Limnoecological characteristics and seasonal distribution of Ostracoda (Crustacea) in a natural lake (Lake Karagöl) and a man-made reservoir (Lake Uşak) in northeastern Turkey

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Abstract. In order to compare the seasonal distribution and limnoecological characteristics of non-marine Ostracoda from a natural lake (Lake Karagöl) and a man-made (Lake Uşak) reservoir in northeastern Turkey, monthly samples were collected from 8 sites from May 2015 to July 2016. Lake Uşak exhibited a two times higher salinity than Lake Karagöl. The two water bodies were found to harbour different species assemblages. While five taxa (*Cypridopsis vidua*, *Ilyocypris bradyi*, *Limnocythere inopinata*, *Prionocypris* cf. *zenkeri*, *Pseudocandona* sp.) were collected from Lake Karagöl, four species (*Candona sanociensis*, *Cypria ophtalmica*, *Herpetocypris chevreuxi* and *Tonnacypris lutaria*) were found in Lake Uşak. All species are new records for the region. The total number of species (alpha diversity) for each of the two lakes is much lower than the average species number (ca. 13.2) in lake ecosystems in general. *Limnocythere inopinata* and *C. ophtalmica* were the most frequently occurring species in Lake Karagöl and Lake Uşak. Finding a male of *I. bradyi* was important to note since bisexual populatons of this species are very rare. According to the Ostracod Watch Model (OWM), with the exception of *C. ophtalmica* which has a eurychronal occurrence, all the species recorded from the two lakes showed stenochronal occurrences, with species richness highest in autumn. SIMPER Analyses comparing numbers of species among 13 other Turkish lakes revealed that *C. vidua* was the most frequently occurring species in these lakes. Jaccard's similarity analysis and UPGMA results showed that Lake Karagöl and Lake Gölcük clustered together, thus showing close relationships. Overall, results suggest that ostracod species diversity was very low in both lakes.

Keywords. Ostracoda, Ostracod Watch Model, seasonal distribution, alpha-beta diversity, stenochronal, euchronal, Turkey.

1. Introduction

Ostracods are small microscopic bivalved crustaceans with a pair of valves called the carapace which is primarily composed of $CaCO_3$. The soft body parts are placed inside of the carapace. Ostracods are found living in almost all aquatic (lakes, ponds, troughs, streams, river, sea water, etc.) and even (semi-)terrestrial environments. Also, they can contribute strong insight into our understanding of ecology, hydrology and chemistry of different aquatic systems (Wise 1961, Scharf 1998, Külköylüoğlu & Vinyard 1998, Nagorskaya & Keyser 2005). Besides, ostracods can show the ways of active (e.g., using swimming setae) and passive dispersion (e.g., birds, fish, wind, water flow) to extend their distribution among water bodies (Proctor 1964, Vinyard 1979, Pérez et al. 2010, Scharf et al. 2016).

Non-marine ostracods display different tolerance and optimum levels to changing environmental conditions. In general, species shows species-specific responses to the fluctuations in water chemistry. Hence, if ecological tolerance levels of the species are known, estimating past, present and future

habitat conditions can be possible by means of reconstructing the history of the area (Wise 1961, Benson 1990, Delorme 1991). Thus, ostracods can be bioindicators of aquatic ecosystems (Külköylüoğlu, 2005a, b, Akdemir 2008). To determine biodiversity over spatial scales, Whittaker (1972) introduced the following three terms: alpha (α, local diversity), beta (β) and gamma (γ, regional diversity) diversity. While α diversity refers to diversity within a distinct area or ecosystem, β diversity is basically the difference between gamma diversities of two or more regions (Wilson & Shmida 1984, Magurran 1988, Ås 1999, Clarke & Lidgard 2000). Knowledge of beta diversity provides understanding of species habitat usage and comparison of the degrees of habitat diversities. Gamma diversity evaluates overall diversity within a large region (Harrison et al. 2004). Külköylüoğlu et al. (2017a,b,c) clearly underlined importance of species diversity that can be measured by different methods (McIntosh 1967, Whittaker et al. 1979, Magurran 1988, Zar 1999, Lande 1996, Novotny & Missa 2000).

Although studies on diversity measurements of various aquatic organisms are common, such studies are relatively few and far from reaching a general conclusion about seasonal occurrences of ostracods (Martens 1998, Martens & Ortal 1999, Nagorskaya & Keyser, 2005, Higuti et al. 2009, Külköylüoğlu et al. 2012) due to short-term sampling efforts. However, it is well known that many freshwater ostracods exhibit seasonal occurrences in particular habitats where the ostracod diversity can be changed seasonally (Külköylüoğlu 1998, 1999). Therefore, without seasonal samplings, a complete species diversity estimate cannot be achieved in fluctuating water bodies. Besides seasonality, species diversity can also be depending on habitat types (natural or artificial). Accordingly, higher species diversity can be expected in natural water bodies than in artificial ones, but this may not be always true (Külköylüoğlu 2009, Külköylüoğlu et al. 2017a,b). Until now, there is no study on the seasonality of ostracods and diversity comparison between a natural lake and a man-made lake within the same sampling period. The aims of this study are to (1) understand ostracod species diversity of Lake Karagöl (a natural lake) and Lake Uşak (a man-made reservoir) in northwestern Turkey, (2) obtain knowledge about seasonal distribution of species in the study sites, and (3) provide the first limnoecological characteristics of these species.

2. Material and methods

2.1. Site description

Lake Karagöl (40°21'22" N, 31°55'26" E) is a natural lake on the border of the Bolu and Ankara provinces and placed nearly 22 km of Kıbrıscık District and 86 km of Bolu center province. The lake is located at 1424 m a.s.l., it has about 4 ha of surface area and about 121×103 m^3 of volume (Fig. 1, this study, pers. comm.). The maximum depth is 6.37 m. While maximum length is nearly 450 m, maximum width is 195 m. Secchi disk depth of the lake was about 100 cm in June 2016. Closer to the northern end, there is a small island covered by macrophytes such as *Phragmites* sp., *Polygonum* sp., *Typha* sp. and *Myriophyllum* sp. The lake is mainly fed by rainfall and snowmelt. There are five bungalov houses around the lake for accommodation. The closest settlements to the lake are the villages Köseler and Deveci which are nearly 5.8 km away from the lake. An asphalt road provides easy access to the lake. This small and shallow lake is also used by local fishermen. In 1986, members of the Department of Forestry had done some deepening work on the lake but details of that activity are not known (Doğan Dağ, pers. comm.). In the summer months, the municipality of Kıbrıscık organizes a festival around the lake.

