COMPARATIVE ANALYSIS OF DIVERSITY HYPOTHESES USED TO DETERMINE THE RELATIONSHIP BETWEEN OSTRACODA (CRUSTACEA) SPECIES AND ENVIRONMENTAL VARIABLES IN DIFFERENT AQUATIC BODIES OF ANKARA

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Approval of the Graduate School of Natural and Applied Sciences.

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I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science.

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This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

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ABSTRACT

COMPARATIVE ANALYSIS OF DIVERSITY HYPOTHESES USED TO DETERMINE THE RELATIONSHIP BETWEEN OSTRACODA (CRUSTACEA) SPECIES AND ENVIRONMENTAL VARIABLES IN DIFFERENT AQUATIC BODIES OF ANKARA

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This study includes samples collected randomly from 173 different aquatic bodies from 17 counties of Ankara between 22 June and 03 July 2011. Total of 31 ostracod species were identified. When two of which (*Eucypris elliptica* and *Cavernocypris subterranea*) are new reports for the Turkish ostracod fauna, 19 taxa are new reports for Ankara region. Ecological correlation was evaluated by means of using multi-variable analyses between ostracod species and environmental variables. Canonical Correspondence Analyses (CCA) outlined 58.9 % of the correlation between species and environmental variables. Five variables (water temperature, humidity, dissolved oxygen, altitude, and atmospheric pressure) were found to be the most effective factors on species. Unweighted Paired Group Mean Analyses (UPGMA) illustrated four main clustering groups of ostracods attained in their ecological conditions. Generally, results showed that species with cosmopolitan characteristics had wide ecological tolerances for different variables. According to the Species-Area relationships, eight diversity hypotheses (passive sampling hypothesis (random placement hypothesis), island biogeography theory (area per se effect), habitat diversity hypotesis, sampling effect hypothesis, intermediate disturbance hypothesis, small island habitat hypothesis, target area hypothesis and species-energy hypothesis) were examined and compared with each other. Accordingly, results imply that habitat diversity hypothesis seems to be the most suitable hypothesis explaining ostracod distribution at different altitudinal ranges. However, results should not be generalized at the moment because of dominancy of sampling from troughs. Thus, future studies are urged to be clarify the situation.

Keywords: Ostracods, Diversity Hypotheses, Ecological Tolerances, Geographical Distribution, Ankara.

ÖZET

ANKARA'NIN FARKLI SUCUL ALANLARINDA OSTRAKOT (CRUSTACEA) TÜR ÇEŞİTLİLİĞİ İLE ÇEVRESEL DEĞİŞKENLER ARASINDAKİ İLİŞKİNİN BELİRLENMESİNDE KULLANILAN ÇEŞİTLİLİK HİPOTEZLERİNİN KARŞILAŞTIRMALI ANALİZİ

UÇAK, Samet

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Bu çalışma Ankara iline bağlı 17 ilçeden rastgele seçilen 173 farklı sucul ortamdan 22 Haziran – 3 Temmuz 2011 tarihleri arasında toplanan örneklerin analizini içerir. Toplam 31 ostrakot türü tespit edilmiştir. Bunlardan iki tür (*Eucypris elliptica* ve *Cavernocypris subterranea*) Türkiye ostrakot faunası için yeni kayıt olarak bulunurken, 19 takson Ankara için yeni kayıttır. Ostrakot türleri ve çevresel değişkenler arasındaki ekolojik ilişki çok değişkenli istatistiksel analizler kullanılarak değerlendirilmiştir. Çok Yönlü Bağlantılı Uyum Analizi (CCA), türler ve çevresel değişkenler arasındaki ilişkiyi %58.9 olarak vermiştir. Beş değişken (su sıcaklığı, nemlilik, çözünmüş oksijen, yükseklik ve atmosfer basıncı) türler üzerinde en etkili çevresel faktörler olarak bulunmuştur. Ağırlıksız Basit Çift Grup Ortalama Analizi (UPGMA) ostrakotların bulundukları ekolojik koşullardaki dört ana grubu göstermiştir. Genel olarak sonuçlar kozmopolitan özellikleri taşıyan türlerin farklı değişkenlere karşı ekolojik toleranslarının geniş olduğunu göstermektedir. Tür-Alan ilişkilerine göre sekiz çeşitlilik hipotezi (pasif örnekleme hipotezi (rastgele yerleştirme hipotezi), ada biyocoğrafyası teorisi, habitat çeşitliliği hipotezi, örnekleme etkisi hipotezi, ara karışıklık hipotezi, küçük ada habitatı hipotezi, hedef alan hipotezi ve tür-enerji teorisi) incelenmiş ve birbirleri ile karşılaştırılmıştır. Bu doğrultuda, sonuçlar farklı yükseklik aralıklarında ostrakotların dağılımını açıklayan en uygun hipotezin habitat çeşitliliği hipotezi olduğunu göstermiştir. Ancak, yalak örneklemesindeki ağırlık nedeniyle, şimdilik sonuçlarda genelleme yapılmaz. Durumun açıklığa kavuşturulması için gelecekte çalışmaların yapılması önerilmektedir.

Anahtar Kelimeler: Ostrakot, Çeşitlilik Hipotezleri, Ekolojik Tolerans, Coğrafik Dağılım, Ankara.

To the meaning of my life Sibel MİNNAS and

to my precious father Bekir UÇAK and mother Tülin UÇAK

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CHAPTER I

Introduction

Ostracoda

Linné was the first to name the first ostracod in 1746 as *Monoculus conchapedata* (Ferguson, 1944). In 1772, O. F. Müller described Ostracoda from Europe firstly (Viehberg, 2006). In 1802, Latreille designated “Ostrachoda” firstly. Furthermore, in 1806, Latreille changed the name Ostrachoda as Ostracoda (Ikeya et al., 2005). Ostacoda (mussel shrimps) name comes from Greek *Ostrakon* which means ‘shell’. Ostracods are small microscopic animals living in a variety of aquatic (or semiaquatic) habitats. They are mostly 0.3 – 5.0 mm long in size with a pair of calcified carapaces which enclose the soft body. Some marine pelagic forms of Ostracoda may reach up to 30 mm of lenght (Meisch, 2000). Ostracoda are one of the most diverse group in Crustacea. There are close to 2000 subjective species and about 200 genera of recent non-marine Ostracoda (Martens et al., 2008).

Ostracoda have a long geologic history. They are also known as ‘oldest microfauna’ (Delorme, 1991) because their valves are easily fossilized and preserved in sediments (Holmes and Horne, 1999). They are known from the Cambrien period (about 500 mya) (Sars, 1928; Henderson, 1990). The first freshwater Ostracoda was reported in Devonian period (about 360 mya) (Martens et al., 2008). However, the true ostracods are known to occur in the Ordovician (Martens, 1998).

Under the Phylum Arthropoda and the Subphylum Crustacea, the Class Ostracoda have two subclasses: Myodocopa and Podocopa (Horne et al., 2002). Myodocopa is made up of Myodocopida and Halocyprida orders. Moreover, Podocopa includes Palaeocopida, Platycopida and Podocopida orders (Horne, 2003). There are three orders of Ostracoda (Meisch, 2000). Myodocopida, Platycopida and Podocopida are the living lineages of Ostracoda. When Platycopida and Myocopida are marine and fossil, Podocopida are non-marine. The non-marine ostracods are made up of three subfamilies which are Cypridoidea, Cytheroidea and Darwinuloidea (Meisch, 2000).

Morphology of Ostracoda

The soft body covered by calcium carbonated valves consists of two main parts: the head (or cephalon) and the thorax. The outer ostracod layers consist of tubercles, spines, nodes and pores that have a sensorial function (Martens, 1998; Meisch, 2000). One of the best diagnostic and most distinct trait of Ostracoda is a bivalved carapace that may completely envelop the whole animal body with limbs. The valves have complex mechanisms controlled by central adductor muscles. There are muscle scars on the valves used during species identification (Martens, 1998). Ostracods have a short compact body with no true segmentation as often recognisable in other crustaceans (Naimotko et al., 2011). There are three thoracic legs; second of them is uniramus and third works as a cleaning organ. Ostracoda have several appandages (soft parts): the antennulae, the antennae, the mandibles, the maxillulae, (A1, A2, Md, Mx1 and three pairs of thoracopods), limbs, furcae (apair of caudal structures; caudal rami and their attachment are of systematic importance) (Bronshtein, 1947; Horne et al. 2002; Meisch, 2007), reproductive organs, cephalon, thorax and single naupli eye (Martens, 2003). Ostracods grow by moulting like other crustaceans and after eight moulting stages they reach adult stage.

Ecology of Ostracoda

Ostracods live in every aquatic habitat such as oceans, shallow littoral zone to abyssal depts, lagoons, estuaries, caves, throughs, arctics, underground waters etc. Also limited number of Ostracoda taxa are known from semi terrestrial environment (Külköylüoğlu and Vinyard, 2000). They can live as predators, herbivores, omnivores or detritivores. Some of the Ostracoda taxa (Cytheroids) can live as symbionts, commensals or ectoparasites (Hobbs, 1971).

Many freshwater species can have conditional habitat preferences indicating a level of tolerance to the environmental variations (e.g. latitude, longitude, elevation, seasonal differences). Previous studies have shown that ostracods are sensitive to changes in water variables such as temperature, conductivity, pH, dissolved oxygen and salinity (Külköylüoğlu, 2005a; Mischke et al., 2007; Perez et al., 2010). Furthermore, ostracods have a wide geographic distribution depending on their dispersal abilities and tolerances of environmental variables. Ostracods have an ability of long distance dispersal. The movement of species can be passive or active transport (Danielopol et al., 1994). In passive mode, generally eggs, individuals can be carried by some insects (Bronstein, 1947), wind, via useful plants (McKenzie and Moroni, 1986), by fish and humans (Külköylüoğlu, 1999). Ostracods disturbed actively by swimming with long swimming setae.

Some species of ostracods are cosmopolitan that they have broad ranges tolerances to environmental fluctuations such as polluted or disturbed habitats (Külköylüoğlu, 2004). They can adapt to the new environment easily (Külköylüoğlu, 2005a). Moreover, rising in the numbers of cosmopolitan species may illustrate the effect of disturbance and pollution causing reduction in the numbers of native species (Külköylüoğlu, 2005b). Such phenomenon is called by “Pseudorichness” (Külköylüoğlu, 2004). According to the pseudorichness of an environment, water quality decreases, all species diversity increases. Besides, ostracod species are sensitive to the environmental changes and if the cosmopolitan species are known, it might be use the ostracods as environmental indicators (Mezquita et al., 1999; Külköylüoğlu, 1999, 2004; Kiss, 2007; Li et al., 2010; Meeren et al., 2010). On the other hand, using ostracods as bioindicator species requires knowledge about the ecological preferences of individual species (Külköylüoğlu, 2003a). They are also enable us great scope for testing biological theories in evolution and ecology due to their long-detailed fossil record broad life histories (Henderson, 1990). Using indicator species can be cheeper, more reliable and time saver than doing long term chemical analysis. This concept exhibits possible relationships between ecological requirements of species and levels of their their response to the changes in aquatic habitats. If such levels are known, estimating the past, prediction of the future and implication of the present conditions of waters can be made (Külköylüoğlu and Dügel 2004; Külköylüoğlu et al., 2007). We do not have much knowledge on Ostracoda ecology because we have not enough data (Külköylüoğlu, 2004).

The knowledge on the ecology of ostracods are important to (1) comprehend the water quality of different aquatic habitats due to using them as indicator species, (2) constitute their role in the food web, since some species have active role at second or third trophic levels and some others may be herbivores or can be food source of the other living things such as fishes (Horne and Boomer, 2000), (3) reconstruct the history of water body and its enveloping climate by analyzing sedimentary records

(Mezquita et al., 1999) and guess the past ecologic conditions of the habitats since they are preserved as fossils.

Evolutionary tree of Ostracoda

Ostracods are shown in clustring of maxillapoda.

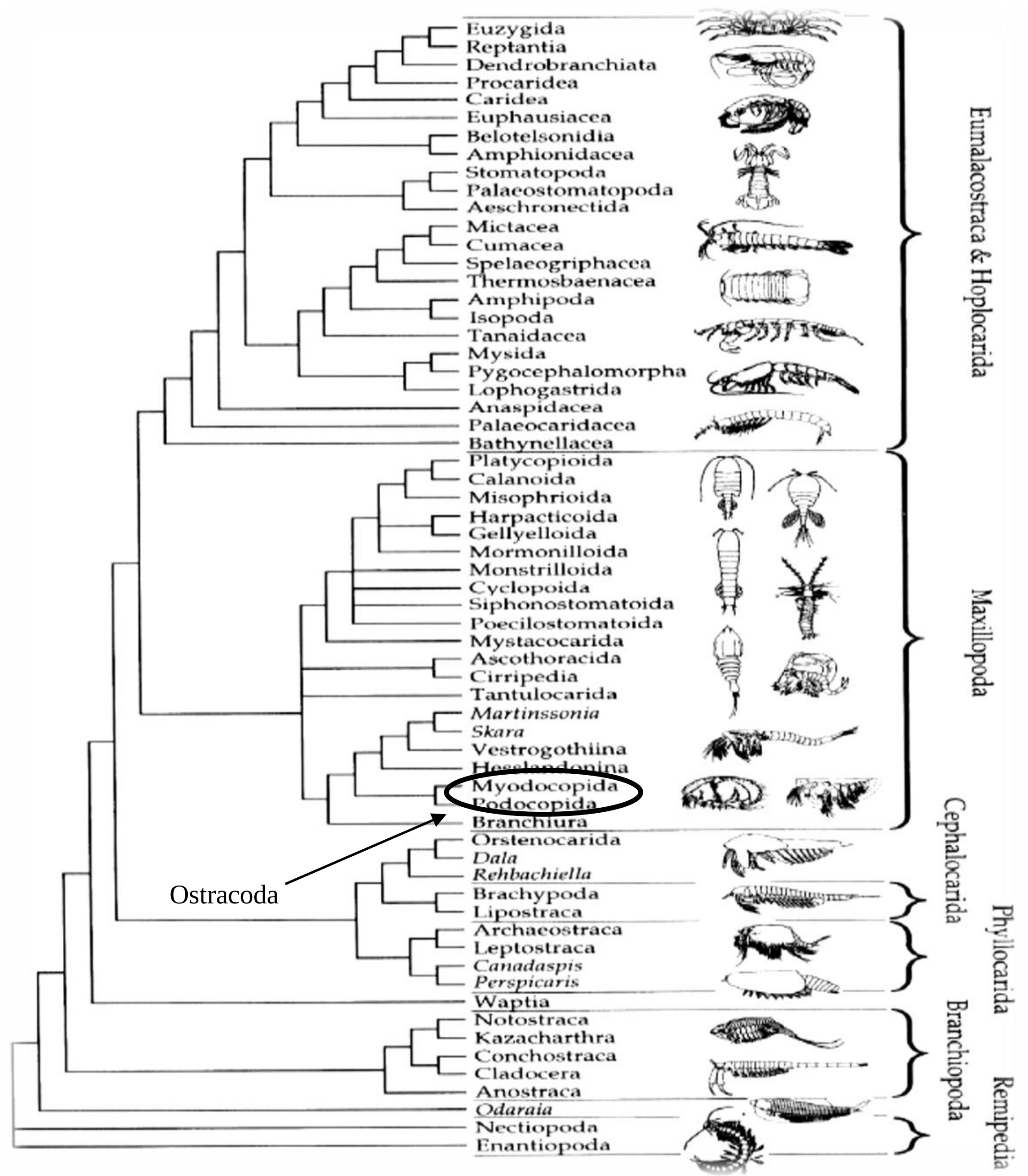


Figure 1. Strict consensus of 24 most parsimonious trees resulting from morphological character analysis of living and fossil taxa. Adapted from Wills (1998).

Ostracoda are showed regard to be crustaceans due to the possession of a characteristic cuticular fold, ontogenetically originating from a cephalic segment. This taxonomically significant structure forms the calcified, bivalved carapace, with dorsally connected valves, linked together by the chitinious connective tissue and closed by muscle tractive effort (Becker, 2005). Ostracods have the best fossil record of any Arthropod group and are major contributors to modern biodiversity (Ikeya et al., 2005). Hexapoda is the common ancestor of Ostracoda. The concept that insects might be descended from Ostracoda (Ikeya et al., 2005; Newman, 2005). Phosphatocopina is not common ancestor of the oldest record of cambrien Ostracoda. There is only monophyletic relationship between them. Phosphatocopina is the sister group of eucrustacean (Maas and Waloszek, 2005; Zhang et al., 2007). "True" Ostracoda are known first in the Lower Ordovician. Truly, the Ostracoda of cambrien were different from modern Ostracoda due to evolution (Becker, 2005). According to one view, podocopans are derived from Myodocopans (Horne, 2005). On the other hand, according to the other view, podocopans are derived from Platycopina (Hartmann, 1963). There are two evolutionary scenarious for Podocopa. First of all, the common ancestor of Podocopa could have lacked an all closing bivalved carapace but have had branchial plates. Secondly, the earliest ostracods might have had the all enclosing carapace lacking branchial plates. According to these scenarious, this is hard to accept the second one (Horne, 2005). The Podocopid Family Darwinuloidea is the ancient asexual group of Ostracoda (Schön et al., 2003; Liebau, 2005; Martens et al., 2005). Ostracods have reproduced exclusively by parthenogenesis for over 200 million years (Martens et al., 2003). Well known modern Cypridoidean Podocopid group is Cyclocypris (about 40 million years ago)

(Ikeya et al., 2005). Although Ostracods are very small animals, their potential and contribution are very big to the science.

History of Ostracoda Studies in Turkey

In Turkey, first studies on Ostracoda were made by H. W. Schäfer in 1954. Later, Hartmann in 1964 studied on ostracoda and he came up with many species new for Ostracoda fauna of Turkey such as *C. neglecta, I. bradyi, I.gibba, E. zenkeri, H. inaequivalves, H. incongruens, H. chevreuxi,* and *Ilyodromus olivaceus*.

Following Hartmann, Prof. Dinçer Gülen from University of Istanbul studied hot-springs of Turkey between 1965 and 1971 and reported *Heterocypris* sp. which will later be a new species for the literature as *H. sabirae.* He mostly studied in the western parts of Anatolia including Kütahya, Eskişehir, Çanakkale, Balıkesir, İzmir during 1971 and 1975. In all eleven species were newly recorded for the ostracod fauna of Turkey as (*Ilyocypris divisia, Cyclocypris ovum, Eucypris lutaria, E. hamadanensis, E. clavata, Physocypria klie, Cypridopsis vidua, Cytherissa lacustris* and *Cypretta dubiosa, Dolerocypris sinensis, Stenocypris malcolmsoni*). Gülen, also studied the western parts of Anotalia during 1977 to 1985 and reported 10 more new species for Turkey as (*Ilyocypris biplicata, Cypridopsis aculeata, C.pavra, Cypris bispinosa, Candonopsis kingsleii, Darwinula stevensoni, Cypria ophthalmica, Eucypris inflata, Limnocythere relicta* and *Heterocypris sabirea*). In 1982, Gülen came up with two new reports (*Notodromas persica, N. monacha*) for Turkey *Notodromas*, in collaboration with another species *Cypris pubera*. In 1985, he found bisexual populations of five species that were reported for the first time in Turkey (*Candona paralella, Cyridopsis newtoni, Ilyodromus olivaceus, Limnocythere inopinata* and *Cyprideis littoralis*). Gülen collected samples related to 11 ostracod species from Adana, Antakya and Mersin (Gülen, 1988). In this study, he also pulled toward oneself more attention to the zoogeographical feature of two species (*Eucpris inflata* and *Candonopsis kingsleii*). In 1994, Prof. Dinçer Gülen and his colleagues (1994a) studied with TÜBİTAK assisted and explored 50 species belonging to 22 genera and recorded 3 new species (*Cyclocypris laevis, Eucypris serrata, Psychrodromus melekperae*) for the ostracoda fauna of the Turkey. And same year (1994b) they studied from Anatolia region and came up with 11 ostracod species. Gülen and Altınsaçlı (1999) studied in Sakarya River Basin and they found 16 species which all samples were the new records for Sakarya.

