisch, Freshwater Ostracoda, s. 352-353, Fig. 147.

Geographic and paleogeographic distribution: Widely distributed in the circum Mediterranean area. Recorded from Hungary, Germany, Algeria, Tunisia, Morocco, Poland, Spain, the Czech Republic (cf. Meisch, 2000).

General stratigraphic level: Recent (Meisch, 2000).

Locality and stratigraphic level in this study: Yerköprü II (sample number: 28) and Yerköprü III (sample number: 41) travertine sites, Holocene-Recent.

Subfamily Cypridopsinae Kaufmann, 1900

Genus ***Potamocypris*** Brady, 1870

Potamocypris fallax (Fox, 1967)

Pl. 2 Figs. 7-11

1967 *Potamocypris fallax* Fox, J. Nat. Hist. 4: 555, fig. 5b-d, g.

1984 *Potamocypris fallax* Fox, Meisch, p. 39-42, figs. 12,13

1995 *Potamocypris fallax* Fox, Griffiths, p. 72, 73.

2000 *Potamocypris fallax* Fox, Meisch, s. 406, 407, fig. 167.

Geographic and paleogeographic distribution: *P. fallax* is known from the United Kingdom, Scotland, Poland, Russia, Germany, Slovenia and Turkey (Meisch, 1984; cf. Meisch, 2000). Also this species is reported from Spain, the Czech Republic, Ireland and Bulgaria (Griffiths, 1995). The species mosty inhabits springs and waters flowing from springs. Besides, fossil specimens of *P. fallax* have been recorded from Quaternary (Late and Post glacial) sediments in Russia and Germany (Meisch, 1984).

General stratigraphic level: Middle Pleistocene-Holocene (Meisch, 2000)

Locality and stratigraphic level in this study: Yerköprü II (sample number:25, 28) and Yerköprü III (sample number: 40, 41) travertine sites, Holocene-Recent.

ENVIRONMENTAL INTERPRETATION

All ostracode species identified from travertine samples are benthic, bottom-dwellers. Three of them (i.e. *Eucyprinotus, Potamocypris, Psychrodromus*) are mobile and crawl over substratum. It seems that the ostracode species in the Yerköprü travertines lived mostly in the low-energy parts of the streams where the thalweg slope is relatively gentle and the flow velocity is slow compared to the cascading parts.

It can be argued that the existence of similar species in European countries (cf. Meisch, 2000), Israel (Martens et al., 1992) and in Turkey is due to the indirect transportation of ostracode species by birds migrating between Europe and Africa (Figure 3, Erdem, 1994, 1995). The region where the studied travertines are located is at the junction of different bird migration routes (Figure 3). The migration routes from Europe, Southern Russia, the Black Sea and Caucasus cross over at a distance of 40 km to the north of the study area and turn into a single route which goes to Africa via Egypt

(Erdem, 1994, 1995). The Sultansazlığı shallow lake which is located 40 km to the northwest of the travertine sites, is among the major stop-over sites for the migrating birds (Erdem, 1994, 1995). Therefore, the travertine sites are assumed to have been visited by these birds during migration periods, although no such event has been observed during field studies