Lake Uşak (40°20'41" N 31°55'43" E) is a man-made shallow reservoir (ca. 2 m of depth) fed by both two temporary rheocrene springs and rainfall. Lake Uşak is located at about 1540 a.s.l. and about 2 km south-east of Lake Karagöl (Fig. 2). The maximum length of the lake is about 250 m when the maximum width is about 130 m. This aquatic habitat is called by local people a "göl" (lake but is better described as a shal-

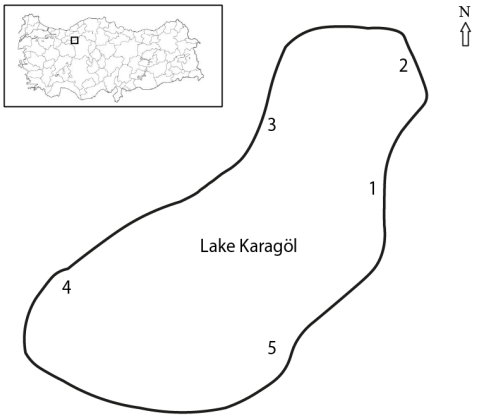


Fig. 1. Lake Karagöl with sampling sites.



Fig. 2. Lake Uşak with sampling sites.

low wetland or pond. Most of the surface area of the lake is covered by *Lemna minor*, the common duckweed.

2.2. Sampling

Samples were randomly collected monthly between May 2015 and July 2016 from the littoral zone of Lake Karagöl (five sites, Fig. 1) and Lake Uşak (three sites, Fig. 2). In December 2015, only three samples were taken from sites 1, 3 and 4 because of partial ice coverage; for the same reason, there was no sampling in January 2016 in Lake Karagöl and in December 2015 in Lake Uşak.

Before sampling, nine environmental variables (pH, dissolved oxygen (DO, mg/L), oxygen saturation (% DO, mg/L), electrical conductivity (EC, µS/cm), specific electrical conductivity (Spec. Ec., µS/cm), water temperature (T°C), total dissolved solids (TDS, mg/L), salinity (ppt) and atmospheric pressure (mm-Hg)) were measured in situ with YSI Professional Plus DO-meter. Wind (m/s), moisture (%) and air temperature (°C) were recorded with Kestrel 3000 Anemometer while geographical data (coordinates and elevation) were recorded with a GPS-device (Garmin E-Trex 30).

Sediments were collected with a standard hand net (200 µm mesh size) from the littoral zone of the lakes at 1 m^2 area and not more than 100 cm of depth. We kept samples in 250 ml plastic jars and fixed with 70 % of alcohol *in situ*. Collected samples were brought to the laboratory and washed under tap water to clean up the sediments through three standard sieves (0.250, 1.00 and 2 mm of mesh size). The remaining sediment was put into plastic jars and fixed with 70% ethanol. Ostracods were identified on both soft body parts and carapace structures (see details in Meisch 2000). Taxonomic identification was done under the light microscope (Olympus BX-51). Dissections were mounted in lactophenol solution for permanent storage. The slides are housed in the Limnology Laboratory of the Biology Department of the Bolu Abant İzzet Baysal University. Lake bathymetric measurements were done at seven sites from a plastic boat on 26 June 2016. Measurements were done with a robe tied to an Ekman Grab. Secchi disk depth was taken with a standard Secchi disk. Depths of contour lines were determined with Netcad v.5 program.

2.3. Statistical analyses

The Ostracod Watch Model (OWM) (Külköylüoğlu 1998) was used to show ostracod species' monthly and seasonal distribution. In order to compare seasonal changes in ostracod species diversity (alpha and beta diversity), 11 other similar types of water bodies (i.e., Lake Abant, Aladağ dam, Lake Büyükçekmece, Lake Küçükçekmece, Gölcük reservoir, Gölköy reservoir, Lake Çubuk, Lake Sünnet, Şamlar reservoir, Lake

Yeniçağa, Taşlıyayla dam) were compared by means of using ostracod binary data set. Our criteria of choosing these water bodies was based on the sampling period: either monthly or seasonal (one sample per season in a year) samplings had previously been conducted in the mentioned lakes above (Dügel et al. 2008, Yılmaz & Külköylüoğlu 2006, Külköylüoğlu et al. 1995, Külköylüoğlu et al. 1993, Külköylüoğlu & Dügel 2004, Külköylüoğlu 2005b, Külköylüoğlu et al. 2014, Külköylüoğlu et al. 2010, Külköylüoğlu 1998, Külköylüoğlu et al. 2007, Külköylüoğlu et al. 2017, respectively). Species Diversity and Richness program version 4.2 (Seaby & Henderson 2006) was used to estimate alpha and beta diversity. Shannon-Wiener (S-H) diversity index was used to compare diversity values among the two lakes. Critical level of S-H ranges between 1.5 and 3.5 (Magurran 1988). For beta diversity measurements, we used Whittaker's βw, Cody βc, Routledge βr, βi, and βe, Wilson & Shmida βt, Harrison 1 and Harrison 2 tests in SDR program. Whittaker βw test was used because of its most wide usage. The critical values of Whittaker βw test range from low (1) to high (10) (Koleff et al. 2003). Community Analysis Package version 4.1.3 (Seaby & Henderson 2007) was used for (1) SIMPER Within Analysis to find out the amount of contribution of each species to the observed dis/similarity values among lakes, (2) Jaccard's Similarity for comparison and diversity of 13 lakes. Multivariate Statistical Package version 3.1 (Kovach 1998) was applied along with Unweighted Pair Group Method with Arithmetic Mean (UPGMA) tested by Jaccard's coefficient analysis to see clustering relationships among 13 lakes, including the lakes Karagöl and Uşak.

3. Results

Water quality measurements (Table 1) were compared between the two lakes studied. Accordingly, mean salinity values were found at least two times higher in Lake Uşak than Lake Karagöl. Comparing the mean pH values, Lake Uşak is very slightly acidic (pH 6.96) while Lake Karagöl shows alkaline (pH 7.83) water characteristics. Also, the mean water temperature value was found to be higher in Lake Karagöl (16.41°C) than in Lake Uşak (13.06°C). Lake Karagöl was mostly covered by ice about two months during winter season while ice formation was mostly effective around Lake Uşak.