Altınsaçlı (1988) studied in Bergama (İzmir) region and recorded two new species (*P. zschokkei* and *I. inermis*) for Turkey. He was able to defined eight ostracod species from Ayvalık (Balıkesir) (Altınsaçlı, 1990). Kubanç and Altınsaçlı (1990) studied in Ayvalık and reported 20 species of ostracods. Following that studies, Kaleli (1993) collected eight species from the coastal areas of the Middle Black Sea Region in his M.S. Thesis. Altınsaçlı (1993) collected samples from Lake Sapanca and aquatic habitats from its environments, and detected 25 species, six of which were recorded as new for the Ostracoda fauna of Turkey as (*Candona angulata, C. crispata, C. fabaeformis, C. vavrai, Loxoconchissa immodulata* and *Tyrrhenocythere amnicola*). And then, he reported a new species (*Heterocypris rotundata*) for Turkey in his studies at Lake Beyşehir (Altınsaçlı et. al., 2000). Altınsaçlı and Griffiths (2001a) studied in Lake Uluabat and then in Lake Kuş (Altınsaçlı and Griffiths, 2001b). Following these studies, they recorded *Hungarocypris* and *Leucocythere* genera from Turkey (Altınsaçlı and Griffiths, 2001c). Later, Altınsaçlı studied in Ankara (2003) and reported 12 species.

Külköylüoğlu and his colleagues (1993) studied in Lake Küçükçekmece from 1989 to 1990. *Cytheretta adriatica* was a new report for Turkey. Külköylüoğlu et al., (1995) studied in Lake Büyükçekmece where six species were a new report for Turkey (*Potamocypris longisetosa, P. variegata, Loxoconcha tamarindus, Callistocythere rostrifera, Semicytherrura sulcata* and *Heterocythereis albomaculata*). Külköylüoğlu (1998) studied in Lake Şamlar during 1990 and 1991 and two new species were recorded for Marmara region (*I. divisa* and *E. lilljeborgi*). In this study, he first bringed in a graphical model called Ostracoda Watch Model (OWM) for seasonal occurence of species. He collected samples from freshwater habitats in Bolu, in which his study was one of the first applied to Canonical Correspondense Analyses on Ostracoda by adding months as variables (Külköylüoğlu, 1998). Külköylüoğlu firstly recorded *Scottia pseudobrowniana* from a limnocrene spring in Turkey (Külköylüoğlu, 2003a). Thereafter, in 2003 he came up with a new species (*Isocypris beauchampi*) from Lake Gölköy (Külköylüoğlu, 2003b), stating that these last two genera were the first reports for Turkey. Külköylüoğlu also worked in lakes and reservoirs in Bolu (Külköylüoğlu, 2003c), and reported a rare species *Paralimnocythere psammophila* from Lake Aladağ (Külköylüoğlu, 2003d). He studied different aquatic habitats in Bolu region in 2004 also in this study the usage of ostracods as bioindicator species was discussed. Külköylüoğlu and Dügel (2004) worked on the ecology and seasonality of Ostracoda in a man-made lake, located at about 1300 m in Bolu. In this study, ostracods seasonal occurrence were studied over two years of monthly sampling. In 2005, Külköylüoğlu worked on the species richness in Yumrukaya Reedbeds, a small wetland located in the western part of Bolu (Külköylüoğlu, 2005a). In the same year he studied on the ecological requirements of Ostracoda species (Külköylüoğlu, 2005b). Külköylüoğlu (2005c) recorded a new species (*Limnocythere inopinata*) from a reservoir Lake Gölköy as a new report for the Bolu region. Külköylüoğlu et al., (2007) newly published another studies done in a heavily polluted shallow lake Lake Yeniçağa (Bolu) where they reported 13 species of Ostracoda (*C. neglecta, C. candida, I. bradyi, D. stevensoni, C. vidua, Physocypria kraepelini, Cypria ophtalmica, P. zenkeri, E. virens, H. reptans, Pseudocandona compressa, Fabaeformiscandona fabaeformis, Potamocypris* cf. *fulva*), among which *P.* cf. *fulva* was a new record for the Turkish freshwater ostracod fauna. In 2009 and In 2011, Külköylüoğlu and his colleagues published their studies from Lake Sünnet and they reported nine ostracod species (Külköylüoğlu et. al., 2009). In addition, *Ilyocypris getica* was reported in Turkey for the first time. Külköylüoğlu and Sarı also studied in 2010 in Bolu and they published 40 taxa (Külköylüoğlu and Sarı, 2010). Külköylüoğlu and his colleagues (2011) reported 23 ostracod taxa in Diyarbakır. His studies on ecology, distribution, diversity and seasonal studies of ostracods and their usage as bioindicator species have still been continued.

Özuluğ et al., (2001) studied in Lake Eğirdir, and reported the first parthenogenetic populations of *Plesiocypridopsis newtoni* from Anatolia. Özuluğ (2005) studied in Thrace which was in the European part of Turkey and she reported a new species (*Ilyocypris salebrosa*) for the freshwater Ostracoda fauna in Turkey. Furthermore, living specimens of *I. salebrosa* recorded in the current study were the first time in Europe. Özuluğ and Yaltıer studied in Rezve stream in 2008 and they found nine non-marine Ostracoda species. Among them *Kovalevskiella bulgarica* (Danielopol, 1980) is new record for the ostracod fauna of Turkey. Özuluğ and her colleagues studied in 2009 and they published a new record for the Ostracoda fauna of Turkey: *Candonopsis scourfieldi.* In 2011, Özuluğ published short communication about the fauna of Istranca Stream and she reported 10 species and also *Pseudocandona albicans* is new record for Thrace region of Turkey.

Kılıç et al., (2000) studied in the coasts of Gökçeada Island (Aegean Sea), and Kılıç completed his Ph.D. Thesis in the Black Sea coasts of Turkey in the year 2001. Then, he studied in the Black Sea Coasts and reported 24 species and three subspecies (Kılıç, 2001). Also 12 of these species (*Potamocypris steueri, Leptocythere multipunctata, Callistocythere mediterranea, C. diffusa, Pontocythere baceseoi, Eucytherura bulgarica, Microcytherura nigrescens, Loxoconcha pontica, Xestoleberis cornelii, Sclerochilus gewmülleri, Paradoxostoma intermedium and P. guttatum*) and three subspecies (*Cythereis rubra pontica, Xestoleberis aurantia aurantia and X. aurantia acutipenis*) were new records for the Ostracoda fauna of Turkey.

In 1996 Aygen studied in İzmir Region and he reported 15 ostracod species in his M.S. Thesis. Aygen and Balık (2002) collected a bisexual population of *Hungarocypris madaraszi* in Küçük Menderes (İzmir). This species was a new record for Turkey. Moreover, Aygen and his colleagues (2004) studied near Köyceğiz in southwestern Anatolia and found two new species (*Humpcypris subterranea* and *H. brevicaudata*) for Turkey.

Akdemir (2004) reported 14 ostracod taxa (*D. stevensoni, C. angulata, Candona* sp.1, *Candona* sp. 2, *Pseudocandona marchica, Cypria* sp., *I. gibba, I. bradyi, I. monstrifica, H. salina, Potamocypris* sp., *Limnocythere* sp., *Paralimnocythere* sp., *and Cythereis* sp.) belonging to 10 genera were identifiedfrom three crater lakes in Konya region in her M.S. Thesis. In 2009, Akdemir reported 43 species in her Ph.D. Thesis which 32 species found in Erzincan were all new reports for the city, five of them (*Fabaeformiscandona angusta, Cypria sywulae, Cyclocypris serena, Psychrodromus robertsoni, Paralimnocythere compressa*) were new reports for Turkish Ostracoda fauna. Among 25 species found in Diyarbakır, 15 were new reports for the city when two of them (*H. intermedia, P. pallida*) were also reported for the first time from Turkey. Akdemir and her colleagues (2011) reported 29 species from Gaziantep region.

Yılmaz and Külköylüoğlu (2006) studied in Lake Aladağ and reported nine ostracod taxa (*C. candida, C. vidua, D. stevensoni, E. virens, L. inopinata, Eucypris* sp.*, Heterocypris* sp.*, P. kraepelini and T. lutaria*).

Karakaş-Sarı (2006) listed 10 more species in her M.S. Thesis from two rheocrene springs in Bolu region, where Scottia pseudobrowniana was reported second time from Turkey.

Dügel et al., (2008) studied in Lake Abant Nature Park where one of the most famous among 16 nature parks in Turkey. They reported a total of 16 taxa of Ostracoda (*C. vidua, C. neglecta, C. candida, D. stevensoni, C. ophtalmica, P. kraepelini, I. bradyi, H. incongruens, N. monacha, P. compressa, E. pigra, H. chevreuxi, P. olivaceus, P. fontinalis, C. pubera, Leucocythere* sp.). (*P. fontinalis and E. pigra*) among them were recorded for the first time for Ostracoda fauna of the region.

In 2007 Sarı reported 41 taxa in his M.S. Thesis pertaining to 21 genus (*P. olivaceus, P. fontinalis, C. neglecta, C. candida, C. weltneri, C. sanociensis, C. lactea, P. compressa, P. albicans, P. cf. semicognita, F.fabaeformis, F. cf. breuili, F. balatonica, F. brevicornis, F. protzi, F. latens, S.* cf. *belgica, H. incongruens, H. salina, H. rotundata, I. bradyi, I. gibba, I. getica, I. inermis, H.chevreuxi, H. reptans,* *H. brevicaudata, P. villosa, P. similis, P. fulva, P. smaragdina, C. vidua, C. ophthalmica, S. pseudobrowniana, P. zenkeri, T. serrata, C. laevis, E. virens, P. kraepelini, Cavernocypris* sp., *D.* aff. *stevensoni*) were defined. 12 new species (*C. weltneri, C. sanociensis, C. lactea, F.* cf. *breuili, F. balatonica, F. brevicornis, F. protzi, F. latens, S.* cf. *belgica, P.* cf. *semicognita, P. similis, P. smaragdina*) were registered to Turkish Ostracoda fauna. Among these *Schellencandona* was a newly recorded genus for non-marine Ostracoda fauna of Turkey.

In 2008, in M.S. Thesis of Balci, he reported nine living Ostracoda species, which 6 are characterized as cosmopolitan were recorded (*C. neglecta, I. bradyi, I. getica, I. inermis, L. inopinata, P. kraepelini, S. fischeri, P.* cf. *eremita and P. albicans*) in the Lake Sünnet.

In 2011, Yavuzatmaca reported nine ostracod species from the freshwater caves in the Western Black Sea Region of Turkey in his M.S. Thesis. Among all the nine taxa, living adult individuals of *I. bradyi, I. inermis* and *C. neglecta* were reported herein for the first time from the cave environments in the literature. Furthermore, the other four taxa (*Ilyocypris* sp., *Candona* sp., *Heterocypris* sp., and *Pseudocandona* sp.) was also the new records for cave Ostracoda fauna of Turkey.

In addition to these previous studies, several other studies reports total of about 135 freshwater ostracod species in Turkey (Külköylüoğlu, pers. comm.). However, such number is believed to be underestimated, and is possibly much higher. Two possible reasons for a small numbers of species recorded so far can be either difficulties in taxonomic works that includes many regions unsampled so far, or a few numbers of ostracodologist found not only in Turkey but also in the world.

Ecological Hypotheses According to Species-Area relationship

H.G. Watson first described the species area relationship in 1835 (Connor and McCoy, 2001). Species–Area relationships have been of interest in ecology for a long time. This relationship is one of the largest and most frequently studied patterns in nature (Hill et al., 1994). The species–area relationship serves invaluable tool for studying the effects of other environmental variables (Lomolino, 1990). The species–area relationship has also played important role in explaining past and predicting future chances in biological diversity (MacArthur and Wilson, 1967). Species–area relationships are important both to understand and to improve the biodiversity (Turner and Tjørve, 2005).

There are at least eight hypotheses about species-area relationship. These are the passive sampling hypothesis or the random placement hypothesis, the island biogeography theory (area per se effect), the habitat diversity hypotesis, the sampling effect hypothesis, the intermediate disturbance hypothesis, the small island habitat hypothesis, the target area hypothesis and the species-energy hypothesis.

The Passive Sampling Hypothesis or The Random Placement Hypothesis

The passive sampling hypothesis (Connor and McCoy, 1979) proposes that larger areas take more colonists than small areas. In addition, these colonists represent a wide arrangement of species than the pool of colonists reaching on small areas. As a result of the higher abundance of colonists is expected that any increase in habitat diversity is independent from large areas and also reduction in extinction possibilities. Colonists are important. Furthermore, more colonists have higher species richness.

The random placement hypothesis (Arrhennius, 1924; Coleman, 1981) is based on a finite area contains only a finite number of individuals. Due to the fact that the area increases, the total number of individuals increases. Generally, there is an increase in the deviation corresponding to increasing area. According to this hypothesis, increasing areas illustrate larger samples of individuals positioned randomly in space.

The passive sampling hypothesis or the random placement hypothesis (Arrhennius, 1924; Connor and McCoy, 1979; Coleman, 1981) has positive relation between area and species number with a non random distribution. But it denies the importance of habitat differences. The sampling hypothesis confuses the species extinction so it differs from the area per se hypothesis. In random placement hypothesis, more cosmopolitan species have higher species richness. The important distinction between the passive sampling hypothesis and the others is viewed solely as a sampling phenomenon.

Island Biogeography Theory (Area per se effect)

The area per se hypothesis (MacArthur and Wilson, 1963; 1967) proposes that the abundance of each species in a sample region diversifies as a positive function of region's area. On the other hand, each species may go extinct in that area. This is the negative function of the area. According to the area per se effects, large areas have more species than small areas because there can be more areas to survive. Furthermore, species – area relationship is examined in a group of patches consisting of a single type of habitat. The most important factor for species richness is the area. If there is large area, extinction rate is low. So, species richness is increased with the large area.

The Habitat Diversity Hypothesis

The habitat diversity hypothesis (Williams, 1964) is based on the increase in species richness in large areas is higher than small areas. In addition, large areas have a greater diversity of habitats than small areas. According to this hypothesis, there is no relation between species number and area. Hence, the most important factor in increasing of species number is habitat diversity.

In the habitat diversity hypothesis, the large areas have more habitat types. When habitat types are diversified, species richness increases. Therefore, area per se is not an important factor. The most important factor in the habitat diversity hypothesis is diversity of habitats. In previous study (Nilsson et al., 1988), if the habitat diversity is correct, there is no relationship between species number and the lenght of area but if the area per se hypothesis is correct, lenght of area is the most important factor for species richness independent of habitat diversity.

The Sampling Effect Hypothesis

According to the sampling effect hypothesis (Williamson, 1988; Hill et al., 1994), the number of species increases with the number of sampling. The sampling effect hypothesis is based on the assumption that all individuals in a community are located randomly. Thus, to find any particular species is a chance. If sampling is increased, species richness increases.

This hypothesis (Williamson, 1988; Hill et al., 1994) is based on the sampling. Area does not have a primary importance. So, it differs from the area per se hypothesis. In previous study (Hill et al., 1994), all individuals in a community is located randomly. Furthermore, species richness is enhanced by the chance of finding any particular species with more sampling.

The Intermediate Disturbance Hypothesis

The intermediate disturbance hypothesis (Connell, 1978) proposes that ecological communities reach an equilibrium state seldomly. Generally, there is a disturbance. Species compete each other and much competitive species kill or damage less competitive individuals. As a result of this, competitive elimination occurs and space for colonization takes place for much competitive species. According to this hypothesis, local species diversity is maximized when ecological disturbance is neither too rare nor too frequent. Diversity is thus maximized both much competitive and less competitive species coexist.

In the intermediate disturbance hypothesis (Connell, 1978), colonizing and competition are the most important factors. According to this hypothesis, if habitat diversity increases, species richness decreases so it differs from the habitat diversity hypothesis. In additon, if area size increases, species richness decreases because larger areas have more competition so it differs from area per se hypothesis (Townsend and Scarsbrook, 2012). If this hypothesis is correct, rapid colonizers and more competitive species co-occur.

The Small Island Habitat Hypothesis

The small island habitat hypothesis (Kelly et al., 1989; Tangney et al., 1990) proposes that if there are difficult conditions in island, number of adapted species is low. In addition, the island richness - area correlation is specified. The habitats in large and small islands are different. The small island habitats show tendency for isolating so species richness.

The small island hypothesis (Kelly et al., 1989; Tangney et al., 1990) refuses the effect of the large areas in the species richness so it differs from the area per se hypothesis. Afterwords, The small islands have more isolation effect but large areas have not. The small island hypothesis refuses the habitat diversity hypothesis, too. Due to the fact that there is no isolation effect on the habitat diversity hypothesis. However, the most important factor in species richness is the isolation in the small island hypothesis. If this hypothesis is correct, small islands with high isolation have more species richness.

The Target Area Hypothesis

The target area hypothesis (Buckley and Knedlhans, 1986; Lomolino, 1990) is based on the importance of island size or geometry. Large areas have huge potential and more effective target areas for potential immigrants. Furthermore, there is positive correlation between immigration rates and large islands. As a result of this, species richness increases with increasing area.

In the target area hypothesis (Buckley and Knedlhans, 1986; Lomolino, 1990) is based on the species richness have positive correlation with area and immigration rate. Immigration is the most important factor. On the other hand, in area per se hypothesis and the species energy theory, immigration rate is negligible (Tangney et al., 1990). In addition, large areas serve more influential target areas for the immigrants by active or passive immigrators. If this hypothesis is correct, colonization rate increases towards the large areas.

The Species – Energy Theory

The species – energy theory (Wright, 1983) differs from the island biogeography theory by replacing “area” with “available energy”. Available energy depends on the resources of the island. Moreover, available energy measures the total amount of the resource production on an island. This situation affects the species population sizes.

In the species energy theory (Wright, 1983), large areas have more species and low extinction rates like area per se effect. On the other hand, area is not important factor in species richness. In the species energy theory, available energy is replaced with the area so it differs from the area per se hypothesis. In addtion, available energy is related with productivity, climate or soil chemistry. When available energy is high, species richness increases. However, it can be low available energy in the large areas and this situation causes the decline of the species richness.

Importance of studying on species – area relationship

Spatial diversity patterns have important inferences for conservation of habitats, so does species. In addition, understanding these patterns contribute us to develope our knowledge about community structure. None of these hypotheses (passive sampling hypothesis or the random placement hypothesis, the island biogeography theory (area per se effect), the habitat diversity hypotesis, the sampling effect hypothesis, the disturbance hypothesis, the small island habitat hypothesis, the target area hypothesis and the species-energy hypothesis) were not used on ostracods before. So, this is very important for science to test these hypotheses on ostracods. Moreover, this study is the first study in this perspective using ostracods in the literature.

The aims of this study are (1) to determine the ostracoda fauna in Ankara, (2) to contribute the knowledge on ostracoda diversity and ecology, (3) to understand the habitat preferences of species with their ecological optimum and tolerance estimates, (4) to indicate the most suitable hypothesis about species-area relationship explaining ostracod diversity and (5) to focus on the importance of ostracods in this perspective.

CHAPTER II

MATERIALS AND METHODS

Site description

During this study, 173 different aquatic bodies (Appendix 1) were randomly selected from 17 counties (Gölbaşı, Şereflikoçhisar, Evren, Bala, Kazan, Kızılcahamam, Güdül, Polatlı, Haymana, Nallıhan, Beypazarı, Ayaş, Çamlıdere, Elmadağ, Akyurt, Kalecik, Çubuk) of Ankara (Figure 2). The selected stations include different aquatic habitats such as lakes, creeks, trough, dam, stream, water body, channel, pond, river and spring.