OTHER MICROFAUNAL AND FLORAL COMMUNITY

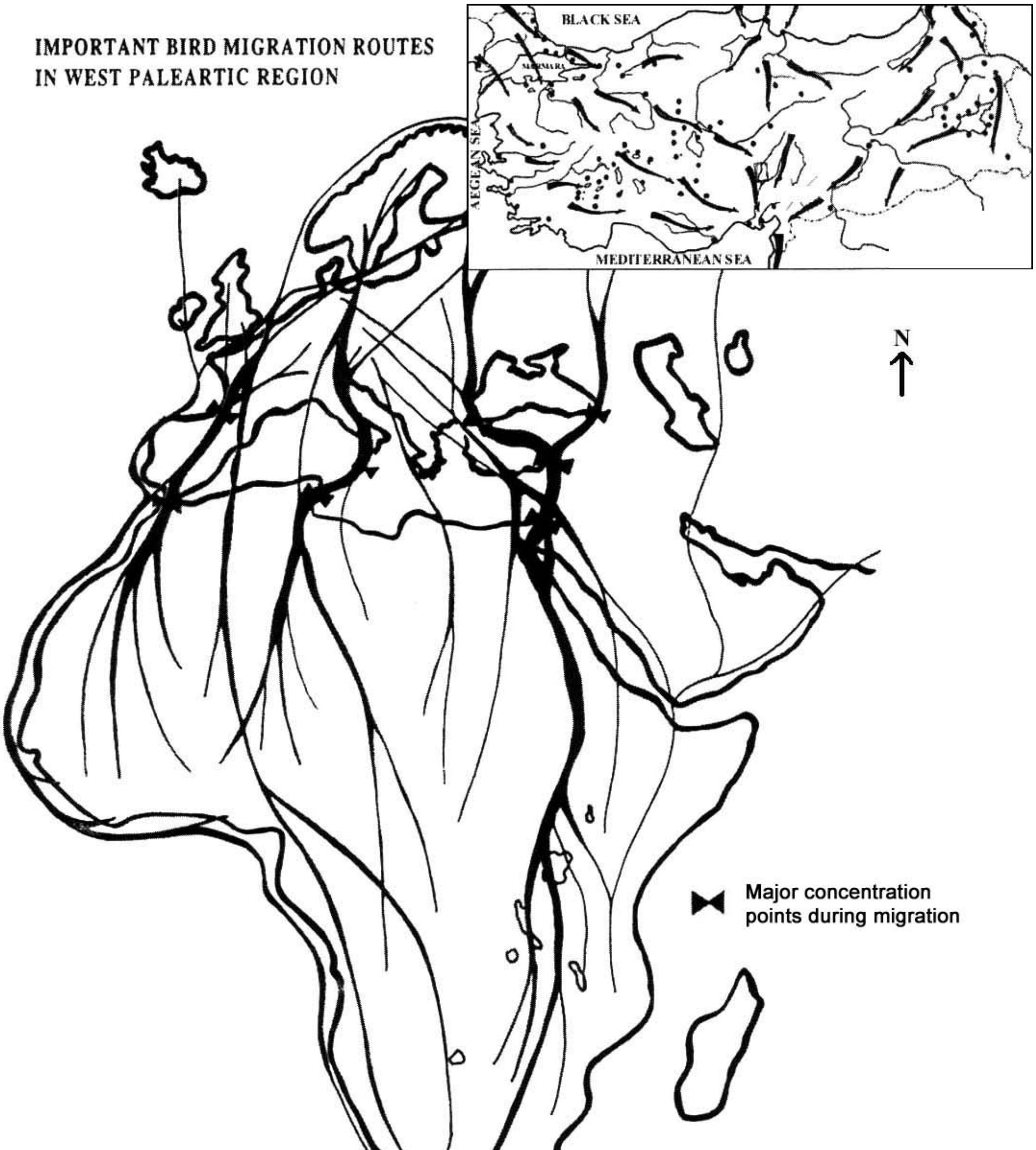


Figure 3. *Bird Migration routes over Turkey (Erdem, 1994,1995. Autumn migration).*

Şekil 3. *Türkiye göçmen kuşları göç yolları (Erdem, 1994,1995. Sonbahar göçü).*

Algae live mostly and are abundant in all carbon-dioxide rich terrestrial waters. Many karstic springs having high carbon-dioxide contents (over $logP_{CO2} = 10^{-2}$ atm) are rich in algal flora. Most of the algae identified belong to the classes *Cyanophyceae* (blue-green algae), *Chlorophyceae* (green algae) and *Bacillariophyceae* (diatoms). One species, from the *Euglenophyceae* and *Xantophyceae* classes, were also identified. Due to the problems which arose in sample preservation, only four genera could be identified to species level (*Lyngbya incrustatum, Nostoc verrucosum, Cocceneis placentula* and *Meridon circulare).* Among the algae identified in travertine sites, blue-green algae *Oscillatoria* sp., *N. verrucosum,* green algae *Cladophora* sp., diatoms *Cocceneis placentula, Cymbella* sp. *Diatoma* sp., *Gomphonema* sp., *Mastoglia* sp., *M. circulare, Navicula* sp., *Xanthophyceae* sp., and *Vaucheria* sp. (determined by Dr. Haluk Soran) were found to be very abundant. Most of the algal species identified in travertine sites are of a filamentous and siphonaceous morphology.