Five ostracod taxa (*Cypridopsis vidua, Ilyocypris bradyi, Limnocythere inopinata, Prionocypris* sp., *Pseudocandona* sp.) were collected from Lake Karagöl while four species (*Candona sanociensis, Cypria ophtalmica, Herpetocypris chevreuxi and Tonnacypris lutaria*) were found in Lake Uşak. The finding of males of *I. bradyi* in October 2015 in Lake Karagöl is important to underline because of the rare occurrence of bisexual populations of that species (Table 2). All

Table 1. Maximum (Max), minimum (Min) and mean values of nine environmental variables for both lakes (Karagöl and Uşak). Abbrevations: DO, dissolved oxygen (mg/L); EC, electrical conductivity of water (μS/cm); SEC, specific electrical conductivity at 25 °C (μS/cm); Tw, water temperature (°C); ORP, oxidation reduction potential (mV); Sal, salinity (ppt); TDS, total dissolved solids in water (mg/L); AtmP, atmospheric pressure (mmHg).

Lake Karagöl	pH	DO	EC	SEC	Tw	ORP	Sal	TDS	AtmP
Max	9.43	20.14	182.3	265	31	375	0.13	193.6	650.2
Min	5.57	2.4	49.5	74.1	1.3	41.4	0.03	48.1	622.2
Mean	7.83	7.84	109.9	131	16.41	178	0.06	86.62	644.3
Lake Uşak	pH	DO	EC	SEC	Tw	ORP	Sal	TDS	AtmP
Max	9.06	18.38	739.2	558	27.5	268	0.28	370.5	639.7
Min	6.07	0.72	48.7	69.5	5.4	-23	0.03	21.6	631.4
Mean	6.96	6.013	188.5	225	13.06	101	0.11	140.64	635.5

Table 2. Monthly numbers of live and adult individuals found in Lake Karagöl and Lake Uşak. Species Code: *Cypridopsis vidua*, Cv; *Ilyocypris bradyi*, Ib; *Limnocythere inopinata*, Li; Co, *Cypria ophtalmica*; Tl, *Tonnacypris lutaria*; Cs, *Candona sanociensis*; Hc, *Herpetocypris chevreuxi*. Specimens not identified at species level are not included.

Months	Cv	Ib	Li	Co	Tl	Cs	Hc
May-15	3		12				
Jun-15	8		3	19			
Jul-15	1		1	35			
Aug-15			1				
Sep-15	5		12	133		9	
Oct-15	75	1	7	207		15	42
Nov-15	60		139	104			2
Dec-15							
Jan-16				152		35	
Feb-16							
Mar-16				87	3	12	
Apr-16			1	161		9	6
May-16				77		3	1
Jun-16				89		12	
Jul-16	1		2	64	1		

Table 3. Shannon-Wiener Alpha Diversity Results of 13 lakes.

Lakes	H	Variance H	Exp H
Karagöl	1.099	0.111	3
Uşak	1.386	0.093	4
Gölköy	2.485	0.038	12
Çubuk	2.708	0.031	15
Sünnet	2.303	0.045	10
Aladağ	1.946	0.061	7
Abant	2.639	0.033	14
Gölcük	1.792	0.069	6
Yeniçağa	2.565	0.035	13
K.Çekmece	2.398	0.041	11
B.Çekmece	2.773	0.029	16
Şamlar	2.639	0.033	14
Taşlıyayla	2.079	0.054	8
All Sample Index	3.573		
Jackknife Std Error	0.1048		

Table 4. Beta diversity measurements from 13 aquatic bodies.

Index	Beta Diversity
Whittaker βw	4.526
Cody βc	47.5
Routledge βr	1.361
Routledge βi	1.157
Routledge βe	3.181
Wilson & Shmida βt	5.357
Harrison 1	32.33
Harrison 2	14.73

the species mentioned are new records for this region. In Lake Karagöl, while *C. vidua* and *L. inopinata* (most frequently occurring species there) were seen in three seasons (spring, summer and autumn), *I. bradyi* was only found in autumn, suggesting a stenochronal occurrence of that species (Fig. 3). Similarly, two of the species (*H. chevreuxi* and *C. sanociensis*) from Lake Uşak revealed stenochronal occurrences, while *T. lutaria* was encountered only once in March and July 2016. In contrast, *C. ophtalmica* was reported almost all the year round, indicating a euchronal occurrence in Lake Uşak. In general, species occurrence along with numbers of species and individuals was higher in autumn comparing to other seasons. There were no ostracod species observed in three months (December, February and March) during the sampling period.

Shannon-Wiener (S-H) alpha diversity results are given for 13 lakes (Karagöl and Uşak (this study), Abant (Dügel et al. 2008), Çubuk (Külköylüoğlu et al. 2014), Aladağ (Yılmaz & Külköylüoğlu 2006), Sünnet (Külköylüoğlu et al. 2010), Büyükçekmece (Külköylüoğlu et al. 1995), Küçükçekmece (Külköylüoğlu et al. 1993), Şamlar (Külköylüoğlu 1998), Taşlıyayla (Külköylüoğlu et al. 2017), Gölköy (Külköylüoğlu 2005b), Gölcük (Külköylüoğlu & Dügel 2004) and Yeniçağa(Külköylüoğlu et al. 2007)) are presented in Table 3. The S-H diversity value (1.01) of Lake Karagöl was the lowest of all the lakes considered. For beta diversity measurements, the Whittaker βw value was 4.526 (Table 4).

Table 5. SIMPER Within Analysis Results of 13 lakes and reservoirs. Average similarity was 21.98. Abbrevations: Av. Abund., Average Abundance; Av. Simil., Average Similarity; % Contribution, Percent Contribution; Cumulative %, Cumulative Percentage.

Name	Av. Abund.	Av. Simil.	% Contribution	Cumulative %
Cypridopsis vidua	0.8	6.139	27.919	27.919
Limnocythere inopinata	0.533	2.962	13.471	41.391
Physocypria kraepelini	0.533	2.088	9.498	50.889
Candona neglecta	0.400	1.227	5.584	56.473
Eucypris virens	0.400	1.162	5.285	61.759
Tonnacypris lutaria	0.333	0.928	4.221	65.980
Candona candida	0.333	0.873	3.972	69.953
Ilyocypris bradyi	0.333	0.846	3.848	73.802
Cypria ophtalmica	0.333	0.819	3.728	77.530
Darwinula stevensoni	0.333	0.805	3.664	81.195
Heterocypris incongruens	0.333	0.759	3.454	84.650
Prionocypris zenkeri	0.333	0.706	3.213	87.863
Herpetocypris chevreuxi	0.266	0.642	2.921	90.784