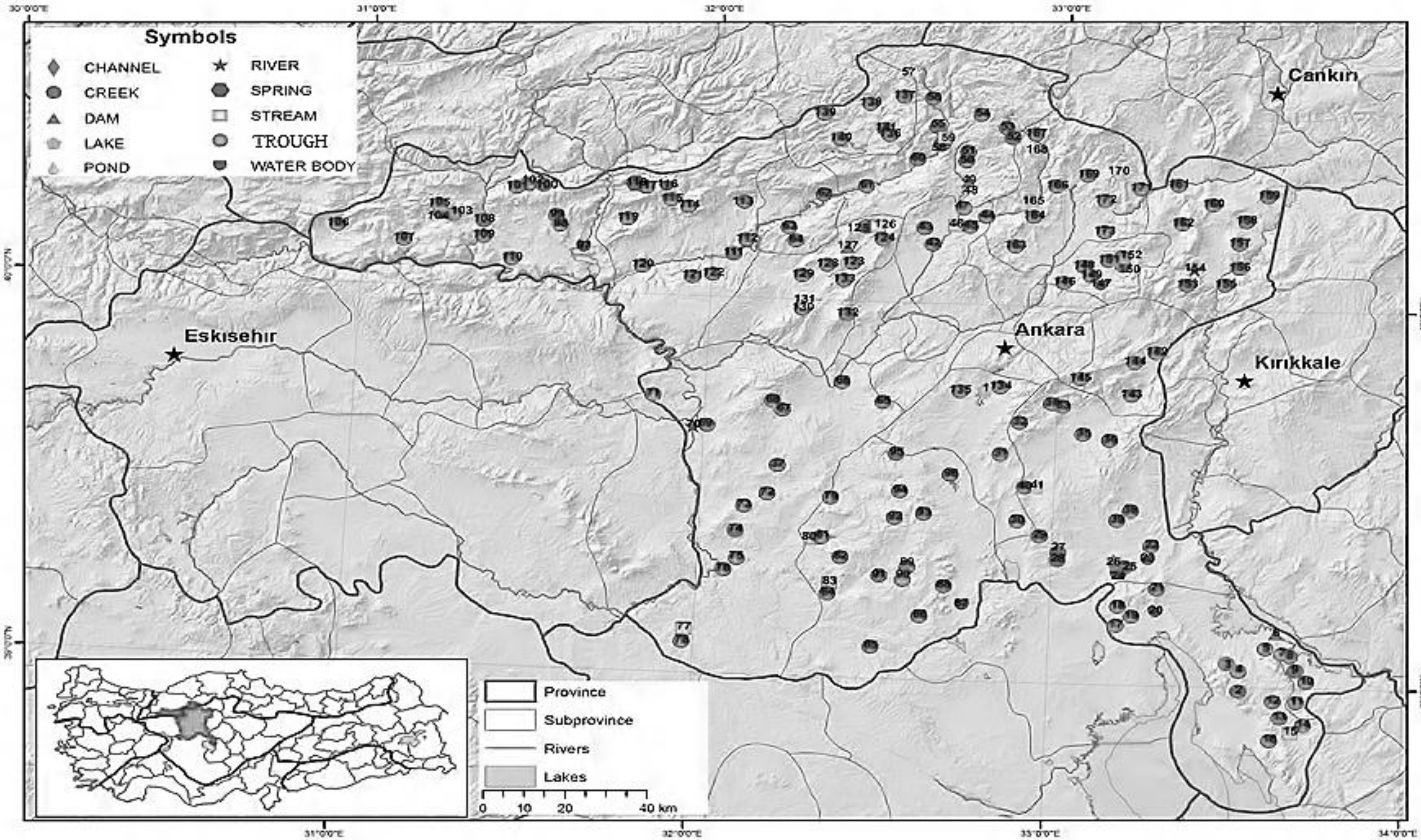


Figure 2. The map illustrates 173 stations which include different aquatic bodies in Ankara region.

Methodology

Materials were collected from June 22, 2011 to July 3, 2011 from different aquatic habitats. In addition to decline of "Pseudoreplication" (Hurlbert, 1984), before collecting materials, 12 environmental variables including pH, altitude (m), water temperature (°C), air temperature (°C), moisture (%), electrical conductivity (µS/cm), specific conductivity (µS/cm), dissolved oxygen (mg/l), percent oxygen saturation, total dissolved solids (mg/l), salinity (ppt), atmospheric pressure (mmHg) were measured from each site before materials collected. While we designate the sampling stations, we use the square measure of the counties. If the square measure of counties is in the range of 0-1000 km^2, we collect samples from nearly five stations. If the square measure of counties is in the range of 1000-2000 km^2, we collect samples from nearly ten stations. If the square measure of counties is bigger than 2000 km^2, we collect samples from nearly 20 stations. Moisture and air temperature were measured using Testo 410-2 model anemometer. Furthermore, Geographical information (e.g., altitude and coordinates) were recorded with a geographical positioning system (GPS 45 XL) unit. All other ecological variables were measured with YSI Professional Plus Series. On the other hand, the volume of the troughs were calculated with standard hand meter.

The samples were collected with a standard hand net (200 µm mash size) and fixed in 70% propanol *in situ* and kept in 250 ml plastic jars. In the laboratory, samples were washed under pressurized water and then filtered through three standard sized sieves (0,25; 1,00; 1,50 mm in mesh size) and stored again in 70% propanol. Ostracods were seperated from sediment under Olympus ACH 1X stereomicroscope. After that, ostracods were fixed in 70% propanol. Species identification was based on the carapaces and soft body parts. Each specimen was dissected using lactophenol solution and mounted on a permanent slide. Moreover, the species were identified under the Olympus BX-51 model. The systematic keys of Meisch (2000) for Western and Central Europe was used for identification of ostracods. Specimens were kept at the Hidrobiology Laboratory of the Department of Biology (Abant İzzet Baysal University).

Statistical Analyses

Four (Shannon Wiener, Simpson, Margalef and Berger Parker Dominance) alpha diversity indices were used to estimate the habitats with high diversity to explain habitat diversity. The diversity methods were examined with the program of *Species Diversity and Richness, Version 4* (Seaby and Henderson, 2006). These alpha indices were used to compare community structures. We preferred species occurred three or more times, during this study while subfossils were excluded from the analyses because this situation can affect the tolerance and optimum values of the species.

Furthermore, Optima (uk) and tolerance (tk) values are calculated for the five most influential variables as disolved oxygen, water temperature, altitude, atmospheric pressure and moisture for 16 ostracods species. Ecological tolerance and optimum estimates were calculated after transfer function with weighted averaging model in C2 program (Juggins 2003).

Unweighted Pair Group Mean Averages (UPGMA) was used to determine the relationships among species of Ankara region. Spearman Coefficient test was applied to UPGMA dendogram. The UPGMA analyses were performed with Multi-Variate Statistical Package (MVSP) version 3. 1. (Kovach 1998).

Spearman Rank Correlation analysis along with two-tailed significance of bivariate correlations was used to indicate the levels of correlations among the species, environmental variables and both (SPSS 17.0).

A multivariate statistical method, Canonical correspondence analysis (CCA) along with Monte Carlo permutation tests (499 permutations) was used to show the effect of five environmental variables on 16 species. (Ter Braak and Barendregt, 1986, Ter Braak and Verdonschot 1995).

ANOVA was used to observe whether variances of the mean values of major environmental variables and species were significantly different each other. In addition, unequal variance of independent t-test was used to indicate whether trough age and species number were significant each other.

CHAPTER III

RESULTS

Taxonomy

Total of 31 taxa were found in this study from the different types of aquatic habitats. The species encountered during this study belong to infraorder (Cypridocopina). Cypridocopina had 15 genera (*Candona, Pseudocandona, Ilyocypris, Cypris, Eucypris, Prionocypris, Trajencypris, Herpetocypris, Psychrodromus, Cyprinotus, Heterocypris, Cypridopsis, Cavernocypris, Potamocypris*) in three families (Candonidae, Ilyocyprididae, Cyprididae). All the species shown in this study belong to the subclass of Podocopa, the order Podocopida, the suborder Podocopina, infraorder Cypridocopina and superfamily Cypridoidea.

PHYLUM: ARTHROPODA Latreille, 1829

SUBPHYLUM: CRUSTACEA Pennant, 1777

CLASS: OSTRACODA Latreille, 1806

SUBCLASS: PODOCOPA Müller, 1894

ORDER: PODOCOPIDA Sars, 1866

Suborder Podocopina Sars, 1866

Infraorder Cypridocopina Jones, 1901

Superfamily Cypridoidea Baird, 1845

Family Candonidae Kaufmann, 1900

Subfamily Candoninae Kaufmann, 1900

Genus *Candona* Baird, 1845

Candona neglecta (Sars, 1887)

Genus *Pseudocandona* Kaufmann, 1900

Pseudocandona eremita (Vejdovsky, 1882)

Family Ilyocyprididae Kaufmann, 1900

Subfamily Ilyocypridinae Kaufmann, 1900

Genus *Ilyocypris* Brady&Norman, 1889

Ilyocypris bradyi (Sars, 1890)

Ilyocypris inermis (Kaufmann, 1900)

Ilyocypris gibba (Ramdohr, 1808)

Family Cyprididae Baird, 1845

Subfamily Cypridinae Baird, 1845

Genus *Cypris* O. F. Muller, 1776

Cypris pubera (O. F. Muller, 1776)

Subfamily Eucypridinae Bronshtein, 1947

Genus *Eucypris* Vávra, 1891

Eucypris virens (Jurine, 1820)

Eucypris lilljeborgi (G.W. Müller, 1900)

Eucypris elliptica (Baird, 1846)

Genus *Prionocypris* Brady&Norman, 1896

Prionocypris zenkeri (Chyzer&Toth, 1858)

Genus *Trajancypris* Martens, 1989

Trajancypris clavata (Baird, 1838)

Trajancypris laevis (G.W. Müller, 1900)

Subfamily Herpetocypridinae Kaufmann, 1900

Genus *Herpetocypris* Brady&Norman, 1889

Herpetocypris reptans (Baird, 1835)

Herpetocypris brevicaudata (Kaufmann, 1900)

Herpetocypris chevreuxi (Sars, 1896)

Herpetocypris helenae (G.W. Müller, 1900)

Herpetocypris intermedia (Kaufmann, 1900)

Genus *Psychrodromus* Danielopol&Mc Kenzie, 1977

Psychrodromus olivaceus (Brady&Norman,1889)

Psychrodromus fontinalis (Wolf, 1920)

Subfamily Cyprinotinae Bronshtein, 1947

Genus *Cyprinotus* Brady, 1886

Cyprinotus sp.

Genus *Heterocypris* Claus, 1892

Heterocypris incongruens (Ramdohr, 1808)

Heterocypris salina (Brady, 1868)

Subfamily Cypridopsinae Kaufmann, 1900

Genus *Cypridopsis* Brady, 1867

Cypridopsis sp.

Genus *Cavernocypris* Hartmann, 1964

Cavernocypris subterranea (Wolf, 1920)

Genus *Potamocypris* Brady, 1870

Potamocypris pallida Alm, 1914

Potamocypris similis (Müller, 1912)

Potamocypris unicaudata (Schafer, 1943)

Potamocypris villosa (Jurine, 1820)

Potamocypris arcuata (Sars, 1903)

Potamocypris zschokkei (Kaufmann, 1900)

Species diversity

During the study, samples were collected and data gained for 31 taxa (*C. neglecta, P. eremita, I. bradyi, I. gibba, I. inermis, C. pubera, E. virens, E. lilljeborgi, E. elliptica, P. zenkeri, T. clavata, T. laevis, H. chevreuxi, H. reptans, H. brevicaudata, H. helenae, H. intermedia, P. olivaceus, P. fontinalis, Cyprinotus* sp., *H. incongruens, H. salina, Cypridopsis* sp., *C. subterranea, P. villosa, P. similis, P. variegata, P. pallida, P. unicaudata, P. arcuata, P. zschokkei*) were evaluated below. The distribution of stations per county follows as, Gölbaşı (5), Şereflikoçhisar (14), Evren (6), Bala (17), Kazan (6), Kızılcahamam (15), Güdül (3), Polatlı (14), Haymana (18), Nallıhan (14), Beypazarı (12), Ayaş (11), Çamlıdere (5), Elmadağ (5), Akyurt (6), Kalecik (11), Çubuk (11). Except a few subfossil forms, no ostracods found in twenty one stations as (St. 2, St. 22, St. 32, St. 47, St. 50, St. 51, St. 84, St. 89, St. 90, St. 91, St. 96, St. 122, St. 123, St. 131, St. 138, St. 141, St. 147, St. 149, St. 153, St. 154 and St. 164) (Apendix 1). Furthermore, two new reports for Turkish ostracoda fauna (*C. subterranea* and *E. elliptica*) were found from two different stations (St. 54 and St. 107) (Appendix 1) and 19 taxa *(P. eremita, I. gibba, I. inermis, C. pubera, E. lilljeborgi, T. clavata, T. laevis, H. reptans, H. brevicaudata, H. helenae, H. intermedia, P. olivaceus, P. fontinalis, Cyprinotus* sp.*, P. similis, P. variegata, P. pallida, P. arcuata, P. zschokkei)* were first records for Ankara. The species *H. incongruens* was the most common species which found in 93 stations with 2760 individuals of all 17 counties. A cosmopolitan species, *I. bradyi* was the second common species with 779 individuals from 39 stations and *H. salina* was the third common species with 1050 individuals from 35 stations. 31 ostracoda taxa were collected from troughes but none of them was bisexual.

Evaluation of Data

The average values of the variables calculated as Dissolved Oxygen (DO) 9.0 mg/L, percentage of disolved oxygen (DO%) 99.31 mg/L, Electrical Conductivity (EC) 745.22 μS cm-1, total dissolved solute (TDS) 0.6819, pH 7.85, Temperature of water (TºC (w)) 18.43ºC, moisture (%) 36.0, Temperature of air (TºC (a)) 27.0ºC and salinity 0.54 ppt.

Table 1. It shows species diversity of 10 different aquatic habitats. Some abbreviations are used for species are given as; (*Candona neglecta* (Cn), *P. eremita* (Pe), *I. bradyi* (Ib), *I. gibba* (Ig), *I. inermis* (Ii), *C. pubera* (Cp), *E. virens* (Ev), *E. lilljeborgi* (El), *E. elliptica* (Ee), *P. zenkeri* (Pz), *T. clavata* (Tc), *T. laevis* (Tl), *H. chevreuxi* (Hc), *H. reptans* (Hr), *H. brevicaudata* (Hb), *H. helenae* (Hh), *H. intermedia* (Hn), *P. olivaceus* (Po), *P. fontinalis* (Pf), *Cyprinotus* sp. (Ci), *H. incongruens* (Hi), *H. salina* (Hs), *Cypridopsis* sp. (Cy), *C. subterranea* (Cs), *P. villosa* (Pi), *P. similis* (Ps), *P. variegata* (Pv), *P. pallida* (Pp), *P. unicaudata* (Pu), *P. arcuata* (Pa), *P. zschokkei* (Ph), *Pseudocandona* sp. (Pc), *potamocypris* sp. (Pm), *psychrodromus* sp. (Py), *Ilyocypris* sp. (Is) *Eucypris* sp. (Es), *Candona* sp. (Ca), *Herpetocypris* sp. (He), *Potamocypris cf. similis* (Pt), *Pseudocandona* cf. *eremita* (Px), *Trajancypris* sp. (Ts)).

Habitats	**Species**
Lakes	Hi, Pc, Tl
Creeks	Hi, Ib, Cn, Pu, Hc, Pi, Pf
Troughs	Cn, Cs, Cy, Cp, Ee, El, Ev, Hc, Hh, Hb, Hr, Hi, Hs, In, Ig, Ib, Ii, Pa, Pp, Ps, Pv, Pi, Pu, Ph, Pz, Px, Pe, Po, Pf, Tc, Tl
Dams	Hi, Pz, Hh, Hn, Hs, Ig
Streams	Pz, Hi, Ib, Pt, Cn, Hs, Ii
Water bodies	Hi, Ev, Hs, Ib, Po, Tl
Channels	Hi, Ib
Pons	Ib, Pz, Hs
Rivers	Hi
Springs	Ib, Pz, Po, Pf

Unweighted Pair Group Mean Averages (UPGMA) was used to show relationships among species (Figure 3). This analysis exhibited four main clustering groups of fourteen species with two outgroups (*I. gibba* and *H. salina*). First group (I) includes three species (*P. zenkeri*, *I. bradyi*, *H. reptans*), second group (II) includes three species (*P. fontinalis*, *P. olivaceus*, *E. virens*), third group (III) includes four species (Hi, Pa, Hb, Hh) and fourth group (IV) includes four species (*H. chevreuxi*, *P. villosa*, *T. laevis* and *E. lilljeborgi*). The species of the first group *I. bradyi* and the species of the third group *H. incongruens* were dominant species. On the other hand, species in the fourth group (*H. chevreuxi*, *P. villosa*, *T. laevis* and *E. lilljeborgi*) were not found in high frequency.

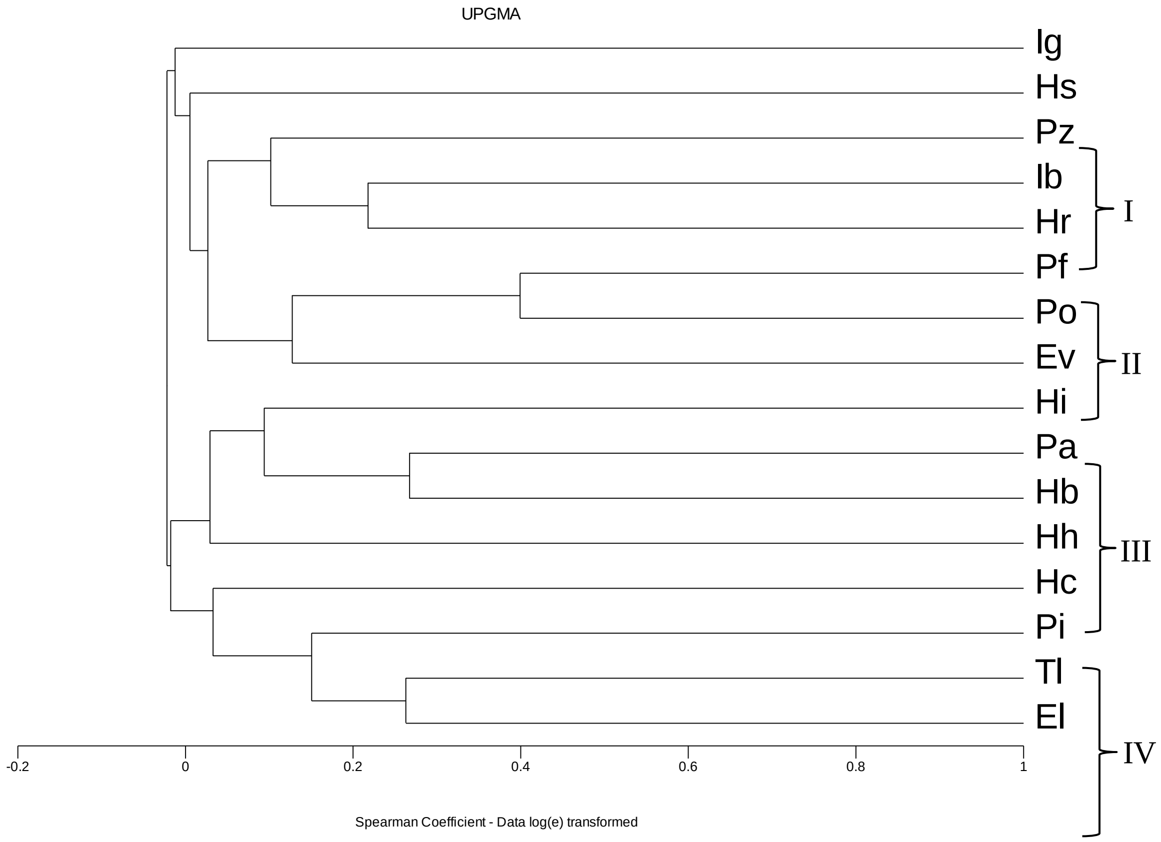


Figure 3. Unweighted Pair Group Mean Averages (UPGMA) illustrates the clustering relationships of 16 ostracods which collected at least three times in this study. Abbreviations were illustrated in Table 1.

Table 2. Optima (uk), tolerance (tk), values are calculated for mean alt, Tw, DO, atmp and moi for 16 ostracods species. Group no (and out group) represents clustering group numbers in UPGMA (*out group). N2 shows Hill's coefficient (measure of effective number of occurrences). Count and Max represent numbers of species occurrence and numbers of individuals. Abbreviations are given in Apendix 1.