GENERAL GEOGRAPHICAL DISTRIBUTION OF OSTRACODE IN THIS STUDY

The study of three travertine sites located in the Eastern Taurides, Southern Turkey has revealed that these sites are inhabited by Ostracoda and algal species which are also observed in similar sites elsewhere in the world where similar environmental conditions prevail. Ten Ostracoda species of nine genera that have been identified from the travertine sites have also been reported in some European countries and Israel (cf.

Meisch, 2000). Possibly this implies that these species might have been transported by migrating birds (Erdem, 1994) which stop over in aquatic sites distributed along the migration route.

The climate dominating over the travertine sites is of a Mediterranean type, and this mild climate provokes both faunal and floral life. Due to intensive rainfalls and groundwater flow, the travertine sites are always kept wet.

Water is mainly supplied to the travertine sites via karstic springs which discharge unpolluted natural water with a substantial carbon-dioxide content. Together with the mild climate, the high carbon-dioxide content of travertine-forming creeks seems to be one of the major factors that provoke algal life.

E. rostratus has been previously reported to exist in Mammila Pool, Israel (Martens et al., 1992). *Potomocypris* and related species are known to inhabit streams and ponds with alkaline waters having a pH ranging between 7-9 (Dolermo, 1990). The *Potomocypris* species are known to inhabit similar environmental conditions in England, Belgium, Poland, Hungary and France (Griffiths et al., 1993). Roca and Balton’s (1993) studies of springs in the Spanish Pyrenees indicated that *P. olivaceous* and a species are characterictic of cool, solute-rich waters. These environments have also been reported to have no substantial annual climatic variations. Griffith et al. (1993) states that *P. olivaceous* seems to dominate in the lowlands of South Wales. *P. olivaceous* is also the dominant species in the travertines investigated. *P. olivaceous, Potamocypris fallax* and *L. inopinata* has been observed by Özuluğ (2005) in some dams in the Istranca Region of Thrace (NW of Turkey).

It can be argued that the existence of similar species in European countries and in Turkey is due to the migration of birds. The area where the studied travertines are located is at the junction of different bird migration routes. The migration routes from Europe, Southern Russia, the Black Sea and Caucases crosses over the study area and turn into a single route which going to Africa via Egypt.

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GENİŞLETİLMİŞ ÖZET

Zamantı Irmağı üzerinde yer alan karstik traverten çökellerinde yarı güncel ostrakod topluluğunun varlığı tespit edilmiştir. 3 familyaya ait 8 cins ile ilgili, 7 bilinen tür ve isimlendirmeye açık 3 tatlısu ostrakod taksonu olmak üzere toplam 10 ayrı takson tanımlanmıştır. Saptanan ostrakodlar: Limnocythere inopinata, Eucyprinotus rostratus, Psychodromus olivaceous, Scottia pseudobrowniana, Potomocypris fallax, Candona neglecta, Psychodromus sp., Trajancypris sp. Heterocypris barbara ve Cypridopsis sp. dir). Zamantı Irmağı üzerinde birbirine yakın 3 ayrı traverten oluşum noktalarından derlenen traverten örneklerinden elde edilen ostrakod faunası sistematik olarak tanımlanmış ve travertenleri oluşturan kaynak suların kimyasal ve fiziksel özellikleri ve diğer fauna ve flora topluluğu ile birlikte değerlendirilerek ortamsal yoruma gidilmiştir. Ayrıntılı güncel iklimsel ve hidrokimyasal koşullar ortaya konulduğunda ortamsal şartların ifade bulduğu koşullar içinde Ostrakoda faunası ile diatome (Bacillariophyceae), yeşil alg (Chlorophyceae) ve mavi-yeşil alg (Cyanophyceae) flora topluluğu baskın durumdadır. Kaynaktaki yüksek karbondioksit içeriği de ortamda alg topluluğunun gelişimini desteklemektedir. Söz konusu alandaki ostrakodların varlığı, gerek Avrupa ve gerekse Ortadoğudaki dağılımı ve yayılımı göz önüne alındığında, Zamantı Irmağının bulunduğu bölgenin Türkiye üzerinden gerçekleşen ana kuş göç yolu üzerinde bulunması nedeni ile ostrakodların bu bölgeye kuşlar aracılığı ile taşındığı düşüncesini getirmektedir.

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