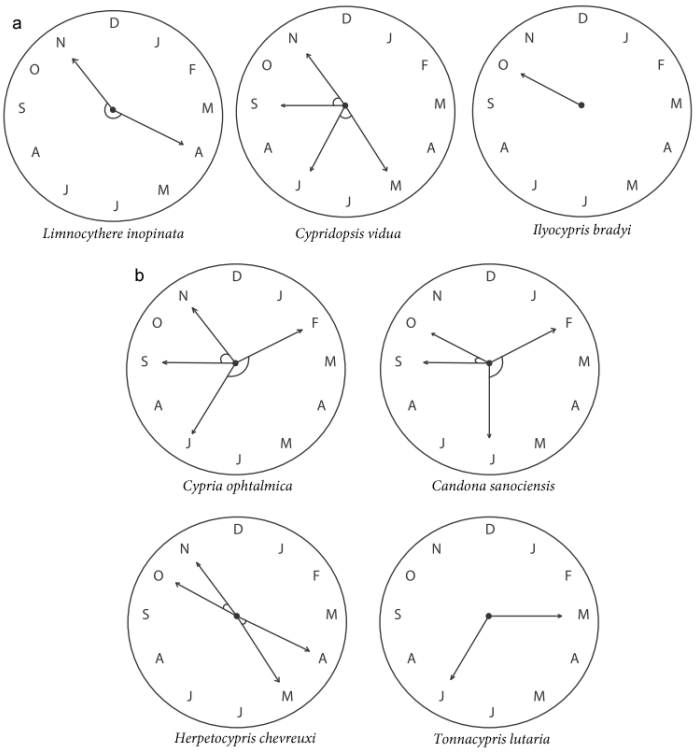


Fig. 3. Ostracod Watch Models (OWM) for a) three ostracod species found in Lake Karagöl and b) four ostracod species found in Lake Uşak. Capital letters (D, J, F, etc.) represent the first letter of each month, such as December, January, February, etc. The angles between the arrows represent occurrence of the species within two or more months.

SIMPER within the analysis using the Bray-Curtis measure of similarity (Table 5) explains the contribution of each species to the observed dis/similarity between the lakes. With a contribution of 27.92%, *C. vidua* was the most frequent species in all 13 lakes followed by *L. inopinata* and *I. bradyi* with 13.47 and 3.84 % contributions, respectively. UPGMA clustering analyses (Fig. 4) showed that Lake Karagöl and Lake

Table 6. Jaccard's Similarities of 13 aquatic bodies. Note that while no similarities were found between the lakes Karagöl and Uşak, lakes located in the same geographical area (e.g., lakes Yeniçağa, Aladağ, Abant) showed relatively high similarities. Bold numbers represent high similarities.

	Karagöl	Uşak	Gölköy	Çubuk	Sünnet	Aladağ	Abant	Gölcük	Yeniçağa	K.Çekmece	B.Çekmece	Şamlar	Taşlıyayla
Karagöl	1.000												
Uşak	0.000	1.000											
Gölköy	0.231	0.063	1.000										
Çubuk	0.125	0.118	0.167	1.000									
Sünnet	0.182	0.000	0.211	**0.316**	1.000								
Aladağ	0.222	0.091	**0.400**	0.211	0.200	1.000							
Abant	0.125	0.118	0.273	0.200	0.136	0.211	1.000						
Gölcük	0.286	0.000	0.188	0.235	0.231	0.273	0.167	1.000					
Yeniçağa	0.143	0.063	**0.300**	0.273	0.211	**0.313**	**0.400**	0.188	1.000				
K.Çekmece	0.077	0.071	0.143	0.040	0.050	0.188	0.238	0.214	0.143	1.000			
B.Çekmece	0.188	0.053	**0.318**	0.192	0.182	0.263	0.148	0.222	0.208	0.286	1.000		
Şamlar	0.063	0.125	0.174	0.208	0.143	0.222	0.160	0.176	0.227	**0.316**	**0.500**	1.000	
Taşlıyayla	0.222	0.091	0.105	0.095	0.125	0.143	0.150	0.167	0.050	0.188	0.200	0.158	1.000

Gölcük (reservoir) clustered closer to each other with about 0.285 of similarity. Lake Uşak clustered separately on the top of the dendrogram.

Among the 13 aquatic bodies, lakes geographically closer to each other showed higher similarities (e.g., see B. Çekmece-Şamlar-K.Çekmece, and Aladağ-Gölköy-Yeniçağa) (Table 6).

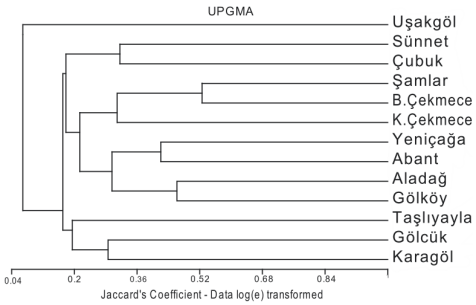


Fig. 4. Dendrogram of UPGMA Analysis with Jaccard's Coefficient and log (e) transformed.

4. Discussion and conclusion

Among 13 aquatic bodies, S-H alpha diversity (Table 3) revealed a relatively low value (1.01) for Lake Karagöl compared to the levels of S-H from low (1.5) to high (3.5). Besides, numbers of species in both lakes (Karagöl and Uşak) were much smaller (4 to 5 species) than species per lake in Turkey (13.2 species/lake) (Külköylüoğlu 2005b). Koleff et al. (2003) classified Whittaker beta diversity from low (1) to high (10) diversity ranges. In our case, Whittaker beta diversity was 4.526 suggesting a low diversity (Table 4)). Finding such a low diversity may imply that the aquatic bodies compared inhere have more species in common than found by this study. Indeed, it is possible to suggest that the similarity values may be caused by cosmopolitan characteristics of the three cosmopolitan species. According to the SIMPER analysis results (Table 5), *C. vidua* and *L. inopinata* with a 40 % proportion alone provided a big contribution to the species diversity. This may explain the low beta diversity. Possible reasons for the low alpha diversity in the two lakes may be related to biotic and abiotic activities (Külköylüoğlu & Yılmaz 2017). Although there is are few examples in the literature with only one or a

couple of species per lake, the observed low diversity is quite surprising for ~~in~~ both lakes studied. For example, Lake Küçükçekmece (İstanbul, Turkey) has been known with one particular ostracod species (*L. inopinata*) and the reason of that was related to heavy pollution of this natural lake by anthropogenic activities (Külköylüoğlu et al. 1993). This was one of the extreme examples from the literature but none of the aquatic bodies studied here were under such a heavy pressure of high antropogenic factors as far as we observed. On the other hand, considering the water quality measurements provided by monthly samplings during the present study, the pollution level of both lakes seems not to be as high as in Lake Küçükçekmece. As mentioned before, deepening works had been done in Lake Karagöl during 1986. Consequently, it is possible to see changes in species composition in the lake. Unfortunately, we do not have any physicochemical and/or ecological data before 1986, and therefore we cannot compare the species diversity and composition with other lakes. Although some amount of anthropogenic stress was observed around the two lakes, we failed to find any strong correlations between the numbers of species and water quality measurements. Actually, seasonal occurrence of individual species may be responsible for the results of the clusters of relationships among the 13 lakes compared here. According to the UPGMA dendrogram (Fig. 4), Lake Karagöl shows close relationship with Lake Gölcük, a man-made reservoir. Although both aquatic bodies are located in the city of Bolu, they are over 45 km apart and separated by the Aladağ Mountain range. Similarly, the lakes B. Çekmece, Şamlar and K. Çekmece showed high similarities despite the fact that they are geographically separated over long distances. One of the possible reasons of such close clustering relationship between these two examples may be related to ostracods seasonal occurrences and similarities in ecological conditions. Such view requires more detailed studies on different taxonomic groups to support a general conclusion but ostracod species discussed below may have answer for similarities among these 13 aquatic bodies.