UPGMA	**Species**	**count**	**Max**	**N2**	**Tw**		**moi**		**DO**		**alt**		**atm**	
group no					**uk**	**tk**	**uk**	**tk**	**uk**	**tk**	**uk**	**tk**	**uk**	**tk**
I	Pz	15	95	3.07	15.41	2.30	51.76	31.15	9.09	1.82	1078.33	266.06	670.19	13.15
	Ib	38	71	17.77	18.41	4.05	36.21	11.29	8.01	2.58	923.15	219.51	681.35	16.77
	Hr	5	113	1.54	18.21	2.28	14.27	6.07	11.06	2.04	865.25	97.59	679.09	4.11
II	Pf	6	18	3.83	13.52	0.61	36.75	6.23	8.46	0.98	1165.63	143.55	679.04	19.16
	Po	4	63	2.11	15.20	2.76	33.49	3.65	8.75	0.67	1129.00	252.68	676.26	14.56
	Ev	7	85	2.62	14.15	1.63	45.51	8.50	7.71	1.16	1227.72	268.89	656.89	22.05
III	Hi	78	223	27.66	19.97	3.60	31.42	11.94	11.01	2.76	951.78	193.76	679.90	13.55
	Pa	4	98	2.73	18.81	1.78	18.40	8.70	10.41	1.44	1021.14	262.50	677.57	5.03
	Hb	3	153	2.04	17.30	1.24	36.88	14.36	9.34	1.70	972.76	107.51	678.69	7.39
	Hh	5	332	2.31	19.20	5.86	20.44	5.60	7.11	0.98	1056.54	220.73	670.66	14.37
IV	Hc	3	63	1.47	20.85	1.67	40.97	10.82	7.17	1.36	769.09	159.86	692.72	13.84
	Pi	9	183	3.01	18.28	2.69	33.14	6.86	10.29	2.37	1199.41	108.26	658.57	8.18
	Tl	4	72	3.60	23.28	2.68	29.53	6.48	10.60	2.81	1148.25	240.79	661.91	20.34
	El	3	8	2.79	17.08	1.35	32.99	7.69	8.87	1.55	951.22	209.28	677.64	17.03
*	Ig	4	31	2.25	14.56	3.52	33.03	13.04	8.41	0.82	1138.45	540.12	663.64	44.70
	Hs	35	144	13.39	20.44	3.56	29.65	7.44	11.36	4.41	916.31	255.98	680.64	19.86
Max		78	332	27.66	23.28	3.52	29.65	31.15	11.06	2.81	1227.72	540.12	692.72	44.70
Min.		3	8	1.47	13.52	0.61	29.65	3.65	7.17	0.67	769.09	97.59	656.89	4.11
Mean		13.94	109.5	5.76	17.05	2.24	29.65	3.65	9.06	1.56	1080.13	230.87	670.92	17.79

Herpetocypris chevreuxi and *E. virens* had minimum and maximum optima values for altitude (Table 2). Furthermore, *I. gibba* showed the highest tolerance level (540 m) for altitude.

T. laevis showed the highest optima value (23 ^{O}C). However, *P. fontinalis* illustrated the lowest optima value (13 ^{O}C) for temperature of water (Table 2). In addition to this, *H. helenae* showed the highest tolerance value (6 ^{O}C).

H. helenae exhibited the minimum optima value (7 mg/l) but *H. salina* (Hs) showed the maximum value (11 mg/l) for dissolved oxygen (Table 2). Also, *H. salina* showed the highest tolerance value (4 mg/l).

Eucypris virens illustrated the minimum optimum value (657 mmHg) for atmospheric pressure (Table 2). On the other hand, *I. bradyi* illustrated the maximum value (681 mmHg). Besides, the highest tolerance value (45 mmHg) referred to *I. gibba*.

H. reptans and *P. zenkeri* had minimum and maximum optima values for moisture (Table 2). Also, *P. zenkeri* showed the highest tolerance value (31 %) for moisture.

H. incongruens illustrated the highest hills number (N2) (28). *H. incongruens* was the dominant species and collected from all the counties from Ankara. Furthermore, another cosmopolitan species *I. bradyi* and *H. salina* showed very high hills numbers (N2) after the *H. incongruens* (18 and 13) (Table 2).

Table 3. Summary of Spearman Correlation analysis showing statistically significant relationships among environmental variables, among ostracod species (see Table 1 for the species codes and Appendix 1 for the environmental variables codes) and among both environmental variables and ostracod species. In this table '*' shows the significant relationship at 0.05 level and '**' shows significant relationship at 0.01 level.'-' is referred to negative relationship.

ELEV-$T^{O}C_{A}$	**ELEV-$T^{O}C_{W}$**	**ELEV-EC**	**ELEV-pH**	**ELEV-ATM**	**ELEV-Hs**	**ELEV-Pf**	**$T^{O}C_{A}$-MOI**	**$T^{O}C_{A}$- $T^{O}C_{W}$**
-0.197*	-0.259**	-0.364**	-.0286**	-0.886**	-0.255**	0.180*	-0.743**	0.413**
$T^{O}C_{A}$-pH	**$T^{O}C_{A}$-Ev**	**$T^{O}C_{A}$-Hh**	**$T^{O}C_{A}$-Pa**	**MOI-$T^{O}C_{W}$**	**MOI-pH**	**MOI-DO**	**MOI-Hh**	**MOI-Hr**
0.204*	-0.229**	0.221*	0.189*	-0.366**	-0.235**	-0.216*	-0.226**	-0.210*
MOI-Hi	**MOI-Pa**	**MOI-Pz**	**$T^{O}C_{W}$-pH**	**$T^{O}C_{W}$-DO**	**$T^{O}C_{W}$-ATM**	**$T^{O}C_{W}$-Ev**	**$T^{O}C_{W}$-Hi**	**$T^{O}C_{W}$-Pf**
-0.234**	-0.207*	0.224**	0.583**	0.263**	0.217*	-0.228**	0.192*	-0.300**
$T^{O}C_{W}$-Tl	**EC-ATM**	**EC-Ib**	**EC-Pi**	**EC-Tl**	**pH-DO**	**pH-ATM**	**DO-Hr**	**DO-Hi**
0.189*	0.369**	0.216*	-0.268**	-0.181*	0.379**	0.241**	0.230**	0.311**
DO-Ib	**ATM-Hs**	**ATM-Pi**	**El-Hr**	**El-Hi**	**El-Pi**	**El-Tl**	**Hh-Pa**	**Hb-Pa**
-0.230**	0.201*	-0.240**	0.224**	0.184*	0.170*	0.263**	0.195*	0.268**
Hb-Po	**Hr-Hi**	**Hr-Ib**	**Hr-Pa**	**Hi-Pf**	**Ib-Pf**	**Po-Pf**		
0.276**	0.194*	0.218*	0.209*	-0.197*	0.177*	0.399**		

Spearman Correlation Analysis (Table 3) was used to examine relationships between 16 species and 10 environmental variables. Spearman Correlation Analysis showed that there are significant negative relationships between water temperature and altitude ($P<0.01$), water temperature and moisture ($P<0.01$), atmospheric pressure and altitude ($P<0.01$) and also dissolved oxygen and moisture ($P<0.05$). On the other hand, there are significant positive relationships between dissolved oxygen and water temperature ($P<0.01$), altitude and water temperature ($P<0.05$). As expected water temperature had significant positive relationship with dissolved oxygen because of evaporation. When atmospheric pressure decreases, water temperature decreases.

Although Spearman Correlation Analysis clearly illustrated relationships among some of the environmental variables, it failed to explain the relationships between some environmental variables and species. However, this analysis was able to give some important knowledge for interspecific relationships between species. For example, *I. bradyi* and *H. reptans* (first group in UPGMA) had a significant positive relationship ($P<0.05$). Moreover, *P. fontinalis* and *P. olivaceus* (second group in UPGMA) ($P<0.01$), *P. arcuata* and *H. helenae* (third group in UPGMA) ($P<0.05$), *P. arcuata* and *H. brevicaudata* (third group in UPGMA) ($P<0.01$), *P. villosa* and *E. lilljeborgi* (fourth group in UPGMA) ($P<0.05$) had also positive relatinships. As we seen such findings were also clearly supported by UPGMA. Relations in the groups of species in UPGMA (Figure 3) may depend on similar habitat preferences.

Figure 4. Canonical Correspondence Analysis (CCA) was used to exhibit relationship between 16 species and 5 environmental variables. In CCA diagram, triangles are symbolizing the species and the arrows are environmental variables. Abbreviations are given in Table 1 and Apendix 1.

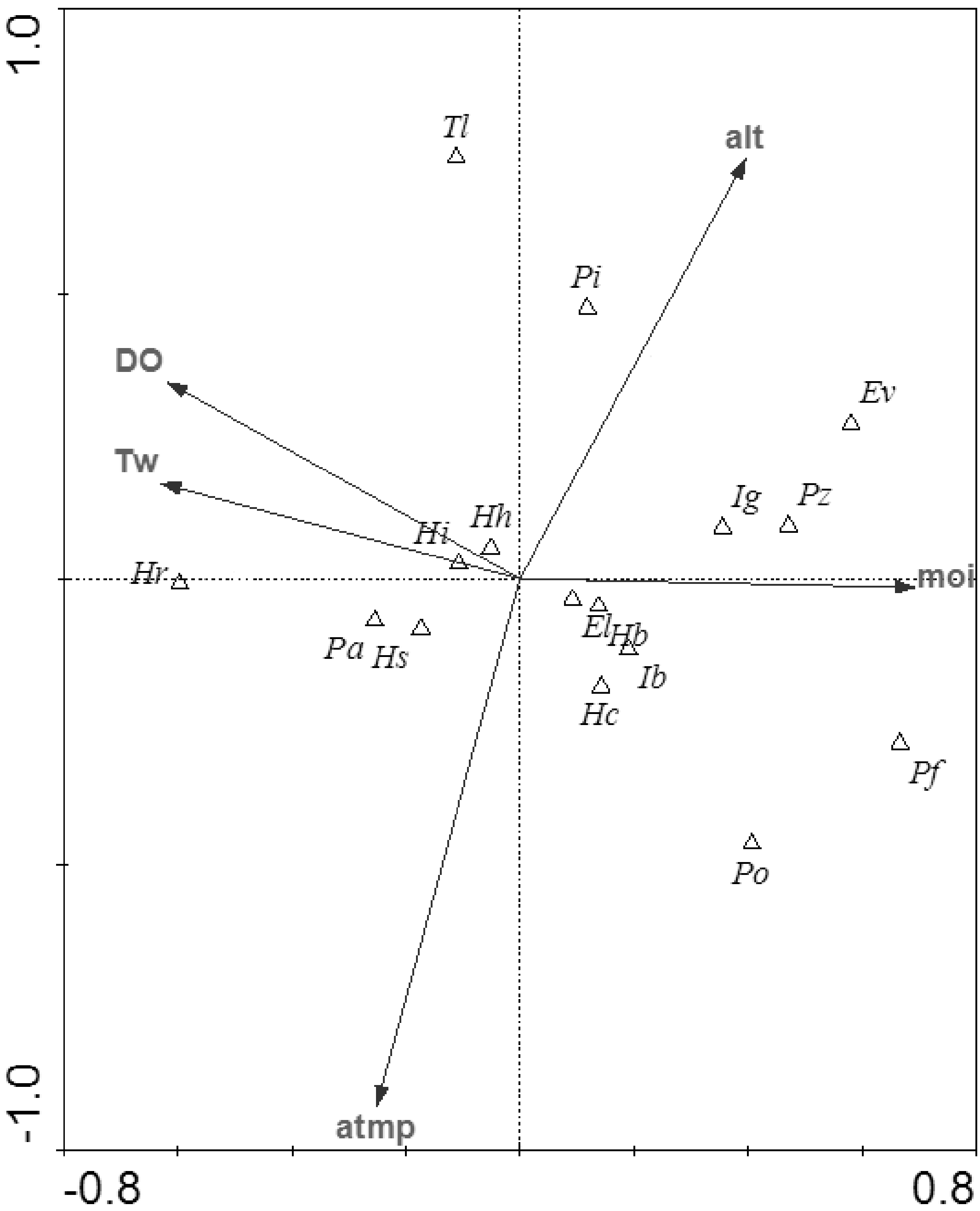


Figure 5. Canonical Correspondence Analysis (CCA) was used to exhibit relationship between stations and 5 environmental variables. In CCA diagram, circles are symbolizing the stations and the arrows are environmental variables. Abbreviations are given in Table 1 and Apendix 1.

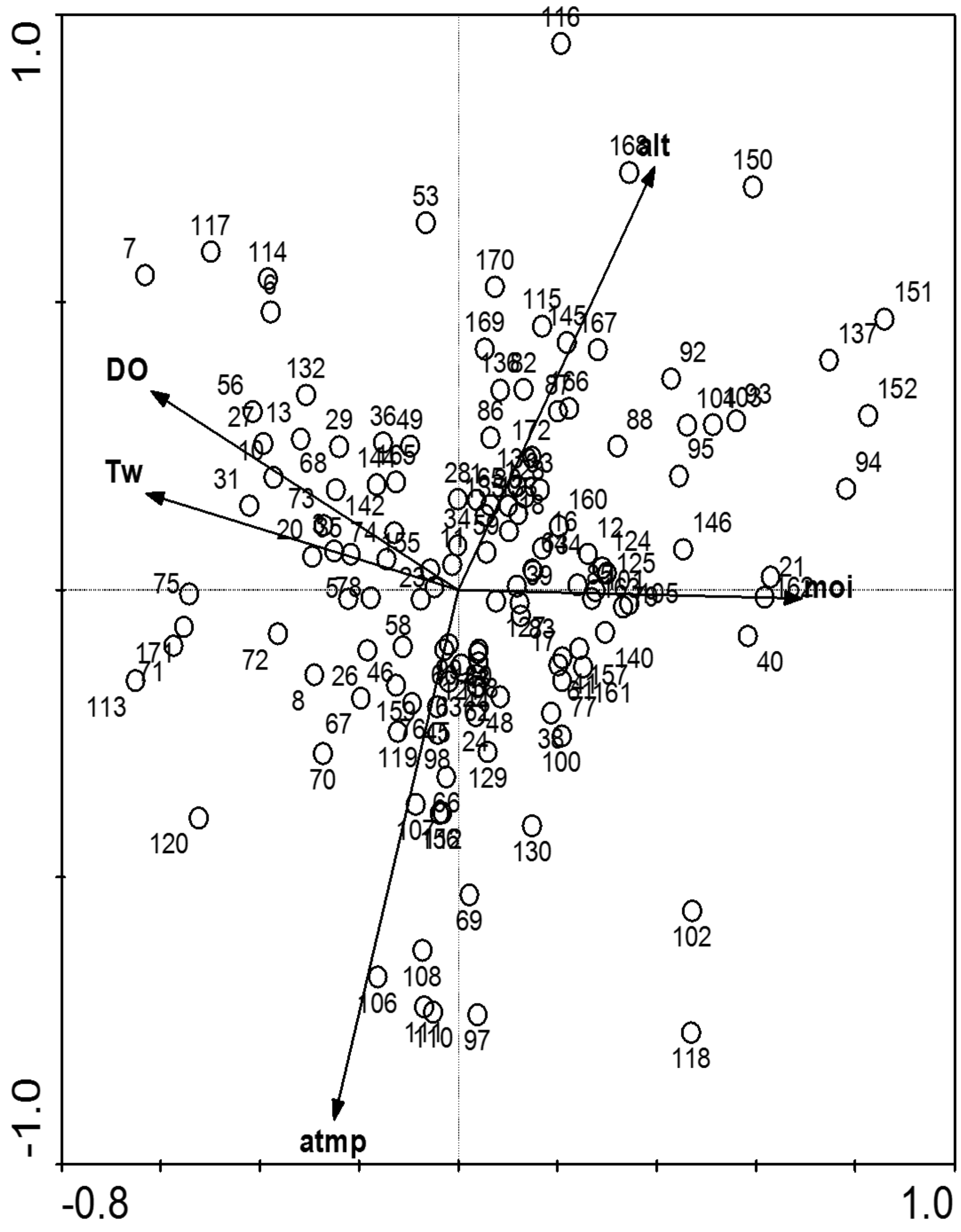


Table 4. Summary table of CCA were recorded using five most significant environmental variables (Figure 4 and 5) selected by a Monte Carlo test with 499 permutations.

Axes	1	2	3	4	Total inertia
Eigenvalues	0.162	0.093	0.076	0.074	7.287
Species-environment correlations	0.576	0.403	0.390	0.402	
Cumulative percentage variance of	2.2	3.5	4.6	5.6	
species data					
species-environment relation	37.4	58.9	76.4	93.4	
Sum of all eigenvalues					7.287
Sum of all canonical eigenvalues					0.434
Sum of all eigenvalue					7.287
Sum of all canonical eigenvalues					0.434

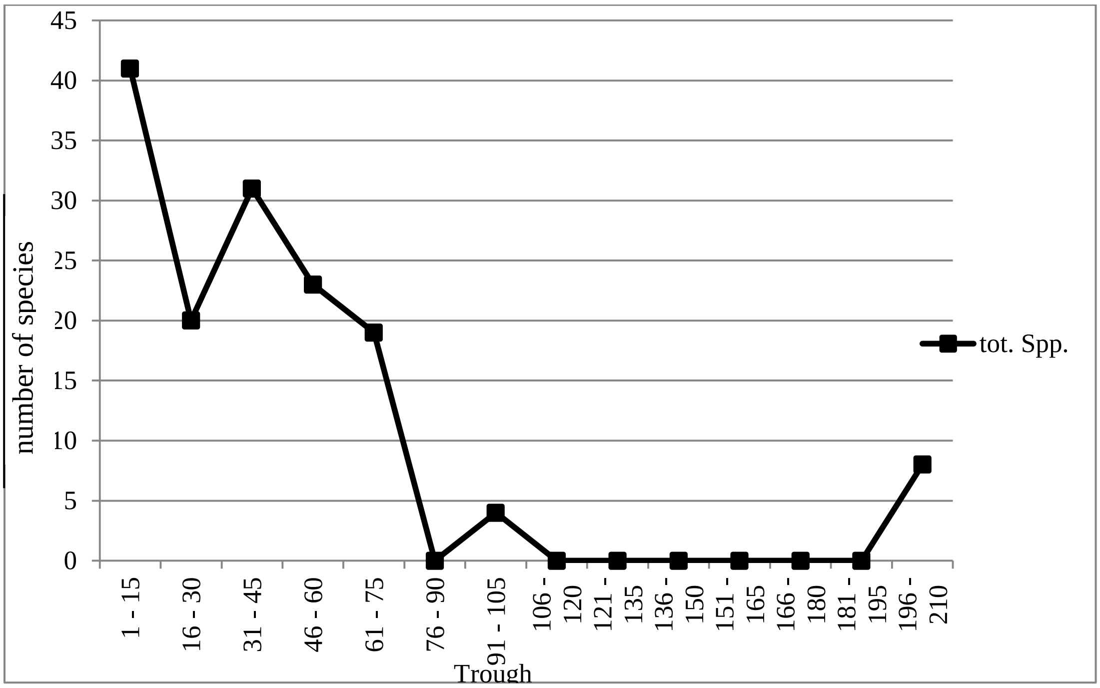
Water temperature: F = 1.896, P = 0.02; moisture: F = 2.098, P = 0.026; dissolved oxygen: F = 1.855, P = 0.044; altitude: F = 1.754, P = 0.046; and atmospheric pressure: F = 1.733, P = 0.05.

The relationships between the environmental datas and the species were analyzed at the 134 stations. In addition, critical values (Table 4) were interpretted the correlations between species and environmental datas about 59% between species occurrence and five environmental variables (water temperature, moisture, dissolved oxygen, altitude and atmospheric pressure) by the second axis of the CCA (Figure 4 and 5).

The placement of the species in CCA illustrates the relationships between the five environmental variables and 16 species with 134 stations. Therefore, eight species (*H. incongruens, H. chevreuxi, H. brevicaudata, I. bradyi, H. helenae, P. arcuata, H. salina, E. lilljeborgi*) are located closer to the center of CCA diagram

(Figure 4). On such an occasion, the location of these species means that they have wide tolerance ranges for these environmental variables.

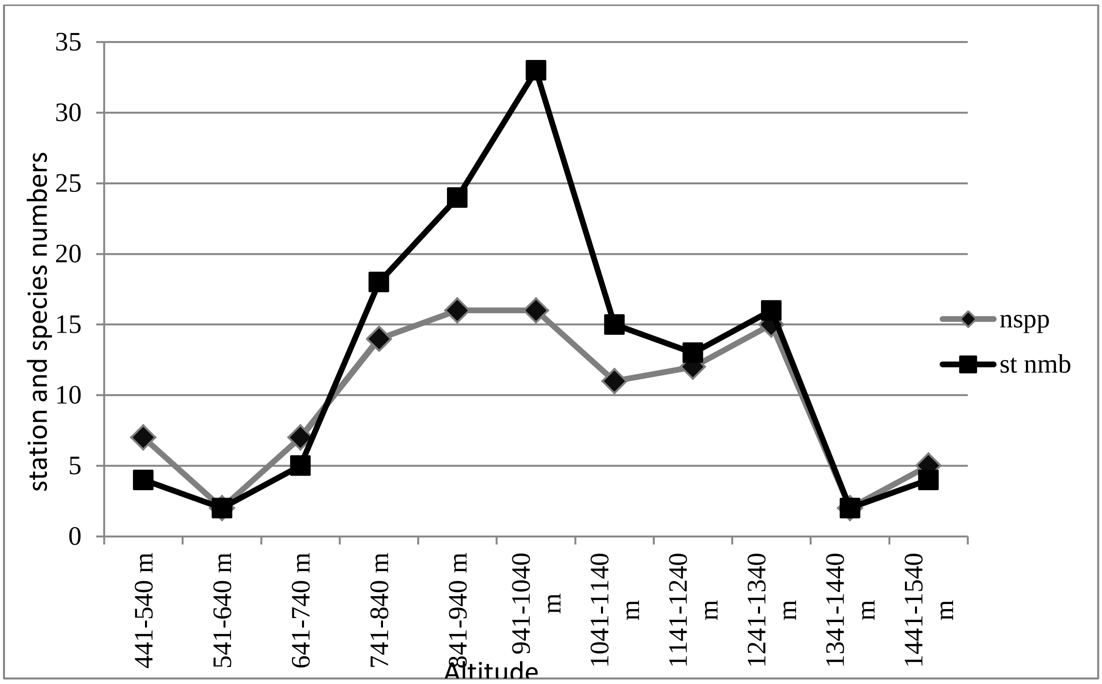
Figure 6. It illustrates differences between trough age and total species number (tot. Spp).



According to the unequal variances of independent t-tests, there were no significant differences (P>0.05) between trough age and total species number as we saw in Figure 6.

There was no significant relationships between the means of major environmental values and number of species (P>0.05).

Figure 7. It shows relationships between number of species (nspp) and station number (st nmb) at different altitudinal ranges.

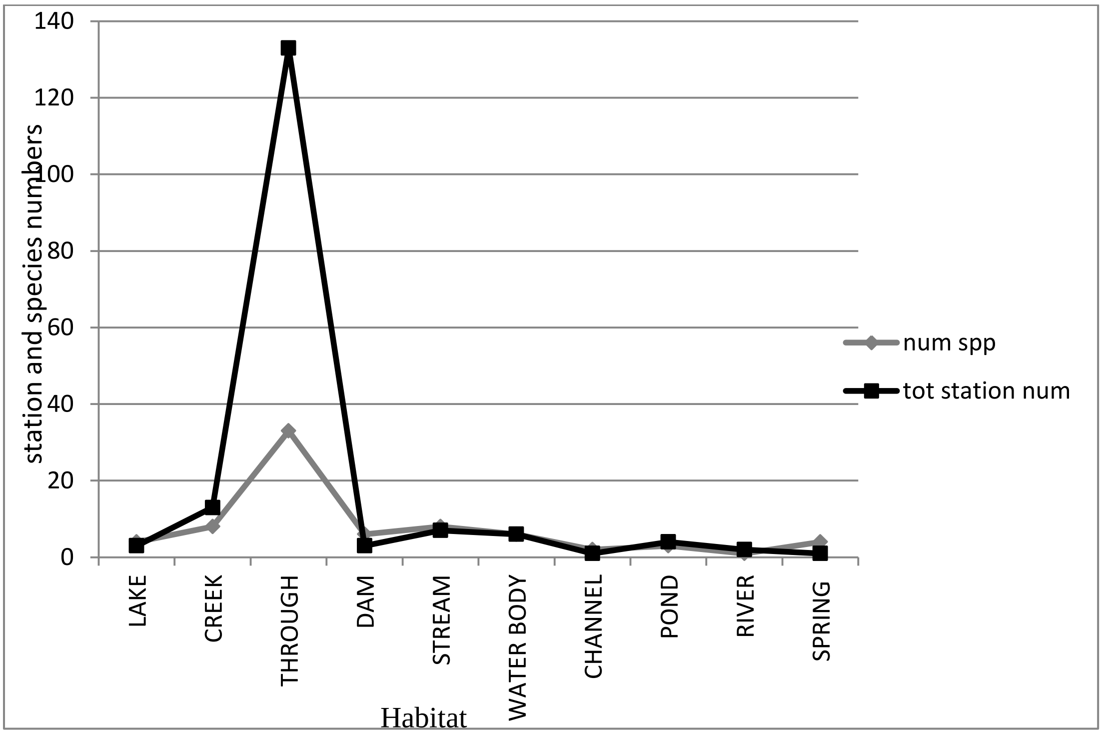


Altitude did not play significant role on the number of species and diversity (Figure 7) during the present study. Indeed, we found seven species from the elevational ranges of 441-540 m and 641-740 m. In contrast, there were 16 species found from the range of 841-940 m and 941-1040 m. Although there were 11 species at the range of 1041-1140 m, 15 species were found at the range of 1241-1340 m. In summary, our results did not show significant role of altitude.

Table 5. It illustrates comparison of diversity hypotheses. Adapted from Hill et. al. (1994).

Hypotheses about Species-Area Relationships	Large area	Habitat diversity	Sampling	Competition	Isolation	Available energy	Immigration
The passive sampling hypothesis (The random placement hypothesis)	✓						
The area per-se effect hypothesis	✓						
The habitat diversity hypthesis	✓	✓					
The sampling effect hypothesis	✓		✓				
The intermediate disturbance hypothesis				✓			
The small island habitat hypothesis					✓		
The target area hypothesis	✓						✓
The species-energy theory	✓					✓	

Figure 8. This figure illustrates the relationships between total station number (tot station num) and number of species (num spp) at different habitat types.



As we see in the Figure 8, species richness increases with habitat diversity.

Regional ostracod diversity was controlled by the ecological factors in different habitat types. Three types of habitats (troughs, creeks, streams) were selected with high habitat diversity in diversity partitioning analyses ($P<0.01$). Cosmopolitan species have great contribution to the ostracod alpha (regional) diversity (Figure 4 and 5). The successful widespread distribution of those cosmopolitans was closely related to their relatively high ecological tolerance and optimum levels (Table 2).

In general, our results support the assumption of the habitat diversity hypothesis, predicting that ostracod species diversity increases with increasing availability of different habitat types.

CHAPTER IV

Discussion and Conclusion

During the study, 31 taxa collected from 173 stations in 17 counties of Ankara. Two species are (*C. subterranea* and *E. elliptica*) new reports for the Turkish Ostracoda fauna, while 19 species (*P. eremita, I. gibba, I. inermis, C. pubera, E. lilljeborgi, T. clavata, T. laevis, H. reptans, H. brevicaudata, H. helenae, H. intermedia, P. olivaceus, P. fontinalis, Cyprinotus* sp., *P. similis, P. variegata, P. pallida, P. arcuata, P. zschokkei*) are attended from Ankara for the first time. *H. incongruens* was the most common species in 93 stations with 2760 individuals. Additionally, *I. bradyi* was the second dominant species with 39 stations and 779 individuals. Thus, *H. salina* was the third most common species which attended in 35 stations with 1050 individuals. According to Meisch (2000), all three species have cosmopolitan properties.

Comparing with the earliest reports in Ankara, Gülen et. al. (1994a) found three species (*E. virens, I. bradyi, H. incongruens*). These three species were also found in the present study from different stations. Moreover, Gülen and Altınsaçlı (1999) studied in Babayakup Stream and Ova Stream in Ankara and found five species (*T. amnicola, I. biblicata, C. vidua, P. zenkeri* and *P. villosa*). In our study, we did not find first three species. This might be due to several reasons such as different sampling time and/or habitat types. Altınsaçlı (2003) studied in Lake Mogan and

Lake Eymir and he reported 12 species (*C. angulata, C. neglecta, l. biblicata, l. bradyi, P. kraepelini, H. chevreuxi, P. zenkeri, H. incongruens, H. salina, C. vidua, P. unicaudata,* and *L. inopinata*) from Lake Mogan. In addition, we found only two species as *H. incongruens* and *Pseudocandona* sp. from Lake Mogan but we found *C. neglecta, l. bradyi, H. chevreuxi, P. zenkeri, H. salina, P. unicaudata* from Ankara. In Lake Eymir, Altınsaçlı (2003) found 10 species (*C. neglecta, l. biblicata, P. kraepelini, H. chevreuxi, P. zenkeri, H. incongruens, H. salina, C. vidua, P. unicaudata,* and *L. inopinata*). On the other hand, all these ten species were interestingly common species found from Lake Mogan by Altınsaçlı. In consequences, in this study, we added the 21 new species (*P. eremita, I. gibba, I. inermis, C. pubera, E. lilljeborgi, T. clavata, T. laevis, H. reptans, H. brevicaudata, H. helenae, H. intermedia, P. olivaceus, P. fontinalis, Cyprinotus* sp., *P. similis, P. variegata, P. pallida, P. arcuata, P. zschokkei*) to the Ostracoda fauna of Ankara. Afterword, number of Ostracoda species in Ankara raised from 15 to 36 with this study.

In Unweighted Pair Group Mean Averages (UPGMA) dendogram (Fig. 3), four groups are seen. In addition, Optima (uk) and Tolerance (tk) values of these species are suitable with Canonical Correspondence Analysis (Figure 4 and 5) and Spearman Correlation Analysis (Table 3). *P. zenkeri*, *I. bradyi* and *H. reptans* are first group species in UPGMA. All these species are related each other as we see in UPGMA, CCA and Spearman Correlation. All these species are cosmopolitan (Meisch, 2000).

P. zenkeri is found from 22 stations (Appendix 1). In addition, this species is collected from trough, spring, pond, dam and stream habitats. *P. zenkeri* shows the highest tolerance value (tk) (31 %) for moisture (Table 2). Also, according to the spearman correlation, *P. zenkeri* has significant positive relation with moisture

(P<0.01). CCA also validates this result. On the other hand, Karakaş-Sarı (2006) and Sarı (2007) independently found that *P. zenkeri* was strongly related with *I. bradyi*. Our results supports their findings as well. The minimum and maximum values of some of the variables effective on species are moisture (22.01-86.4 %), dissolved oxygen (3.02-15.24 mg/l), altitude (566-1357 m), water temperature (12-31.7 ^{O}C) and atmospheric pressure (629.7-709.8 mmHg). Ecological values of *P. zenkeri* are nearly similar with Sarı (2007).

I. bradyi is a well known cosmopolitan species which is the second dominant species in Ankara. This species was found from 39 stations from variety of habitat types except lake and dams. However, Külköylüoğlu and his colleagues (2007) found the species from a eutrophic lake, Lake Yeniçağa. In CCA, *I. bradyi* is located on center of the diagram. This implies that five variables are not significantly effective on *I. bradyi* supporting Külköylüoğlu and his colleagues (2007). In spearman correlation, *I. bradyi* has positive relationship with *H. reptans* as in UPGMA (P<0.05) (Figure 3, Table 3). The minimum and maximum values of some of the variables effective on species are moisture (12.6-58.212 %), dissolved oxygen (1.33-16.13 mg/l), altitude (482-717.4 m), water temperature (12-26.9 ^{O}C) and atmospheric pressure (629.7-717.4 mmHg).

H. reptans is found from five troughs only. In a previous study, Külköylüoğlu (2000b) said that *H. reptans* prefers waters with low salinity. In this study, salinity range of Hr is 0.2-1.04 ppt. According to this, our results support Külköylüoğlu (2000b). The minimum and maximum values of some of the variables effective on *H. reptans* are moisture (12.6-38.5 %), dissolved oxygen (10.51-16.13 mg/l), altitude (839-1132 m), water temperature (17-26.9 ^{O}C) and atmospheric pressure (662-682.3 mmHg).

Figure 3 displays three species as *P. fontinalis, P. olivaceus* and *E. virens*. Meisch (2000) classified them as 'cosmopolitan'. According to the spearman correlation, *P. fontinalis* and *P. olivaceus* have positive relationship each other as we see in UPGMA dendogram (Figure 3, Table 3).

P. fontinalis was collected from six stations with trough, spring and creek habitats. Some of the variables effective on species are changing from maximum to minimum as moisture (30.6-52.6 %), dissolved oxygen (6.9-9.25 mg/l), altitude (920-1269 m), water temperature (12.5-15.3 ^{O}C) and atmospheric pressure (654.4-706.6 mmHg). In spearman correlation, *P. fontinalis* has the positive significant relationship with altitude ($P<0.05$). In a previous study (Dügel et al., 2008), they said that *P. fontinalis* prefers cool and well oxygenated waters. We find that *P. fontinalis* has the highest tolerance levels for water temperature from the other species as 0.6072 ^{O}C. So, we can say that *P. fontinalis* prefers cool waters but the same is not true for well oxygenated waters during the present study.

Although *P. olivaceus* is a cosmopolitan species (Meisch, 2000), *P. olivaceus* was found from four stations with trough, spring and water body habitats. The minimum and maximum ecological ranges are moisture (30.2-38.4 %), dissolved oxygen (6.24-9.25 mg/l), altitude (499-1265 m), water temperature (13-17.8 ^{O}C) and atmospheric pressure (669-716.2 mmHg). According to Külköylüoğlu (2007), *P. olivaceus* prefers well oxygenated waters (7.28-11.28). However, *P. olivaceus* can also tolerate very low levels of oxygen as 2.08-4.26 mg/l and low salinity (0.3 ppt). (Külköylüoğlu, 2007). During the present study, we found that *P. olivaceus* prefers well oxygenated waters (Table 2) and low salinity (0.17-0.55) (Apendix 1). *P. olivaceus* showed a significant positive relationship ($P<0.01$) with *H. brevicaudata*.

E. virens, a well known cosmopolitan species, was found from seven localities with trough and water body habitats. In this study, The minimum and maximum ecological ranges are pH (7.36-8.09), Electrical conductivity (387.2-943 μS cm-1), water temperature (12.4-18.9 ^{O}C), and DO (6.24-9.7 mg/l). Our measurements are consistent with the results of Külköylüoğlu (2005a), *E. virens* had a negative significant relationship with water temperature and air temperature ($P<0.01$). So, we can say that *E. virens* seems to prefer cools waters. The other effective ecological variables are moisture (28.1-50 %), altitude (499-1335 m) and atmospheric pressure (646.6-716.2 mmHg) (Table 2).

According to third group of UPGMA dendogram (Figure 3), there were four clustering as *H. incongruens*, *P. arcuata*, *H. brevicaudata* and *H. helenae*. Although all species in this group are located on the center of the CCA diagram (Figure 4 and 5), only *H. incongruens* is cosmopolitan (Meisch, 2000). In spearman correlation analysis, *P. arcuata* and *H. helenae* have positive significant relationship ($P<0.01$) each other. So, UPGMA dendogram is confirmed with spearman correlation analysis.

H. incongruens, well known cosmopolitan species, was the most dominant species found from 93 stations of all kinds of habitats except spring and pond. However, distribution of the species from springs and ponds is not surprising (Meisch, 2000). *H. incongruens* can be used as bioindicator species (Külköylüoğlu, 2000b). *H. incongruens* is known with high tolerance and wide distribution. So, we can call this species as "Cosmoecious Species" (Külköylüoğlu, 2007). According to Mezquita et al. (1999), some environmental variables measured for the species were water temperature (6-23 ^{O}C), pH (7.2-8.7), percentages of oxygen (22-127 %). As we see, ranges of variables are supporting our results. The effective ecological values changed from minimum to maximum are moisture (12.4-91.6 %), dissolved oxygen

(1.33-18.84 mg/l), altitude (442--1457 m), water temperature (12-31.7 ^{O}C) and atmospheric pressure (629.7-720.3 mmHg). In spearman correlation analysis, *H. incongruens* had a significant negative relationship ($P<0.01$) with moisture. On the other hand, *H. incongruens* had a positive significant relationship ($P<0.01$) with dissolved oxygen and water temperature ($P<0.05$).

P. arcuata is poorly known species which was found from small ponds and ditches in summer (Meisch, 1985, 2000). We found *P. arcuata* from four troughs only in summer. On the other hand, Van Der Meeren and his colleagues (2010) find *P. arcuata* from lake during summer that is the only time for sampling for us. The effective ecological values changed from minimum to maximum of *P. arcuata* are moisture (12.6-33.1 %), dissolved oxygen (7.11-11.31 mg/l), altitude (832-1271 m), water temperature (17.6-28 ^{O}C) and atmospheric pressure (673.3-684.3 mmHg). Acording to the spearman correlation analysis, *P. arcuata* had a significant negative relationship ($P<0.05$) with moisture. *P. arcuata* is located closer to the center of the CCA diagram (Figure 4 and 5) but because of lack of knowledge, this cannot show its cosmopolitan characteristics. This should be confirmed with the future studies.

H. brevicaudata was found only three troughs. The minimum and maximum ecological ranges are moisture (18.7-50.3 %), dissolved oxygen (8.35-11.31 mg/l), altitude (925-1271 m), water temperature (16.2-19.5 ^{O}C) and atmospheric pressure (672.1-683 mmHg). Meisch (2000) said that *H. brevicaudata* is known from scattered localities and is not cosmopolitan. We find that *H. brevicaudata* is not cosmopolitan species in this study which was only collected from three stations. In a previous study, Roca and Baltanas (1993) found that *H. brevicaudata* prefers low altitudes (550 m). However, we find that *H. brevicaudata* prefers high altitudes (max 1271 m) in this study. Roca and Baltanas (1993) also said that *H. brevicaudata* prefers low water temperature (14.9 ^{O}C). In addition, Roca and Wansard (1997) said that the survival of *H. brevicaudata* is 15 ^{O}C. This knowledge is not supported in this study (Table 2). During the present study, *H. brevicaudata* can live at 19.5 ^{O}C (Table 2).

H. helenae was found from five stations with troughs and dams habitats. According to Meisch (2000), *H. helenae* prefers slightly salty waters (max 3-4%). However, this knowledge is not supported that *H. helenae* prefers unsaline waters (0.11-0.5 ppt) in present study (Table 2). *H. helenae* shows the highest tolerance value to water temperature (5.861) (Table 1). In spearman correlation analysis, *H. helenae* had a significant negative relationship with moisture ($P<0.01$) (Table 3). Some of the variables effective on species are changing from maximum to minimum as moisture (17.2-28.5 %), dissolved oxygen (5.4-11.72 mg/l), altitude (794-1183 m), water temperature (14.1-28 ^{O}C) and atmospheric pressure (663-691.1 mmHg).

There are four species (*H. chevreuxi*, *P. villosa*, *T. laevis* and *E. lilljeborgi*) in the fourth group in UPGMA dendogram (Figure 3). In CCA, *H. chevreuxi* and *E. lilljeborgi* is located on the center of the diagram (Figure 4 and 5). However, only *P. villosa* is cosmopolitan (Meisch, 1985; 2000). According to the spearman correlation analysis, *P. villosa* and *E. lilljeborgi* had a showed a significant positive relationship each other ($P<0.05$).

H. chevreuxi was found from only three stations with trough and creek habitats. In a previous study, Dügel and his colleagues (2008) collected *H. chevreuxi* from only two springs. Our results supports their findings as well. In a previous study, Rosetti et. al., (2004) said that *H. chevreuxi* prefers highly oxygenated waters (17 mg/l) in Spain. On the other hand, we find dissolved oxygen level as 8.72 mg/l.

During the present study, results showed that *H. chevreuxi* prefers oxygenated water (Table 2). In previously, Külköylüoğlu and Vinyard (2000) found that temperature range of the species was between 15 and 24°C and Külköylüoğlu and Vinyard (2000) said that these values are relatively high. In addition, we found suitable temperature range with them (20.2-26.5 °C). The minimum and maximum ecological ranges are moisture (15.2-51.6 %), dissolved oxygen (4.8-8.72 mg/l), altitude (726-967 m) and atmospheric pressure (675.9-696.5 mmHg).