Cypridopsis vidua (O. F. Müller, 1776)

According to Meisch et al. (2019), this species has a worldwide distribution, the Antarctic excepted. *Cypridopsis vidua* can be found in ponds, lakes, springs, streams, creeks, rivers, temporary ponds (Meisch 2000). Külköylüoğlu (2005a) encountered *C. vidua* in a man-made reservoir (Lake Gölköy, Turkey) between June and October. In the study on a reed bed area in Turkey, Külköylüoğlu (2005b) reported the species from April to December. The species was also common in a natural lake (Lake Çubuk) from June to December (Külköylüoğlu et al. 2014). Similarly, Külköylüoğlu et al. (2017c) found this species in February, from June to December in the Turkish Taşlıyayla reservoir. According to Kitchell & Clark (1979), *C. vidua* was one of the most common species in a eutrophic lake (Lake Mendota, Wisconsin, USA) from April to September. *C. vidua* can be found all year around (Külköylüoğlu 2000). Our results of OWM indicate that this species has a stenochronal occurrence in Lake Karagöl from May to June and September to October (Fig. 3a). According to the literature, *C. vidua* tolerates a wide range such as pH (5.20 – 12, Delorme, 1991), dissolved oxygen (1.44 – 19 mg/L, Green 1994, Külköylüoğlu 2004), electrical conductivity (37 – 7410 µS/cm, Meisch & Broodbaker 1993, Meisch et al. 2007), water temperature (3.8-36ºC, Yılmaz & Külköylüoğlu 2006). Consequently, our results agree with the current literature and they indicate that *Cypridopsis vidua* can be considered a cosmoecious species with a wide geographical distribution and a relatively wide tolerance to ecological variables such as pH, dissolved oxygen, and water temperature (Külköylüoğlu 2013). This may explain the high contribution of the species to total diversity values.

Ilyocypris bradyi (Sars, 1890)

Meisch et al. (2019) indicated that *Ilyocypris bradyi* was reported from the Nearctic, Neotropical, Oriental and Palaearctic zoogeographical regions. Habitat preferences of this species include springs, ponds, rivers, swamps, lakes and eutrophic gravel pits (Meisch 2000, Karanovic 2012). Follow-

ing the suggestion of Külköylüoğlu (2013), *I. bradyi* can be considered a cosmoecious species. In this study, one male of the species was found in October 2016 in Lake Karagöl. Karanovic & Lee (2013) reported the first finding of males from Korea. According to Külköylüoğlu (2005a) and Külköylüoğlu et al. (2010), the species can be classified as stenochronal. Indeed, Scharf et al. (2016) collected living individuals of the species from a brook, a ditch, and pits in April, August-October, and December in Germany, where the species was found in cold (5-18°C) and relatively saline (1260-3190 µC/cm) water bodies. Karanovic & Lee (2013) mentioned only two ecological variables (water temperature (19.2 °C) and pH (8.49)) from their sites in Korea, which were from an unnamed stream (depth 15 cm) with sandy and gravelly bottom. We collected *I. bradyi* only from one site in Lake Karagöl, where pH (7.72) and water temperature (9.1°C) were much lower than previously reported for the species. However, the finding of one single individual cannot make a significant contribution to the ecology of the species. Nevertheless, it is most likely that the high tolerance ranges of the species (Külköylüoğlu et al. 2018) can increase its success in different water bodies in a wide geographical area.

Limnocythere inopinata (Baird, 1843)

This species' geographical distribution covers the Afrotropical, Nearctic and Palaearctic regions (Meisch et al. 2019). As stated by Meisch (2000), the species can be found in ponds, swamps, lakes, slow brooks and rivers, and rice fields. Generally, the species is recognized as a typical form of lakes and ponds (e.g., Van der Meeren et al. 2011). Previous studies (Yılmaz & Külköylüoğlu 2006, Külköylüoğlu et al. 2010, 2014) showed this species to have a stenochronal occurrence. From the results of OWM, this species was found between April and November. Also, Külköylüoğlu and Dügel (2004) reported the species as occurring between May and December. The SIMPER analysis (Table 5) revealed the species to have the second highest percent of contribution (13.47%) to similarities among the commonly occurring species. In the literature, *C. vidua*'s ecological range includes pH values of 6.4 – 10.4) (Van der Meeren et al. 2011, Ruiz et al. 2013,), dissolved oxygen contents of 2.91 – 13.26 mg/L (Yılmaz & Külköylüoğlu 2006, Akdemir & Külköylüoğlu 2014), electrical conductivity values of 28.2 – 24265 µS/cm (Külköylüoğlu et al. 2012, Yavuzatmaca et al. 2017), a water temperature range of 4.75 – 35 °C (Külköylüoğlu et al. 2014, Karan-Žnidaršič & Petrov 2007). Most recently, Külköylüoğlu et al. (2018) revealed that the species along with two other most common species (*H. salina*, *I. bradyi*) displayed highest tolerance values for electrical conductivity. All these reports are found in accordance to our present findings.

Cypria ophtalmica (Jurine, 1820)

According to Meisch (2000), this species is almost cosmopolitan (except Australia). The species is common in all kinds of aquatic habitats where it shows high degrees of tolerance of organic pollution and other environmental variables (Meisch 2000). In Turkey, Yavuzatmaca et al. (2017) reported the species from ponds and a stream while Külköylüoğlu et al. (2017b) recorded it from the littoral zone of Lake Efteni, with a dissolved oxygen content of 8.96 mg/l, at pH 8.58 and a water temperature of 22.9°C. It is however important to note that this lake has been under heavy pressure of anthropogenic activities for the last 50 years or so. The species usually produces two generations per year and can be found all year around (Meisch 2000). In accordance with this, *C. ophtalmica* was collected from Lake Uşak almost all year around during the present study (Table 3). On the other hand, the species showed seasonal occurrence patterns in a natural lake (Lake Çubuk, Turkey) from June to December (Külköylüoğlu et al. 2014). A similar euchronal occurrence pattern was also reported by Scharf et al. (2016) from Germany. According to the latter authors, the species was collected within a relatively wide temperature range (5-24°C) and saline (1046-6140µS/cm) waters of brooks, ditches, pits, ponds and harbours. Thus, seasonal occurrence of the species in our study agrees with previous reports. The

same also applies to the values of ecological factors, which are all in the range of earlier studies (Külköylüoğlu 2013, Yavuzatmaca et al. 2017).