P. villosa was a true cosmopolitan species which has been found from all countries in Europe (Meisch, 1985). However, this knowledge was not supported in present study. We collected *P. villosa* from only eight troughs. The effective ecological values changed from minimum to maximum are moisture (26.5-43.5 %), dissolved oxygen (7.99-18.84 mg/l), altitude (1025-1316 m), water temperature (12.8-19.4 ^{O}C) and atmospheric pressure (647.9-672.3 mmHg). In a previous study, Külköylüoğlu and Yılmaz (2006) found that *P. villosa* had a significant relation with ph, conductivity and water temperature. However, during the present study, *P. villosa* had not any significant relation with ph, conductivity and water temperature (Table 3). There was a significant positive relationship between *P. villosa* and altitude ($P<0.01$) (Table 3). CCA diagram confirmed this knowledge (Figure 4 and 5). Furthermore, *P. villosa* prefers well oxygenated waters (Külköylüoğlu and Yılmaz, 2006). Our results supports their findings as well. According to Sarı (2007), *P. villosa* had a specific relationship with *P. olivaceus* and *H. incongruens*. On the other hand, we found that *P. villosa* had a specific relationship ($P<0.05$) only with *E. lilljeborgi*.

T. laevis was found for the first time in Van for Turkish ostracoda fauna (Sarı et al., 2010). During the present study, *T. laevis* was reported for the second time.

According to the previous study, *T. laevis* is a rare species and found in only in summer from small ponds (Meisch, 2000). However, this knowledge was not supported exactly because we collected *T. laevis* from four stations with trough, water body and lake habitats. The minimum and maximum ecological ranges of *T. laevis* are moisture (21.8-38.5 %), dissolved oxygen (7.24-13.61 mg/l), altitude (1015-1500 m), water temperature (18.3-25.4 ^{O}C) and atmospheric pressure (632.2-673.5 mmHg). In the present study, we might say that *T. laevis* prefers high altitudes, well oxygenated waters and warm waters (Table 2). In the spearman correlation analysis, there was a significant positive relation between *T. laevis* and water temperature ($P<0.05$) (Table 3). CCA diagram supported this knowledge (Figure 4 and 5).

E. lilljeborgi is not a cosmopolitan species (Meisch, 2000). *E. lilljeborgi* was collected from only troughs. The effective ecological values changed from minimum to maximum are moisture (26.1-38.5 %), dissolved oxygen (7.7-10.9 mg/l), altitude (765-1132 m), water temperature (15.9-18.3 ^{O}C) and atmospheric pressure (662-692.7 mmHg). According to the spearman correlation analysis, there was a significant positive relationship between *E. lilljeborgi* and water temperature ($P<0.05$). During the present study, we might suggest that *E. lilljeborgi* prefers warm waters.

There are two outgroups in UPGMA (*I. gibba* and *H. salina*). *I. gibba* and *H. salina* are cosmopolitan species (Meisch, 2000). There are not any significant relationship between outgroup species and other species (Figure 3, Table 3).

I. gibba is a cosmopolitan species (Külköylüoğlu, 2004) which is found from three stations with trough and dam habitats. In a previos study, Külköylüoğlu (2004) found that some environmental variables of *I. gibba* are pH (8.33-8.36), dissolved oxygen (3-14 mg/l) and water temperature (21 ^{O}C). In present study, we found nearly same environmental values (Appendix 1). Our results support their findings as well and we might suggest that *I. gibba* prefers warm and well oxygenated waters (Külköylüoğlu, 2004). The minimum and maxiumum values of some of the variables effective on species are moisture (26-43.4 %), dissolved oxygen (8.15-8.85 mg/l), altitude (482-1420 m), water temperature (12.9-20.8 ^{O}C) and atmospheric pressure (642.1-717.4 mmHg). Furthermore, *I. gibba* shows the highest tolerance to altitue (540 m) and atmospheric pressure (45) (Table 2).

H. salina was the third most common species. *H. salina* was collected from 45 stations with trough, dam, water body and stream habitats. In a previous study, Külköylüoğlu and Vinyard (2000) found that some environmental variables are conductivity (1149 μS cm-1), pH (7.9-8.14) and water temperature (29.5 ^{O}C). During the present study, these variables were supported that ecological values were changed as conductivity (15.94-5555 μS cm-1), pH (7.31-9.89) and water temperature (12.8-25.8 ^{O}C). According to Külköylüoğlu and Vinyard (2000), *H. salina* is a halobiont species where it lives in waters including high salinity. In present study, our results support their findings that *H. salina* prefers high saline waters (max 3.78). The effective ecological values changed from minimum to maximum are moisture (17.2-56 %), dissolved oxygen (3.02-18.84 mg/l), altitude (499-1316 m) and atmospheric pressure (647.9-716.2 mmHg). *H. salina* shows the highest tolerance value to dissolved oxygen (4) (Table 2). In spearman correlation analysis, *H. salina* significant positive relationship with atmospheric pressure ($P<0.05$) (Table 3).

C. subterranea and *E. elliptica* are first reports for the Turkish ostracoda fauna. *C. subterranea* and *E. elliptica* were collected from only trough habitat. In a previous study, Külköylüoğlu and Vinyard (1998) found *C. subterranea* from Idaho that the ecological values were altitude (1842 m), water temperature (9.6 ^{O}C), conductivity (528 μS cm-1) and pH (7.73). In this study, we found nearly same environmental values as altitude (1404 m), water temperature (14 ^{O}C), conductivity (380.1 μS cm-1) and pH (7.81). According to these values, we might suggest that *C. subterranea* prefers high altitudes and cold waters. In addition, The minimum and maximum ecological ranges are moisture (21 %), dissolved oxygen (11.48 mg/l) and atmospheric pressure (644.7 mmHg). The minimum and maxiumum values of some of the variables effective on species are moisture (38.9 %), dissolved oxygen (11.21 mg/l), altitude (751 m), water temperature (16.7 ^{O}C) and atmospheric pressure (696.5 mmHg). According to there results, we might suggest that *E. elliptica* prefers low altitudes, well oxygenated and warm waters.

Asexual reproductive mode is more common, more successful to adapt and more wide spread than sexual forms (Schwander and Crespi, 2009). Sexual lineages should be better competitors in long lived unstable environments but asexual species are dominant in short lived stable habitats because of the colonizing ability of parthenogens (Chaplin et al., 1994). Rossi and his colleagues (2009) said that conspecific asexual lineages have advantages in stable environments. Another view, in Marten's opinion (1998), asexual conspecifics are more adaptive and coloniser in stable environments. Troughs are man-made 'artificially natural' habitats (Külköylüoğlu, pers. comm.). We collected 31 taxa from troughs. All the species are found asexual. This may support the idea of Külköylüoğlu (pers. comm.) that converting springs to trough is changed the water quality, providing much better places for cosmopolitan and/or asexual forms to survive.

In Table 5, diversity hypotheses about species-area relationships are illustrated. The area per se hypothesis (MacArthur and Wilson, 1963; 1967) and the habitat diversity hypothesis (Williams, 1964) are the most popular hypotheses to debate.

In our study, we collected 31 taxa from 173 stations with 10 different aquatic habitats. We collected three taxa from lake, seven taxa from creek, six taxa from dam, 31 taxa from trough, seven taxa from stream, six taxa from water body, two taxa from channel, three taxa from pond, one taxa from river and four taxa from spring habitats (Table 1). If we compare our study with diversity hypotheses, our study refuses the area per se hypothesis for some reasons. First, if area per se hypothesis were true, lake could have the highest species richness. On the other hand, troughs had the highest species number in present study. Area was not found as important factor during the present study. Besides, our study refuses the area per se hypothesis. Target area hypothesis and the passive sampling hypothesis or the random placement hypothesis are related to area (Table 5). According to the target area hypothesis, colonization rate increases towards the large areas but during the present study large area was not important for species diversity. Besides, the passive sampling hypothesis or the random placement hypothesis has positive relation between area and species number with a non random distribution but it denies the importance of habitat diversities. So, our findings did not support these hypotheses, too. Because, in the present study, habitat diversity was the most effective factor for species diversity. Second, the sampling effect hypothesis is related to the size of the area. According to the this hypothesis, big area with more sampling increases the species diversity. In the during study, although we collected 31 taxa from troughs, it was the limit number of species number. If we did more sampling from troughs, number of species would not increase progressively (Külköylüoğlu, pers. comm.). So, our results do not support these assumptions. Third, the intermediate disturbance hypothesis is declined in this study because co-existing of rapid colonizers with more competitive species is not seen none of the habitats. Fouth, if we think our habitats like a small island, water body need to have the highest species richness according to the small island hypothesis. However, this is not true. Troughs have the highest species richness; therefore, this hypothesis was rejected by this study. Fifth, the species energy theory is based on the available enegy. When we did not measure the available energy (productivity etc.) of the areas, we cannot say much about this hypothesis. However, one implication is that since the sampling was made in a short time during which there was no significant change observed in the water conditions, one may assume similar implication for the energy received by the habitats. However, again, such approach need to be studies and cannot be generalized at the moment. Finally, We found 31 taxa from troughs because of the fact that we collected samples from 133 stations. In a previous study (Külköylüoğlu, 2005a), average number of species in lakes is 13.20. If we had more sampling from the lakes and/or other habitats, we would increase the numbers of species as well. Habitat diversity is the most important factor in species diversity. If we collect our samples from equal stations, our results will change. If we look at the Table 1, we did sampling from three stations both lake (3 species) and dam (6 species) habitats. Also, we did sampling from one station both channel (2 species) and spring (4 species) habitats. However, none of the species diversities of the habitats are not same. Results showed that habitat diversity is the most influential factor for species diversity. We should also consider seasonal and temporal habitat differences. Since our study has a limited sampling period and different habitats during summer, result are not clearly support one of those hypotheses. If we collect samples from equal station numbers with long sampling period, we see the importance of the habitat diversity. In consequences, our results may support that the best suitable diversity hypothesis for ostracods is the habitat diversity hypothesis but again such result should not be generalized at the moment.

In brief;

19 taxa (*P. eremita, I. gibba, I. inermis, C. pubera, E. lilljeborgi, T. clavata, T. laevis, H. reptans, H. brevicaudata, H. helenae, H. intermedia, P. olivaceus, P. fontinalis, Cyprinotus* sp., *P. similis, P. variageta, P. pallida, P. arcuata, P. zschokkei*) are new for Ankara ostracoda fauna and 2 species (*C. subterranea* and *E. elliptica*) are new reports for the Turkish ostracoda fauna.

Troughs have only asexual ostracod species during this study because of the colonizing ability in short lived stable habitats by ostracods.

Cosmopolitan species have wide ecological tolerances for different variables.

The best suitable hypothesis for ostracods seems to be the habitat diversity hypothesis.

REFERENCES

Akdemir D. 2004. Konya-Karapınar krater göllerinin Ostrakot faunası [Ostracoda fauna of the crater lakes of Konya, Karapınar]. M.Sc. Thesis, Istanbul University, İstanbul.

Akdemir D. 2008. Differences of Ostracoda (Crustacea) Assemblages among Two Maar Lakes and One Sinkhole Lake in the Konya Region (Turkey). Turkish Journal of Zoology. 2 (32): 107-113.

Akdemir D. 2009. Erzincan ve Diyarbakır (Türkiye) Ġölleri Ostrakotlarının (Crustacea) Biyocoğrafik Dağılımı, Ekolojik Özellikleri ve Tolerans Seviyelerinin Tespiti. [Determination of Biogeographical Distribution, Ecological Characteristics and Tolerance Levels of Ostracods (Crustacea) in Erzincan and Diyarbakır Cities (Turkey)]. Ph.D Thesis, Marmara University, İstanbul.

Akdemir D., Külköylüoğlu O., Sarı N. and Yavuzatmaca M. 2011. Habitat preferences of swimming and non-swimming Ostracods (Crustacea) from Gaziantep region, Turkey. Joannea Geology Palaontology. 11: 13-14.

Altınsaçlı S. 1988. Bergama (İzmir) Yöresi Ostrakod (Crustacea) Faunası ve Mevsimsel dağılımları [The Ostracoda fauna of the Bergama region and its seasonal changes]. M.Sc. Thesis, Istanbul University, İstanbul.

Altınsaçlı S. and Kubanç C. 1990. Ayvalık Yöresi Ostrakod (Crustacea) Faunası. X. Ulusal Biyoloji Kongresi Tebligleri. Erzurum. 55-62.

Altınsaçlı S. 1993. The Ostracoda (Crustacea) fauna of Bergama (İzmir) region. İstanbul Üniversitesi Fen Fakültesi Biyoloji Dergisi. 56: 9-20.

Altınsaçlı S. 1997. The Ostracoda (Crustacea) Fauna of Lake Sapanca. İstanbul Üniversitesi Fen Fakültesi Biyoloji Dergisi. 60: 17-45.

Altınsaçlı S. 1999. The Ostracoda (Crustacea) fauna of Lake İznik. İstanbul Üniversitesi Fen Fakültesi Biyoloji Dergisi. 61-32: 81-105.

Altınsaçlı S., Kılıç M. and Altınsaçlı S. 2000. A preliminary study on the Ostracoda (Crustacea) fauna of Lake Beyşehir. Turkish Journal of Zoology. 24: 375-385.

Altınsaçlı S. 2001a. A study on the seasonal distributions of Ostracoda (Crustacea) species found in Lake Eğirdir (Isparta/Turkey). Turkish Journal of Zoology. 25: 431-439.

Altınsaçlı S. 2001b. The Ostracoda fauna of Lakes Erikli, Hamam, Mert, Pedina and Saka (İğneada, Kırklareli, Turkey). Turkish Journal of Zoology. 25: 343-355.

Altınsaçlı S. and Griffiths H. I. 2001a. Ostracoda (Crustacea) of Lake Uluabat (Apolyont Gölü) (Bursa Province, Turkey). Limnologica. 31: 109-117.

Altınsaçlı S., and Griffiths H. I. 2001b. Ostracoda (Crustacea) from the Turkish Ramsar site of Lake Kuş (Manyas Gölü). Aquatic Conservation: Marine and Freshwater Ecosystems. 11: 217-225.

Altınsaçlı S. and Griffiths H. I. 2001c. The freshwater ostracods Hungarocypris and Leucocythere from Turkey. Crustaceana. 74(7): 681-688.

Altınsaçlı S. 2003. A preliminary study on the ostracoda (Crustacea) fauna of the lakes Mogan and Eymir (Ankara/Turkey). İstanbul Üniversitesi Su Ürünleri Dergisi. 15: 57-67.

Arrhenius O. 1924. Species and area. Journal of Ecology. 9: 95-9.

Aygen C. 1996. İzmir ili ve civarında tatlısu Ostrakoda (Crustacea) faunası [The Ostracoda (Crustacea) fauna of İzmir Region]. M.Sc. Thesis, Ege Universitesi, İzmir.

Aygen C. and Balık S. 1998. İzmir ili ve civarında tatlısu Ostrakoda (Crustacea) faunası. Su Ürünleri Dergisi. 15 (3-4): 283-292.

Aygen C. and Balık S. 2002. A new record for the freshwater ostracod fauna of Turkey: Hungarocypris madaraszi (Örley, 1886) (Crustacea: Ostracoda). Zoology in the Middle East. 25: 49-52.

Aygen C., and Balık S. and Ustaoğlu R. 2004. Two new records for the non-marine ostracod fauna of Turkey: Humphcypris subterranea (Hartmann, 1964) and Herpetocypris brevicaudata Kaufmann, 1900. Zoology in the Middle East. 31: 77-81.

Balcı M. 2008. Ecological Changes and Ostracoda (Crustacea) Fauna of Lake Sünnet (Bolu, Turkey). M.Sc. Thesis, Abant İzzet Baysal University, Bolu.

Becker G. 2005. Functional Morphology of Palaezoic Ostracods: Phylogonetic Implications. Hydrobiologia. 538: 23-53.

Berger W.H. and Parker F.L. 1970. Diversity of planktonic foraminifera in deep sea sediments. Science. 168: 1345-7.

Bronshtein Z.S. 1947. Fauna SSSR. Crustacea. vol 2 no: 1 Ostracodes des Eaux Douches. Institut Zoologique de l'Academine des Sciences de URSS, Nouvelle Serie. 31: 1–339.

Buckley R.C. and Knedlhans S.B. 1986. Beachcomber biogeography: interception of dispersing propagules by islands. Journal of Biogeography. 13: 69-70.

Chaplin J. A., Havel J. E. and Hebert P. D. N. 1994: Sex and ostracods. — Trends in Ecology and Evolution 9: 435–439.

Cohen A.C., Martin J.W. and Kornicker L.S. 1998. Homology of Holocene ostracode biramous appendages with those of other crustaceans: the protopod, epipod, exopod and endopod. Lethaia, 31: 251-265.

Coleman B.D. 1981. On random placement and species-area relationships. Mathematical Biosciences, 54: 191-215.

Connell, J.H. 1978. Diversity in tropical rain forests and coral reefs. Science. 199 (4335): 1302–1310.

Connor E.F. and McCoy E.D. 1979. The statistics and biology of the species-area relationship. American Naturalist, 113: 791-833.

Connor E.F. and McCoy E.D. 2001. Species-Area Relationships. Encyclopedia of biodiversity. 5: 397-411.

Danielopol, D. L. 1980. An essay to assess the age of the freshwater interstitial ostracods of Europe. Bijdragen Tot De Dierkunde. 50: 243–291.

Danielopol D.L., Creuzé des Châtteliers M., Mösslacher F., Pospisil P. and Popa R. 1994. Adaption of Crustacea to interstitial habitats: a practical agenda for ecological studies. In: Gibert, J., Danielopol, D. L. & J. A. Stanford (eds.): Groundwater Ecology. New York.

Delorme D. 1991. In Ecology and Classification of North American Invertebrates. In: J. H. Thorpe, and A. P. Covich (eds): Academic Press, New York.

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

Ferguson Jr. E. 1944. Studies on the Seasonal Life History of Three Species of Freshwater Ostracoda. American Midland Naturalist. 32 (3): 713-727.

Gleason H. A. 2012. On the Relation Between Species and Area. Ecology. 3 (2): 158-162.

Gülen D. 1975. Kuzey Batı Anadolu sıcaksu kaynaklarında rastlanan hayvanlar. Medikal Terapi Hidroklimatoloji Yıllığı. 16-17.

Gülen D. 1977. Contribution to the knowledge of the freshwater Osracoda fauna of Turkey. İstanbul Üniversitesi Fen Fakültesi Biyoloji Dergisi. 42(1-4): 101-106.

Gülen D. 1982. Türkiye için yeni Notodromus (Ostracoda) türleri. Tübitak VII. Bilim Kongresi Tebliğleri: 561-564.

Gülen D. 1984. Ege Bölgesi sıcak su kaynaklarında rastlanan favna elemanlarından ostracodlar (Crustacea) [The living ostracod (Crustacea) species of the hot spring of the Aegean Region]. Tıbbi Ekoloji ve Hidro-klimatoloji Dergisi, 1.Ulusal Balneoloji Sempozyumu. Özel Sayısı. 2-3: 124-130.

Gülen D. 1985a. The Species and Distribution of the Group of Podocopa (Ostracoda-Crustacea) in Freshwaters of Western Anatolia. İstanbul Üniversitesi Fen Fakültesi Mecmuası. 50 (B): 65-80.

Gülen D. 1985b. Bisexual Ostracoda (Crustacea) Populations in Anatolia. İstanbul Üniversitesi Fen Fakültesi Biyoloji Mecmuası. 50 (B): 81-86.

Gülen D. 1988. Contribution to the taxonomy of the freshwater Ostracod Fauna of Turkey. Su Ürünleri Dergisi. 2(1): 199–203.

Gülen D., Altınsaçlı S., Kubanç C. and Kılıç M. 1994a. Türkiye Ostracoda (Crustacea) Faunası [The Ostracoda (Crustacea) fauna of Turkey]. -Unpublished project report TBAG-989: 1-45. –TÜBİTAK, Ankara.

Gülen D., Altınsaçlı S., Kubanç, C. and Kılıç M. 1994b. İç Anadolu Ostrakod (Crustacea) Faunası [The Ostracoda (Crustacea) fauna of Central Anatolia Region]. -Ulusal Biyoloji Kongresi Tebliğleri, 6-8 Temmuz, Edirne. 187-190.

Gülen D. and Altınsaçlı S. 1999. The Ostracoda (Crustacea) fauna of Sakarya River Basin. Geosound. 35: 69-84.

Hartmann G. 1963. Zur Phylogenie und Systematik der Ostracoden. Zeitschrift Fur Zoologische Systematik und Evolutionsforschung. 1 (1-2): 1-154.

Hartmann G. 1964. Asiatische Ostracoden, Systematische und Zoogeographische Untersuchungen-Internationale Revue der Gesamten Hydrobiologie. Systematische Beihefte. 3: 1-155. Henderson, P. A., 1990. Freshwater Ostracods. –Synopses of the British Fauna (New Series) 42. In: D.M. Kermack and R.S.K. Barnes (eds.): Universal Book Services/Dr. W. Backhuys.

Henderson P.A. 1990. Freshwater Ostracoda: Keys and notes for the identification of the species. Synopses of the British Fauna (New Series). In: Doris M. Kernack and R.S.K. Barnes (eds):. London.

Hill J.L., Curran P.J. and Foody G.M. 1994. The effect of sampling on the species-area curve. Global Ecological and Biogeography Letters. 4: 97-106.

Hobbs H.H.Jr. 1971. T he Entocytherid Ostracods of Mexico and Cuba. Smithsonian Contributions to Zoology. 81: 1-5.

Holmes J.A. and Horne D.J. 1999. Non-marine Ostracoda: evolution and environment. Palaeogeography, Palaeoclimatology, Palaeoecology. 148: 1-7.

Horne D.J. and Boomer I. 2000. The role of Ostracoda in saltmarsh meiofaunal communities. In: Sherwood, B.R. et al. (eds.): British Saltmarshes.

Horne D.J., Cohen A. and Martens K. 2002. Biology, taxonomy and identification techniques. In: Holmes J.A. and Chivas A. (eds.): The Ostracoda: Applications in Quaternary Research, Washington DC: American Geophysical Union.

Horne D.J. 2003. Key events in the ecological radiation of the Ostracoda. The Paleontological Society. 9: 181-201.

Horne D.J. 2005. Homology and homoeomorphy in ostracod limbs. Hydrobiologia. 538: 55-80.

Hurlbert S.H. 1984. Pseudoreplication and the design of ecological field experiments. Ecological Monographs. 54(2): 187-211.

Ikeya N., Tsukagoshi A. and Horne D.J. 2005. Preface: The phylogeny, fossil record and ecological diversity of ostracod crustaceans. Hydrobiologia. 538: 7-8.

Juggins, S., 2003: Software for Ecological and Palaeoecological Data Analysis and Visualization. C2 User Guide.University of Newcastle, Newcastle-Upon-Tyne.

Kaleli A. 1993. Orta Karadeniz Sahil Ostrakod (Crustacea) Faunası ve Zoocoğrafik Yayılışı. Yüksek Lisans Tezi, İstanbul Üniversitesi. İstanbul.

Karakaş-Sarı P. 2006. Comparative ecology of Ostracoda (Crustacea) in two rheocrene springs (Bolu,Turkey). M.Sc. Thesis, Abant İzzet Baysal University, Bolu.

Karakaş-Sarı P. and Külköylüoğlu O. 2007. Comparative ecology of Ostracoda (Crustacea) in two rheocrene springs (Bolu, Turkey). Ecological Research. 23: 821-830.

Kelly B.J., Wilson J.B. and Mark A.F. 1989. Causes of the species-area relation: A study of the islands in Lake Manapouri, New Zealand. Journal of Ecology. 77: 1021-1028.

Kılıç M. 2000. Altınsaçlı, S., Balkıs, H., and Balkıs, N. 2000. The ostracods Species Collected From Coasts of the Gökçeada (Imbroz) Island (Aegean Sea). Turkish Journal of Marine Sciences. 6(1): 87-102.

Kılıç M. 2001. Recent Ostracoda (Crustacea) Fauna of The Black Sea Coasts of Turkey. Turkish Journal Zoology. 25: 375-388.

Kiss A. 2007. Factors affecting spatial and temporal distribution of Ostracoda assemblages in different macrophyte habitats of a shallow lake (Lake Fehér, Hungary). Hydrobiologia. 585: 89-98.

Kovach, W. 1998. Multi-variate statistical package, ver. 3.0. Kovach Computer Services. Pentraeth, UK.

Kubanç C. and Altınsaçlı, S. 1990. Ayvalık-Bergama Lagün Ostrakod Faunası X. Ulusal Biyoloji Kongresi Tebliğleri, Erzurum. 1990: 37-46.

Külköylüoğlu O., Altınsaçlı, S. and Kubanç C. 1993. The Ostracoda (Crustacea) Fauna of Küçükçekmece Lake (İstanbul) and seasonal distributions. Turkish Journal of Zoology. 17: 19–27.

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

Külköylüoğlu O. 1998. Freshwater Ostracoda and their Quarterly Occurance in Şamlar Lake (Istanbul, Turkey). Limnologica. 28: 229-235.

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

Külköylüoğlu O. 1999. Seosanal distribution of freshwater Ostracoda (Crustacea) in springs of Nevada. Geosound. 35: 85-91.

Külköylüoğlu O. 2000a. The importance of cosmopolitan and indicator species of Ostracoda (Crustacea) in Turkey based on some water parameters. Sinop Water Product Conference. 421-437.

Külköylüoğlu O. 2000b. Türkiye'deki Kozmopolitan ve Gösterge Ostracoda (Crustacea) Türlerinin Değişik Su Parametrelerine Göre Önemi. Su Ürünleri Sempozyumu Sinop Ondokuz Mayıs Üniversitesi. 421-437.

Külköylüoğlu O. and Vinyard G.L., 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. 2003a. A new report on and the loss of Scottia pseudobrownianana Kempf, 1971 (Ostracoda) from a limnocrene spring in Bolu, Turkey. Crustaceana.76 (3): 257-268.

Külköylüoğlu O. 2003b. First report of the genus, Isocypris (Ostracoda) from Turkey: Taxonomy, ecology, and general distribution. Crustaceana. 75: 1083–1093.

Külköylüoğlu O. 2003c. Ecology of freshwater ostracoda (Crustacea) from lakes and reservoirs in Bolu, Turkey. Journal of Freshwater Ecology. 18: 343-347.

Külköylüoğlu O. 2003d. Paralimnocythere psammophila (Flössner, 1965) (Crustacea), a species new for the freshwater ostracod fauna of Turkey. Zoology in the Middle East. 30: 114-116.

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

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

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

Külköylüoğlu O. 2005b. Ecological requirements of freshwater Ostracoda (Crustacea) in two limnocrene springs (Bolu, Turkey). Annales de Limnologie International Journal of Limnology. 41 (4): 237-246.

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

Külköylüoğlu O. and Yılmaz F. 2006. Ecological requirements of Ostracoda (Crustacea) in three types of springs in Turkey. Limnologica. 36: 172-180.

Külköylüoğlu O. 2007. Ecological Succession of Freshwater Ostracoda (Crustacea) in A Newly Developed Rheocrene Spring (Bolu, Turkey). Turkish Journal of Zoology. 33: 115-123.

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

Külköylüoğlu O., Dügel M., Balcı M., Deveci A., Avuka D. and Kılıç M. 2009. Limnoecological relationships between water level fluctuations and Ostracoda (Crustacea) species composition in Lake Sünnet (Bolu, Turkey). Turkish Journal of Zoology. 34: 429-442.

Külköylüoğlu O. and Sarı N. 2010. Ecological characteristics of the freshwater Ostracoda in Bolu Region (Turkey). Hydrobiologia. 688 (1): 37-46.

Külköylüoğlu O., Akdemir D. and Yüce R. 2011. Distribution, ecological, tolerance and optimum levels of freshwater Ostracoda (Crustacea) from Diyarbakır, Turkey. Limnology. 13 (1): 73-80.

Li X., Liu W., Zhang L. and Sun Z. 2010. Distribution of Recent ostracod species in the Lake Qinghai area in Northwestern China and its ecological significance. Ecological Indicators. 10: 880–890.

Liebau A. 2005. A revised classificaiton of the higher taxa of the Ostracoda (Crustacea). Hydrobiologia. 538: 115-137.

Lomolino M.V. 1990. The target area hypothesis: the influence of island area on immigration rates of non-volant mammals. Oikos. 57: 297-30.

Maas A. and Waloszek D. 2005. Phosphatocopina – Ostracode like sister group of Eucrustacea. Hydrobiologia. 538: 139-152.

MacArthur R.H. and Wilson E.O. 1963. An equilibrium theory of insular zoogeography. Evolution. 17: 373-387.

MacArthur R.H., Wilson E.O. 1967. The Theory of Island Biogeography. Princeton University Press, Princeton, New Jersey, U.S.A.

Maddocks R.F. 2000. Antennule chaetotaxy of podocopid Ostracoda: Systematic analysis. Micropaleontology. 46 (2): 1-37.

Martens K. 1998. General morphology of non-marine ostrocods. 57-75. In: K.Martens (ed.): Sex and parthenogenesis: evolutionary ecology of reproductive modes in non-marine ostrocods. Backhuys Publishers, Leiden, The Netherlands.

Martens K. 2003. On a remarkable South African giant ostracod (Crustacea, Ostracoda, Cyprididae) from temporary pools, with additional appendages. Hydrobiologia. 500 (1-3): 115-130.

Martens K., Rossetti G.P. and Horne D.J. 2003. How are ancient asexuals? Proceedings of the Royal Society of London Series B, Biological Sciences. 270: 723-729.

Martens K., Rossetti G.P., Butlin R.K. and Schön I. 2005. Molecular and morphological phylogeny of the ancient asexual Darwinulidae (Crustacea, Ostracoda). Hydrobiologia. 538: 153-165.

Martens K., Schön I., Meisch C. and Horne D.J. 2008. Global diversity of ostracods (Ostracoda, Crustacea) in freshwater. Hydrobiologia 595: 185–193.

MacArthur, R. H., and Wilson, E. O. 1963. An equilibrium theory of insular zoogeography. Evolution. 17: 373-387.

MacArthur, R. H., and Wilson, E. O. 1967. The theory of island biogeography. Princeton University Press, Princeton.

McKenzie K.G. and Moroni A. 1986. Man as an agent of crustacean passive dispersal via useful plants exemplified by ostracoda ospiti esteri of the Italian ricefields ecosystem and implications arising therefrom. Journal of Crustacean Biology. 6: 181-198.

Meeren T. Van der., Almendinger J.E. Ito E. and Martens K. 2010. The ecology of ostracodes (Ostracoda, Crustacea) in western Mongolia. Hydrobiologia. 641: 253-273.

Meisch C. 1985. Revision of the Recent West European Species of the Genus Potamocypris (Crustacea, Ostracoda). Part II. Luxembourg.

Meisch C. 2000. Freshwater Ostracoda of Western and Central Europe. Süsswasserfauna von Mitteleuropa 8/3. Spektrum Akademischer Verlag, Heidelberg, Berlin.

Meisch C. 2007. On the origin of the putative furca of the Ostracoda (Crustacea). Hydrobiologia. 585 (1): 181-200.

Mezquita F., Hernández R. and Rueda J. 1999. Ecology and distribution of ostracods in a polluted Mediterranean river. Palaeogeography, Palaeoclimatology, Palaeoecology. 148: 87–103.

Mischke S., Herzschuh U., Massmann G. and Zhang C. 2007. An ostracod-conductivity transfer function for Tibetan lakes. Journal of Paleolimnology. 38: 509-524.

Namiotko T., Danielopol D. L. and Baltanas A. 2011. Soft body morphology, dissection and slide-preparation of Ostracoda: a primer. Joannea - Geologie und Palaontologie. 11: 327-343.

Newman W. A. 2005. Origin of the Ostracoda and their maxillopodan and hexapodan affinities. Hydrobiologia. 538 (1-3): 1-21.

Nilsson S. G., Bengtsson J. and As S. 1988. Habitat Diversity or Area Per Se? Species Richness of Woody Plants, Carabid Beetles and Land Snails on Islands. Journal of Animal Ecology. 57: 685-704.

Özuluğ O., Kubanç N. and Gülen D. 2001. Ostracoda (Crustacea) Fauna of Lake Eğridir (Isparta). Turkish Journal of Zoology. 25: 421-425.

Özuluğ O. 2005. Living specimens of Ilyocypris salebrosa Stepanaitys, 1959 (Crustacea: Ostracoda) from Thrace, Turkey. Zoology in the Middle East. 34: 114-116.

Özuluğ O. and Yaltalıer S. 2008. A preliminary study on the Rezve stream and a new record for Ostracoda (Crustacea) fauna of Turkey. Istanbul University Faculty of Science Journal of Biology. 67(1): 93-96.

Özuluğ O. and Yaltalıer S. 2009. A new record for the Ostracoda fauna of Turkey: Candonopsis scourfieldi Brady, 1910 (Crustacea: Podocopida), Zoology in the Middle East. 48: 112-113.

Özuluğ O. 2011. A preliminary study on Ostracoda (Crustacea) fauna of the Istranca Streams-Turkey. Journal of Fisheries Sciences. 5(2): 93-98.

Pérez L., Lorenschat J., Brenner M., Scharf B and Schwalb A. 2010. Extant freshwater ostracodes (Crustacea: Ostracoda) from Lago Petén Itzá, Guatemala. Revista de Biología Tropical. 58 (3): 871-895.

Roca J. R., and Baltanás A. 1993. Ecology and distribution of ostracoda in Phyrenean springs. Journal of Crustacean Biology. 13 (1): 165-174.

Roca J. R., and Wansard G. 1997. Temperature influence on development and calcification of Herpeteocypris brevicaudata Kaufmann, 1900 (Crustacea: Ostracoda) under experimental conditions. Hydrobiologia. 347: 91-95.

Rosetti G, Bartoli M. and Martens K. 2004. Limnological characteristics and recent ostracods (Crustacea, Ostracoda) of freshwater wetlands in the Parco Oglio Sud (Northern Italy). Annales de Limnologie. 40: 329-341.

Rossi V., Piotti A, Geiger W., Benassi G. and Menozzi P. 2009. Genetic structure of Austrian and Italian populations of Limnocythere inopinata (Crustacea, Ostracoda): a potential case of post-glacial parthenogenetic invader? Annales Zoologici Fennici. 47: 133–143.

Sarı N. 2007. Determination of Ecological Features of the Freshwater Ostracoda (Crustacea) in Bolu Region (Turkey). M.Sc. Thesis, Abant İzzet Baysal University, Bolu.

Sarı N. and Külköylüoğlu O. 2010a. Ostracods (Crustacea) and habitat similarities in the Bolu region (Turkey). Turkish Journal of Zoology.. 34: 225-230.

Sarı N., Akdemir D. and Külköylüoğlu O. 2010b. Van İli Kuzeydoğu Bölgesi Ostrakotlarının (Crustacea) Ekolojik Tercihlerinin Belirlenmesi. Ekoloji Sempozyumu. Aksaray, Türkiye.

Sars G.O. 1928. Ostracoda –An account of the Crustacea of Norway, Bergan. 9: 1-227.

Seaby R.M. and Henderson P.A. 2006. Species Diversity and Richness Version 4. Pisces Conservation Ltd., Lymington, England.

Schäfer, H. W. 1954. Über süswaser-Ostracoden aus der Türkei. Hidrobiologi İstanbul. 1(1): 7-32.

Schön I., Martens K., Doninck K.V. and Butlin R.K., 2003. Evolution in the slow lane-molecular rates of evolution in sexual and asexual ostracods (Crustacea, Osrtacoda). Biological Journal of the Linnean Society. 79: 93-100.

Schwander, T. & Crespi, B. J. 2009: Twigs on the tree of life? Neutral and selective models for integrating macroevolutionary patterns with microevolutionary processes in the analysis of asexuality. Molecular Ecology. 18: 28–42.

Simpson E.H. 1949. Measurement of diversity. Nature. 163: 688.

Tangney R.S., Wilson J.B. and Mark A.F. 1990. Bryophyte island biogeography. A study in Lake Manapouri, N.Z. Oikos. 59: 21-26.

Ter Braak C.J.F. 1986. Canonical correspondence analysis: a new eigenvector technique for multivariate direct gradient analysis. Ecology. 67: 1167-1179.

Ter Braak C.J.F. and Barendregt L.G. 1986. Weighted averaging of species indicator values: its efficiency in environmental calibration. Mathematical Biosciences. 78: 57-72.

Ter Braak C.J.F. and Verdonschot P.F.M. 1995. Canonical correspondence analysis and related multivariate methods in aquatic ecology. Aquatic Sciences 55 (4): 1-35.

Townsend C. R., Scarsbrook M. R., Doledec S. 2012. The Intermediate Disturbance Hypothesis, Refugia, and Biodiversity in Streams. Limnology and Oceanography. 42 (5): 938-949.

Turner W. R. and Tjørve E. 2005. Scale-dependence in species-area relationships. Ecography. 28: 721-730.

Vanschoenwinkel B., Gielen S., Seaman M. and Brendonck L. 2008. Any way the wind blows frequent wind dispersal drives species sorting in ephemeral aquatic communities. Oikos. 117: 125-134.

Viehberg F.A. 2006. Freshwater ostracod assemblages and their relationship to environmental variables in waters from northeast Germany. Hydrobiologia. 571: 213-224.

Whittaker R.H. 1977. Evolution of species diversity in land communities. In: M. K. Hecht, W. C. Steere and B. Wallace (eds.): Plenum, New York.

Williams C.B. 1964. Patterns in the Balance of Nature. Academic Press, London.

Williamson M. 1988. Relationship of species number to area, distance and other variables. Analytical biogeography: an integrated approach to the study of animal and plant distributions. In: A. A. Myers and P. S. Giller (eds.): London.

Wills M.A. 1998. Crustacean disparity through the Phanerozoic: comparing morphological and stratigraphic data. Biological Journal of the Linnean Society. 65: 455-500.

Wright D.H. 1983. Species-energy theory: an extension of species-area theory. Oikos. 41: 496-506.

Yavuzatmaca M. 2011. Determination of Ostracoda (Crustacea) Fauna of Some Freshwater Caves in the Western Black Sea Region of Turkey. M.Sc. Thesis, Abant Izzet Baysal University, Bolu.

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

Zhang X, Siveter D.J., Waloszek D. and Maas A. 2007. An epipodite-bearing crown-group crustacean from the Lower Cambrian. Nature. 449: 595-598.

APPENDICES

Appendix 1. Measurements of 18 different variables and geographical data of 173 stations. Abbrevation: pH; DO (mg/L): dissolved oxygen; EC (μS/cm): electrical conductivity; TDS (mg/l): Total Dissolved Solids; %S: oxygen saturation; (T°Cw): water temperature; T(a)(°C): air temperature; Sal (ppt): salinity; Elev: elevation: (m); ATM: atmospheric preesure: mmHg; volume of troughs: (m^3); dep.: depth of troughs: (m); wid.: width of troughs: (m); heig: height of troughs: (m); moisture: (%); ST. NUMB: station number; ST. TYPE: station type and habitat type codes are lake (la), creek (cr), trough (th), dam (da), stream (st), water body (wb), channel (ch), pond (pd), river (ri), spring (sp).