Herpetocypris chevreuxi (Sars, 1896)

This species is distributed throughout the Holarctic and the Neotropical Regions (Meisch et al. 2019). The species was reported from several types of spring waters in Nevada (USA) where water temperature ranged from 15 to 24°C (Külköylüoğlu & Vinyard 2000). Rossetti et al. (2004) reported the species from well oxygenated (17 mg/l) Spanish waters. In Turkey, the species was collected from reed beds and a man-made pond located at about 1921 m a.s.l., at a dissolved oxygen level of 4.78 mg/l under alkaline conditions (pH 7.78) (Akdemir & Külköylüoğlu 2014). Uçak et al. (2014) recorded. *H. chevreuxi* from a trough and freshwater creeks within the previously known temperature ranges. Külköylüoğlu et al. (2012) reported the species from the highly alkaline (pH 9.01) shallow zone of a freshwater (EC = 189.3 mS/cm) creek in the Kahramanmaraş province (Turkey), where the water temperature was relatively high (27.8°C) in June. Scharf & Meisch (2014) reported the species from a man-made basin fed by a spring (Fuenta Peňa) on Gran Canaria (Canary Islands) at 15°C and a salinity of about 3‰.

Despite the fact that these studies provide some important knowledge about ecological characteristics and habitat preferences of the species, most of them are not seasonal studies. Therefore, knowledge about species seasonal occurrence and habitat preferences is not enough. For example, *H. chevreuxi* was reported in all year around in the waters of Slovakia (Onderíková 1993) and on the Canary Islands (Beyer et al. 1997) but detailed information about its seasonal occurrence pattern is not known. During the present study, *H. chevreuxi* was collected from October, November, April and May (Fig. 3). Our results suggest that in Lake Uşak the species occurs in two or more seasons within a wide ranges of dissolved oxygen content (1.69 – 14.9 mg/l) and water temperatures (5.9–15.4°C).

Candona sanociensis (Sywula, 1971)

Syn.: *Candona dancaui* Danielopol, 1973

Candona sanociensis is presently only known from the Palaearctic region (Meisch et al. 2019). The species was previously found in springs, a roadside pool, streams, a river, wells, and the groundwater (Sywula 1971, Danielopol 1973, 1978, Meisch 2000). The life history remains poorly known. In Lake Uşak, we found the species from September to October and from February to June.

During the present study, *C. sanociensis* was found within a temperature range of 7.5 – 26.6 °C and from slightly acidic (pH 6.34) to alkaline (pH 8.86) conditions (Table 1). It is also important to note that the species was mostly collected from site 2 of the lake, where a small temporary limnocrene spring discharges into it. The species was also recorded from this spring. Although the present study provides some ecological and seasonal data about the species, this is certainly not enough to understand its ecological preferences. Future studies are needed to better understand the life history of the species.

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References

Akdemir, D., 2008. Differences in Ostracoda (Crustacea) assemblages between two Maar Lakes and one Sinkhole Lake in Konya Region (Turkey). *Turkish Journal of Zoology* 32: 107-113.

Akdemir, D. & O. Külköylüoğlu, 2014. Preliminary study on distribution, diversity, and ecological characteristics of nonmarine Ostracoda (Crustacea) from the Erzincan region (Turkey). *Turkish Journal of Zoology* 38: 421-431.

Ås, S., 1999. Invasion of matrix species in small habitat patches. *Conservation Ecology* 3 (1):1-15.

Benson, R.H., 1990. Ostracoda and the discovery of global Cainozoic palaeoceanographical events. In R. Whatley and C. Maybury (Eds.), Ostracoda and Global Events (pp. 41–59). London, Chapman & Hall, 644 pp.

Beyer G., C. Meisch & K. Wouters, 1997. New records of freshwater Ostracoda (Crustacea) from La Gomera, El Hierro, Fuerteventura and Tenerife (Canary Islands). *Bulletin de la Société des naturalistes Luxembourgeois* 98: 239-259.

Clarke, A. & S. Lidgard, 2000. Spatial patterns of diversity in the sea: bryozoan species richness in the North Atlantic. *Journal of Animal Ecology* 69:799-814.

Danielopol, D.L., 1973. Sur la morphologie des aesthetascs chez quelques ostracodes hypogés de la sous-familie des Candoninae (Cyprididae, Podocopida). *Annales de Spéléologie* 28 (2): 233-245.

Danielopol, D.L., 1978. Über Herkunft und Morphologie der europäischen Süßwasser-Ostracoden. *Sitzungsberichte der Österreichischen Akademie der Wissenschaften, Mathematisch-naturwissenschaftliche Klasse*, Abt. I 187:1-162.

Delorme, D., 1991. Ostracoda. In J.H. Thorp & A.P. Covich (eds): Ecology and Classification of North American Freshwater Invertebrates. Academic Press, San Diego: 691-722.

Dügel, M., O. Külköylüoğlu & M. Kılıç, 2008. Species assemblages and habitat preferences of Ostracoda (Crustacea) in Lake Abant (Bolu, Turkey). *Belgian Journal of Zoology* 138 (1): 50-59.

Green, G.D., 1994. Freshwater Ostracoda (Crustacea) from the Southern Interior of British Columbia. Royal British Columbia Museum: 31.

Harrison, I., M. Laverty & E. Sterling, 2004. Alpha, Beta and Gamma Diversity, OpenStax CNX, http://cnx.org/contents/b7c8bf78-7538-41bd-a603-bd3ada1631f1@2.

Higuti, J., F.A. Lansac-Tôha, L.F.M. Velho & K. Martens, 2009. Biodiversity of non-marine ostracods (Crustacea, Ostracoda) in the alluvial valley of the upper Paraná River, Brazil. *Brazilian Journal of Biology* 69 (2, Suppl.): 661-668.

Karanovic, I., 2012. Recent Freshwater Ostracods of the World, Springer-Verlag, Berlin, Heidelberg, 608 pp.

Karanovic, I. & W. Lee, 2013. On the ostracod genus *Ilyocypris*, with description of one new species from Korea and the first report of males of *I. bradyi* (Crustacea: Ostracoda: Podocopida). *Biological Society of Washington* 126 (1): 39-71.

Karan-Žnidaršič, T. & B. Petrov, 2007. Non-marine Ostracoda (Crustacea) of Banat district in Serbia. *Hydrobiologia* 585: 57-66.

Kitchell, J.A. & D.L. Clark, 1979. Distribution, ecology, and taxonomy of recent freshwater Ostracoda of Lake Mendota, Wisconsin. 1-24. Natural History Council, University of Wisconsin-Madison: 1-24.

Koleff, P., K.J. Gaston & J.J. Lennon, 2003. Measuring beta diversity for presence-absence data. *Journal of Animal Ecology* 72: 367-382.

Kovach, W., 1998. Multi-variate statistical package, ver. 3.1. Kovach Computer Services. Pentraeth, UK.

Külköylüoğlu, O., 1998. Freshwater Ostracoda (Crustacea) and their quarterly occurence in Şamlar Lake (İstanbul, Turkey). *Limnologica* 28: 229-235.

Külköylüoğlu, O., 1999. Seasonal distribution of freshwater Ostracoda (Crustacea) in springs of Nevada. *Geosound-Science and Technology Bulletin on Earth Science* 35: 85-91.

Külköylüoğlu, O., 2000. The importance of cosmopolitan and indicator species of Ostracoda (Crustacea) in Turkey based on some water parameters. *National Water Product Conference*, 22-24 September, Sinop.

Külköylüoğlu, O., 2004. On the usage of Ostracoda (Crustacea) as bioindicator species in different aquatic habitats in the Bolu region, Turkey. *Ecological Indicators* 4:139-147.

Külköylüoğlu, O., 2005a. Ecology and phenology of freshwater ostracods in Lake Gölköy (Bolu, Turkey). *Aquatic Ecology* 39: 295–304.

Külköylüoğlu, O., 2005b. Factors effecting Ostracoda (Crustacea) occurrence in Yumrukaya Reedbeds (Bolu, Turkey). *Wetlands* 25: 224-227.

Külköylüoğlu, O., 2009. Ecological succession of freshwater Ostracoda (Crustacea) in newly developed rheocrene spring (Bolu, Turkey). *Turkish Journal of Zoology* 33:115-123.

Külköylüoğlu, O., 2013. Diversity, distribution and ecology of nonmarine Ostracoda (Crustacea) in Turkey: Applications of pseudorichness and cosmoecious species concepts. *Recent Research Developments in Ecology* 4: 1-18.

Külköylüoğlu, O., S. Altınsaçlı & C. Kubanç, 1993. Küçükçekmece Gölünün (İstanbul) Ostrakod (Crustaceae) Faunası ve Mevsimsel Dağılımı. *Turkish Journal of Zoology* 17: 19-27.

Külköylüoğlu, O., S. Altınsaçlı, M. Kılıç & C. Kubanç, 1995. The Ostracoda (Crustacea) fauna of Lake Büyükçekmece (İstanbul) and seasonal distributions. *Turkish Journal of Zoology* 19(3): 249-256.

Külköylüoğlu, O. & M. Dügel, 2004. Ecology and spatiotemporal patterns of ostracoda (Crustacea) from Lake Gölcük (Bolu,Turkey). *Archiv für Hydrobiologie* 160: 67-83.

Külköylüoğlu, O., M. Dügel & M. Kılıç, 2007. Ecological requirements of Ostracoda (Crustacea) in a heavily polluted shallow lake, Lake Yeniçağa (Bolu, Turkey). *Hydrobiologia* 585:119-133.

Külköylüoğlu, O., M. Dügel, M. Balcı, A. Deveci, D. Avuka & M. Kılıç, 2010. Limnoecological relationship between water level fluctuations and Ostracoda (Crustacea) species composition in Lake Sünnet (Bolu, Turkey) *Turkish Journal of Zoology* 34: 429-442.

Külköylüoğlu, O., N. Sarı, M. Dügel, S. Dere, N. Dalkıran, C. Aygen & S.C. Dinçer, 2014. Effects of limnoecological changes on the Ostracoda (Crustacea) community in a shallow lake (Lake Çubuk, Turkey). *Limnologica* 46: 99-108.

Külköylüoğlu, O. & G.L. Vinyard, 1998. New bisexual form of *Cavernocypris subterranea* (Wolf, 1920) (Crustacea, Ostracoda) from Idaho. *Great Basin Naturalist* 58 (4): 380-385.

Külköylüoğlu, O. & G.L. Vinyard, 2000. Distribution and ecology of freshwater Ostracoda (Crustacea) collected from springs of Nevada, Utah, and Oregon: A preliminary study. *Western North American Naturalist* 60: 291-303.

Külköylüoğlu, O., M. Yavuzatmaca, D. Akdemir & N. Sarı, 2012. Distribution and local species diversity of freshwater Ostracoda in relation to habitat in Kahramanmaraş province of Turkey. *International Review of Hydrobiology* 97 (4): 247-261.

Külköylüoğlu, O., M. Yavuzatmaca, E. Çelen, D. Akdemir & N. Dalkıran, 2018. Habitat preferences, water quality requirements and ecological characteristics of freshwater Ostracoda (Crustacea). *International Journal of Limnology* 2018: 54:26.

Külköylüoğlu, O., M. Yavuzatmaca, M. Tanyeri & O. Yılmaz, 2017a. Ostracoda (Crustacea) species composition and environmental correlates in different aquatic habitats of the Zonguldak and Bartın regions (Turkey). *Turkish Journal of Zoology* 41: 686-695.

Külköylüoğlu, O., S. Yılmaz & M. Yavuzatmaca, 2017b. Comparison of Ostracoda (Crustacea) species distribution, diversity and ecological characteristics among habitat types. *Fundamental and Applied Limnology* 190 (1): 63-86.

Külköylüoğlu, O. & O. Yılmaz, 2017. Seasonal changes of ostracods in troughs (Bolu, Turkey). *Review of Hydrobiology* 10 (2): 99-105.

Külköylüoğlu, O., M. Tanyeri & O. Yılmaz, 2017c. Alpha and beta species diversity of freshwater Ostracoda (Crustacea) and their seasonal distribution in Seben-Taşlıyayla reservoir (Bolu, Turkey). *Turkish Journal of Fisheries and Aquatic Science* 17: 1357-1365.

Lande, R., 1996. Statistics and partitioning of species diversity, and similarity among multiple communities. *Oikos* 76: 5-13.

Magurran, A.E., 1988. Ecological diversity and its measurements. Princeton University Press, Princeton, New Jersey, 179 pp.

Martens, K., 1998. Diversity and endemicity of recent non-marine ostracods (Crustacea, Ostracoda) from Africa and South America: a faunal comparison. *Verhandlungen des Internationalen Vereins für Limnologie* 26: 2093-2097.

Martens, K., & R. Ortal, 1999. Diversity and zoogeography of inland-water Ostracoda (Crustacea) in Israel (Levant). *Israel Journal of Zoology* 45: 159-173.

Meisch, C., 2000. Freshwater Ostracoda of western and central Europe. Süsswasserfauna von Mitteleuropa 8/3. Spektrum Akademischer Verlag, Heidelberg, Berlin, 552 pp.

Meisch, C. & N.W. Broodbakker, 1993. Freshwater Ostracoda (Crustacea) collected by Prof. J.H. Stock on the Canary and Cape Verde islands. With an annotated checklist of the freshwater Ostracoda of the Azores, Maderia, the Canary, the Selvages and Cape Verde islands. *Travaux scientifiques du Musée national d'historie naturelle de Luxemburg* 19: 3-49.

Meisch, C., N. Mary-Sasal, J.-P. Colin & K. Wouters, K., 2007. Freshwater Ostracoda (Crustacea) collected from the islands of Futuna and Wallis, Pacific Ocean, with a check-list of the non-marine Ostrsacoda of the Pacific Islands. *Bulletin de la Société des naturalistes Luxembourgeois* 108: 89-103.

Meisch, C., R. J. Smith & K. Martens, 1919. A subjective global checklist of the extant nonmarine Ostracoda (Crustacea). *European Journal of Taxonomy* 492:1-135.

McIntosh, R.P., 1967. An index of diversity and the relation of certain concepts to diversity. *Ecology* 48 (3): 392-404.

Nagorskaya, L. & D. Keyser, 2005. Habitat diversity and ostracod distribution patterns in Belarus. *Hydrobiologia* 538: 167-178.

Novotny, V. & O. Missa, 2000. Local versus regional species richness in tropical insects: one lowland site compared with the island of New Guinea. *Ecological Entomology* 25: 445-451.

Onderíková, V., 1993. *Herpetocypris chevreuxi* G.O. Sars, 1896 (Crustacea, Ostracoda). Un éliminateur important de la pollution organique des eaux usées. *Bulletin de la Société des naturalistes luxembourgeois* 94: 233-240.

Pérez, L., J. Lorenschat, R. Bugja, M. Brenner, B. Scharf & A. Schwalb, 2010. Distribution, diversity and ecology of modern freshwater ostracodes (Crustacea), and hydrochemical characteristics of Lago Petén Itza, Guatemala. *Journal of Limnology* 69 (1) :146-159.

Proctor, V.W., 1964. Viability of crustacean eggs recovered from ducks. *Ecology* 45: 656-658.

Rossetti, G., M. Bartoli & K. Martens, 2004. Limnological characteristics and recent ostracods (Crustacea, Ostracoda) of freshwater wetlands in the Parco Oglio Sud (Northern Italy). *International Journal of Limnology* 40: 329-341.

Ruiz, F., D. Abad, A.-M. Bodergat, P. Carbonel, J. Rodriguez-Lazaro, M.L. Gonzalez-Regalado, A. Toscano, E.X. Garcia & J. Prenda, 2013. Freshwater ostracods as environmental tracers. *International Journal of Environmental Science and Technology* 10: 1115-1128.

Seaby, R.M. & P.A. Henderson, 2006. Species Diversity and Richness, Version 4.2, Pisces Conservation Ltd., Lymington, UK.

Seaby, R.M. & P.A. Henderson, 2007. Community Analysis Package Version 4.1.3, Pisces Conservation Ltd., Lymington, UK.

Scharf, B.W., 1998. Eutrophication history of Lake Arendsee (Germany). *Palaeogeography, Palaeoclimatology, Palaeoecology* 140: 85-96.

Scharf, B. & C. Meisch, 2014. New records of nonmarine Ostracoda (Crustacea) from Gran Canaria (Canary Islands), with an updated checklist of the nonmarine Ostracoda of the Canary Islands. *Bulletin de la Société des naturalistes luxembourgeois* 115: 259-270.

Scharf, B., M. Herzog & A. Pint, 2016. New occurrences of *Cyprideis torosa* (Crustacea, Ostracoda) in Germany. *Journal of Micropalaeontology* 36: 120-126.

Sywula, T., 1971. Notes on Ostracoda 11: New taxa of the nominate subgenus of genus *Candona* Baird from Poland. *Bulletin de l'Academie Polonaise des Sciences , cl. 2, Sér. Sci. Biol.* 19: 587-591.

Uçak, S., O. Külköylüoğlu, D. Akdemir & E. Başak, 2014. Distribution, diversity and ecological characteristics of freshwater Ostracoda (Crustacea) in wetland sites of the Ankara region, Turkey. *Wetlands* 34: 309-324.

Van der Meeren, T., E. Ito, D. Verschuren, J.E. Almendinger. & K. Martens, 2011. Valve chemistry of *Limnocythere inopinata* (Ostracoda) in a cold arid environment - Implications for paleolimnological interpretation. *Palaeogeography, Palaeoclimatology, Palaeoecology* 306: 116-126.

Vinyard, G.L., 1979. An ostracod (*Cypridopsis vidua*) can reduce predation from fish by resisting digestion. *American Midland Naturalist* 102: 188–190.

Whittaker, R.H., 1972. Evolution and measurement of species diversity. *Taxon* 21: 213-251.

Whittaker, R. H.,L.E. Gilbert & J.H. Connell, 1979. Analysis of two-phase pattern in a mesquite grassland. *Journal of Ecology* 67: 935-952.

Wilson, M.V. & A. Shmida, 1984. Measuring beta diversity with presence-absence data. *Journal of Ecology* 72: 1055-1064.

Wise, C.D., 1961. Taxonomy and ecology of fresh-water ostracods of south-central Texas. Ph.D. thesis, The University of New Mexico, Albuquerque, 334 pp.

Yavuzatmaca, M., O. Külköylüoğlu & O. Yılmaz, 2017. Estimating distributional patterns of non-marine Ostracoda (Crustacea) and habitat suitability in the Burdur province (Turkey). *Limnologica* 62: 19–33.

Yılmaz, F. & O. Külköylüoğlu, 2006. Tolerance, optimum ranges, and ecological requirements of freshwater Ostracoda (Crustacea) in Lake Aladağ (Bolu, Turkey). *Ecological Research* 21: 165-173.

Zar, J.A., 1999. Biostatistical Analysis. Prentice-Hall, Upper Saddle River, New Jersey, 944 pp.