ST. NUMB	ST. TYPE	age	dep. (m)	wid. (m)	heig (m)	VOL (m^3)	ELEV (m)	T^oC_A	MOI	T^oC_W	EC	SAL	PH	SPEC	DO	DO%	TDS	ATM	COORD	SPP,
1	la						987	26.9	48.5	23.6	17.99	0.94	8.42	1854.00	10.95	131.80	1.2090	679.3	N39°46'463" E32°47'721"	Hi, Pc
2	cr						1002	33.5	35.9	30.7	68.30	18.50	7.94	330.38	8.65	12.50	19.5000	677.2	N38°59'465" E33°32'410"	
3	th		0.2	3	2	1.20	1062	34.5	19.4	21.0	716.00	0.38	7.99	769.00	12.34	139.20	0.5005	676.2	N39°03'482" E33°30'677"	Hi
4	th		0.4	0.5	7	1.40	1062	35.4	21.2	20.2	915.00	0.50	7.82	999.00	13.90	154.30	0.6500	688.9	N39°03'243" E33°31'545"	Pm
5	th	17	0.5	0.5	3	0.75	972	36.1	19.4	14.1	551.00	0.34	7.50	696.00	11.72	114.00	0.4550	670.0	N39°06'236" E33°36'831"	Hh, Hi, Ii
6	da						844	29.4	43.1	26.8	1393.00	0.67	8.22	1347.00	13.37	162.80	0.8775	668.4	N39°08'687" E33°38'471"	Hi, Pz

ST. NUMB	ST. TYPE	age	dep. (m)	wid. (m)	heig (m)	VOL (m^3)	ELEV (m)	T^oC_A	MOI	T^oC_W	EC	SAL	PH	SPEC	DO	DO%	TDS	ATM	COORD	SPP.
7	th	23	0.1	1	10	1.00	996	33.3	22.1	31.7	615.00	0.26	8.94	544.00	15.24	209.60	0.3510	669.9	N39°05'495" E33°39'618"	Hi, Pz
8	th	6	0.5	0.5	9	2.25	930	36.7	19.9	17.0	809.00	0.47	7.35	955.00	12.80	133.80	0.6240	682.3	N39°05'092" E33°40'985"	Hi, Hr
9	cr						939	38.0	17.6	17.5	322.00	0.18	8.03	375.30	10.46	110.50	0.2438	673.5	N39°02'860" E33°41'938"	Py
10	th		0.3	0.8	3	0.68	1041	33.8	18.5	21.7	347.20	0.18	7.81	369.80	13.43	155.70	0.2405	671.1	N39°02'515" E33°42'382"	Hi, Is
11	th		0.4	0.4	8	1.28	1271	31.6	18.7	19.5	213.90	0.11	7.51	238.80	11.31	123.00	0.1547	673.3	N38°57'751" E33°42'257"	Hb, Hi, Pa
12	th		0.4	0.4	10	1.60	1271	24.2	34.4	20.8	768.00	0.41	7.40	836.00	9.04	102.00	0.5460	675.4	N38°57'868" E33°38'297"	Hi, Pz, Ib
13	th		0.4	0.4	8	1.28	1042	24.1	30.4	21.1	369.00	0.19	8.02	299.10	14.72	165.00	0.2593	668.8	N38°55'306" E33°39'490"	Hi
14	th		0.2	0.6	3	0.36	1175	22.9	41.7	21.7	599.00	0.31	7.00	639.00	11.50	135.50	0.4160	677.2	N38°54'176" E33°43'484"	Cn, Es, Is
15	st						1050	19.1	51.9	17.9	718.00	0.41	8.11	832.00	9.45	100.80	0.5395	669.9	N38°52'987" E33°41'407"	Ca, Is, Pz
16	th		0.4	0.3	6	0.72	1017	18.2	50.3	16.2	1155.00	0.70	7.48	1389.00	10.76	109.40	0.9035	672.1	N38°51'670" E33°37'904"	Hb, Hi, Ib
17	th		0.2	0.6	3	0.36	1019	16.6	52.7	14.7	1084.00	0.68	7.60	1350.00	13.06	100.60	0.8775	677.2	N39°09'478" E33°11'380"	Is

ST. NUMB	ST. TYPE	age	dep. (m)	wid. (m)	heig (m)	VOL (m^3)	ELEV (m)	T^oC_A	MOI	T^oC_W	EC	SAL	PH	SPEC	DO	DO%	TDS	ATM	COORD	SPP,
18	th	72	0.5	1	18	9.00	1074	19.7	44.6	18.4	402.90	0.22	7.86	461.00	11.30	151.00	0.2996	673.1	N39°12'465" E33°11'620"	Hi
19	th	10	0.2	0.5	14	1.40	984	24.1	32.2	13.6	779.00	0.50	7.44	996.00	6.34	60.60	0.6500	680.3	N39°10'972" E33°13'961"	Hi, Is
20	wb						1019	24.6	32.5	19.6	2178.00	1.25	8.79	2428.00	15.68	173.20	1.5795	678.0	N39°11'802" E33°18'013"	Hi
21	th	26	0.2	0.5	18	1.80	1041	26.1	91.6	13.6	584.00	0.37	7.37	750.00	11.84	116.20	0.4875	676.4	N39°15'372" E33°18'089"	Hi, Is
22	th	57	0.3	0.5	6	0.90	843	31.2	23.8	14.0	1965.00	1.29	7.31	2490.00	1.82	18.70	1.6185	691.1	N39°20'099" E33°16'412"	
23	wb						847	26.8	27.9	24.2	3125.00	1.66	8.23	3177.00	6.42	78.60	2.0670	684.3	N39°20'099" E33°16'412"	Hi, Is
24	th	5	0.2	0.5	12	1.20	907	26.7	28.1	17.5	896.00	0.52	7.59	1065.00	8.04	83.40	0.6760	685.9	N39°18'835" E33°12'500"	Hi
25	cr						907	26.7	28.1	24.7	557.00	0.27	8.37	558.00	6.87	82.50	0.3640	686.4	N39°18'828" E33°12'508"	Hi, Is
26	ch						873	34.5	17.4	22.9	1079.00	0.56	8.60	1129.00	8.03	96.20	0.7345	687.2	N39°19'321" E33°10'616"	Hi, Ib
27	th	8	0.1	0.5	3	0.15	1020	18.3	18.8	26.9	563.00	0.26	8.61	543.00	12.45	158.00	0.3510	675.9	N39°19'642" E33°01'104"	Hi, Ib, Hr
28	cr						1027	28.3	21.2	24.6	693.00	0.34	8.41	698.00	6.12	74.10	0.4550	674.8	N39°19'642" E33°01'105"	Hi, Ib

ST. NUMB	ST. TYPE	age	dep. (m)	wid. (m)	heig (m)	VOL (m^3)	ELEV (m)	T^oC_A	MOI	T^oC_W	EC	SAL	PH	SPEC	DO	DO%	TDS	ATM	COORD	SPP,
29	th	14	0.2	0.4	13	1.04	1064	33.4	23.4	24.2	2690.00	1.41	8.60	2730.00	11.59	141.00	1.7745	671.9	N39°23'369" E32°57'936"	Hi, Ib
30	th	63	0.3	0.6	7	1.26	1183	37.3	18.5	17.2	486.30	0.28	7.80	574.10	7.28	76.60	0.3725	663.0	N39°25'688" E32°54'001"	Hi, Ib, Hh
31	th		0.5	0.6	21	6.30	1068	34.4	21.1	18.8	1782.00	1.04	7.46	2027.00	16.13	177.10	1.3130	670.5	N39°36'252" E32°50'735"	Hr, Hi, Hs, Ib
32	th	43	0.5	0.7	6	2.10	1182	33.1	24.8	13.6	642.00	0.41	7.30	822.00	5.50	52.80	0.5330	662.0	N39°41'341" E32°53'791"	
33	th		0.4	0.4	6	0.96	1202	28.9	23.4	15.9	412.00	0.24	0.34	498.20	7.44	76.70	0.3244	660.1	N39°44'474" E32°59'133"	Hi, Ib
34	th		0.2	0.5	10	1.00	1212	23.8	35.0	19.6	778.00	0.43	8.10	869.00	13.54	148.50	0.5655	675.2	N39°44'472" E32°59'128"	Hi
35	th		0.2	0.5	7	0.70	959	24.3	44.9	19.7	752.00	0.41	8.64	836.00	15.85	175.50	0.5395	680.0	N39°39'727" E33°04'664"	Hi
36	th		0.3	0.5	12	1.80	1029	25.6	38.9	24.3	2141.00	1.11	7.97	2171.00	12.64	153.10	1.4105	674.4	N39°38'860" E33°09'233"	Hi
37	th	6	0.7	0.4	10	2.80	1049	24.1	30.0	19.9	478.10	0.26	0.50	529.60	6.90	76.40	0.3445	673.3	N39°33'435" E32°12'932"	Hi, Is, Es
38	th	13	0.4	0.5	8	1.60	926	21.3	36.7	15.3	4121.00	2.74	6.93	5070.00	7.54	79.50	3.2955	683.0	N39°27'744" E33°13'202"	Hi, Ib
39	th		0.5	0.7	18	6.30	1001	21.3	35.8	19.3	410.60	0.22	7.56	459.60	8.18	89.00	0.2970	677.4	N39°26'158" E33°10'946"	Hi

ST. NUMB	ST. TYPE	age	dep. (m)	wid. (m)	heig (m)	VOL (m^3)	ELEV (m)	T^oC_A	MOI	T^oC_W	EC	SAL	PH	SPEC	DO	DO%	TDS	ATM	COORD	SPP,
40	th		0.1	0.4	6	0.24	1032	20.7	46.6	15.4	1220.00	0.79	7.45	1553.00	2.84	27.90	1.2075	674.7	N39^{O}31'259" E32^{O}57'174"	Hi
41	pd						1034	21.7	46.1	22.3	765.00	0.39	8.62	806.00	9.46	110.10	0.5265	690.4	N39^{O}31'259" E32^{O}57'174"	He, Ib, Pm
42	th	100	0.1	0.4	14	0.56	884	24.1	41.5	13.1	632.00	0.41	7.57	820.00	4.48	44.00	0.5330	687.9	N40^{O}09'349" E32^{O}37'696"	Py
43	th	40	0.2	0.3	11	0.66	992	26.4	28.6	16.5	279.10	0.16	7.87	334.50	9.05	94.20	0.2171	678.6	N40^{O}11'866" E32^{O}36'193"	Hi,Hs
44	th	61	0.3	0.6	4	0.72	925	25.3	30.2	17.8	309.70	0.17	7.92	359.70	8.35	89.50	0.2334	683.0	N40^{O}13'997" E32^{O}46'739"	Hb, Hi, Po
45	th		0.5	0.3	9.6	1.44	923	31.2	24.5	16.5	433.90	0.25	7.66	522.50	9.13	95.80	0.3387	683.4	N40^{O}12'320" E32^{O}43'956"	Hi
46	st						881	31.2	29.2	21.6	633.00	0.33	8.28	677.00	9.53	109.30	0.4420	687.0	N40^{O}12'461" E32^{O}41'487"	Hi, Ib, He, Pt
47	th	59	0.2	0.4	6	0.48	922	35.2	26.8	19.3	435.20	0.24	7.46	490.20	8.71	95.50	0.3165	683.5	N40^{O}15'404" E32^{O}42'349"	
48	th	31	0.3	0.5	2	0.30	976	32.9	25.8	14.7	452.60	0.28	7.56	576.00	7.93	80.10	0.3685	679.0	N40^{O}19'646" E32^{O}43'431"	He, Hi, Is
49	da						968	33.3	28.2	23.7	221.20	0.11	9.18	226.50	8.25	98.00	0.1475	670.8	N40^{O}19'571" E32^{O}43'375"	Hh, Hn
50	th	19	0.3	0.4	3	0.36	1117	33.8	25.0	20.1	188.80	0.11	8.05	208.60	7.08	78.90	0.1352	667.2	N40^{O}24'222" E32^{O}43'059"	

ST. NUMB	ST. TYPE	age	dep. (m)	wid. (m)	heig (m)	VOL (m^3)	ELEV (m)	T^oC_A	MOI	T^oC_W	EC	SAL	PH	SPEC	DO	DO%	TDS	ATM	COORD	SPP.
51	cr						1114	37.7	25.0	25.7	206.50	0.30	8.88	203.70	7.45	91.40	0.1326	667.9	N40°24'200" E32°43'074"	
52	cr						1498	36.2	22.4	21.3	74.50	0.04	8.08	80.40	7.33	83.10	0.0520	638.0	N40°26'629" E32°50'673"	Cn, Pu
53	th		0.3	0.5	2	0.30	1457	37.7	18.0	19.4	479.80	0.26	7.71	543.30	12.10	132.80	0.3517	641.1	N40°27'363" E32°50'382"	Hi, Is, Pm
54	th	74	0.6	0.5	6	1.80	1404	38.5	21.0	14.0	380.10	0.23	7.81	482.80	11.48	112.40	0.3133	644.7	N40°30'181" E32°45'127"	Cs, Pp
55	cr						1403	32.5	15.0	19.5	258.10	0.14	8.26	291.00	7.38	80.20	0.1885	671.4	N40°28'041" E32°37'627"	Cc, Is, Pm
56	th	62	0.2	0.3	6	0.36	1028	32.3	21.8	25.4	137.40	0.06	9.15	136.70	13.61	164.50	0.0890	671.5	N40°32'548" E32°36'664"	Cy, Pv, Tl
57	pd						1357	21.8	31.2	27.2	344.70	0.16	8.67	330.40	6.52	83.40	0.2145	648.4	N40°36'356" E32°32'125"	Pz
58	th	17	0.3	0.4	3	0.36	940	27.6	27.9	19.8	234.80	0.12	8.22	260.70	9.31	104.50	0.1697	679.2	N40°26'398" E32°38'982"	Hi
59	st						937	22.8	28.6	23.9	359.50	0.10	7.99	367.40	5.72	64.20	0.2386	679.9	N40°26'397" E32°38'973"	Hs, Pz
60	th	48	0.5	0.3	16	2.40	936	28.4	29.4	16.1	491.10	0.29	8.09	594.90	9.65	98.50	0.3861	678.4	N40°22'829" E32°34'457"	Hi, Pz
61	th		0.1	0.6	6	0.36	776	27.3	45.5	22.1	580.00	0.30	7.48	617.00	5.21	62.10	0.4030	690.3	N40°18'253" E32°25'829"	Hi,Hs, Cc, Ib

ST. NUMB	ST. TYPE	age	dep. (m)	wid. (m)	heig (m)	VOL (m^3)	ELEV (m)	T^OC_A	MOI	T^OC_W	EC	SAL	PH	SPEC	DO	DO%	TDS	ATM	COORD	SPP.
62	th	5	0.6	0.6	18	6.48	869	27.2	33.1	17.6	174.00	0.10	7.72	202.40	8.17	85.80	0.1313	684.3	N40°16'738" E32°18'594"	Hi, Pa
63	th	60	0.7	0.5	14	4.90	880	26.1	29.9	18.3	664.90	0.26	7.77	535.20	8.62	93.30	0.3478	684.7	N40°11'362" E32°12'861"	Hi, Is
64	th	100	0.4	0.6	12	2.88	1025	23.5	41.3	16.5	437.80	0.25	7.52	522.40	9.45	96.80	0.3400	672.7	N40°09'281" E32°14'132"	Hi, Pz, Ib
65	th		0.32	0.5	10	1.60	1044	27.4	39.2	19.1	727.00	0.48	7.47	823.00	9.98	109.10	0.5330	670.7	N39°44'000" E32°30'352"	Is, Pz
66	th	58	0.45	0.9	11	4.21	779	30.4	32.5	17.9	936.00	0.54	7.61	1085.00	8.57	92.00	0.7020	693.7	N39°46'970" E32°23'272"	Is, Pz
67	th		0.3	0.2	5	0.30	772	34.6	26.1	16.3	429.80	0.25	9.13	519.80	9.95	102.50	0.3387	683.8	N39°42'280" E32°13'301"	Is, Pm
68	th		0.3	0.4	28	3.36	1032	38.1	17.5	21.3	424.30	0.22	8.12	439.30	10.70	121.90	0.2977	670.3	N39°43'666" E32°11'525"	Hi,Hs, Is
69	th		0.32	0.6	13	2.50	689	39.1	17.2	15.0	5555.00	3.78	7.44	6873.00	4.25	436.00	4.4590	696.5	N39°39'465" E31°59'473"	Hi,Hs
70	ri						690	40.8	12.4	23.3	13.94	0.72	8.20	1441.00	6.53	80.50	0.9360	697.0	N39°39'225" E31°58'234"	Hi, Pc
71	th	7	0.3	0.6	20	3.60	765	40.1	12.9	23.4	3205.00	1.74	8.70	3311.00	12.90	163.40	2.1515	689.8	N39°43'956" E31°51'136"	Hi
72	th	40	0.5	1.5	12	9.00	839	37.6	12.6	18.2	258.20	0.20	7.72	417.80	10.51	111.30	0.2695	679.0	N39°28'856" E32°11'370"	Hr, Hi, Pa, Ib

ST. NUMB	ST. TYPE	age	dep. (m)	wid. (m)	heig (m)	VOL (m^3)	ELEV (m)	T°C_A	MOI	T°C_W	EC	SAL	PH	SPEC	DO	DO%	TDS	ATM	COORD	SPP,
73	th	17	0.15	0.7	17	1.79	832	39.5	17.2	28.0	1070.00	0.50	7.82	1012.00	7.11	95.00	0.6565	683.6	N39°26'801" E32°07'537"	Hh, In, Pa
74	cr						840	38.2	15.2	26.5	84.60	0.40	8.18	823.00	4.80	63.10	0.5330	683.0	N39°22'845" E32°06'323"	Hc, Hi, Pi, Ib
75	th	45	0.3	0.4	25	3.00	743	34.1	23.1	25.8	995.00	0.48	8.54	981.00	13.32	164.30	0.6370	690.5	N39°17'392" E32°03'869"	Hi,Hs
76	th	4	0.3	0.3	35	2.63	785	34.4	30.4	18.3	4667.00	2.94	7.31	5422.00	8.82	94.20	3.5230	687.4	N39°16'219" E32°00'279"	Hi,Hs, Ib
77	st						782	32.3	33.3	19.1	1407.00	0.80	7.52	1591.00	3.02	33.00	1.0335	684.4	N39°05'435" E32°00'244"	Cn, He, Hi, Hs, Ib, Pz
78	th		0.5	0.4	2	0.35	842	31.8	30.0	20.7	975.00	0.53	9.22	1061.00	10.00	112.30	0.6890	681.7	N39°05'390" E31°59'649"	Es, Ib
79	th		0.4	0.6	12	2.64	1053	25.4	40.0	12.5	483.70	0.31	7.40	635.30	6.90	64.80	0.6128	668.3	N39°28'538" E32°22'223"	Ib, Pz, Pf
80	st						902	29.3	34.4	17.1	697.00	0.40	8.28	822.00	8.66	89.50	0.5330	680.4	N39°21'981" E32°19'610"	Hi,Ii, Ib, Pz
81	th	80	0.2	0.5	5	0.50	930	27.7	34.5	18.2	956.00	0.55	7.50	1497.00	7.09	76.70	0.7150	678.2	N39°22'201" E32°20'654"	Hi
82	th	2	0.3	0.7	8	1.68	1152	28.6	33.5	20.7	641.00	0.34	7.75	699.00	7.86	89.10	0.4550	660.3	N39°19'125" E32°24'287"	Es, Is, Hi, Py

ST. NUMB	ST. TYPE	age	dep. (m)	wid. (m)	heig (m)	VOL (m^3)	ELEV (m)	T^{O}C$_{A}$	MOI	T^{O}C$_{W}$	EC	SAL	PH	SPEC	DO	DO%	TDS	ATM	COORD	SPP,
83	st						901	28.0	42.8	19.0	914.00	0.51	8.34	1033.00	8.15	88.40	0.6695	680.0	N39^{O}13'851" E32^{O}22'362"	Cc, Is, Pz, Pc
84	th		0.05	0.5	3	0.08	1057	23.4	39.7	21.1	392.20	0.20	8.53	423.10	7.27	83.80	0.2750	667.8	N39^{O}13'284" E32^{O}22'425"	
85	th		0.35	0.5	6	1.05	983	24.2	44.0	16.6	1921.00	1.18	7.43	2293.00	7.64	79.90	1.4885	674.0	N39^{O}05'022" E32^{O}30'091"	Hi, Ib
86	th	42	0.15	0.5	20	1.50	1132	25.0	38.5	17.6	424.10	0.24	7.77	496.50	10.90	115.10	0.3224	662.0	N39^{O}10'149" E32^{O}38'139"	Hr, Hi, Hs, El, Ib, Pz
87	wb						1064	25.2	43.2	23.1	738.00	0.37	8.80	766.00	7.00	82.60	0.5005	667.5	N39^{O}12'150" E32^{O}45'209"	Hi, Is, Tc
88	th		0.3	0.5	45	6.75	1140	22.0	42.2	17.9	652.00	0.37	7.56	755.00	6.76	70.70	0.4875	661.8	N39^{O}14'997" E32^{O}42'048"	Ib
89	th	200	0.6	0.8	16	7.68	1110	23.3	41.9	13.0	889.00	0.58	7.43	1154.00	5.82	55.50	0.7475	664.1	N39^{O}17'875" E32^{O}35'671"	
90	th	13	0.4	0.5	20	4.00	1064	20.4	42.7	18.7	1198.00	0.68	7.75	1362.00	9.21	102.40	0.8840	668.2	N39^{O}16'430" E32^{O}35'031"	
91	cr						1064	21.3	48.6	16.6	1267.00	0.76	8.23	1510.00	8.77	90.40	0.9815	668.6	N39^{O}16'419" E32^{O}31'021"	
92	th	55	0.3	0.4	10	1.20	1335	18.5	44.6	12.4	431.50	0.28	7.37	568.00	8.59	80.10	0.3698	647.0	N39^{O}25'669" E32^{O}33'210"	Ev, Hi

ST. NUMB	ST. TYPE	age	dep. (m)	wid. (m)	heig (m)	VOL (m^3)	ELEV (m)	T^oC_A	MOI	T^oC_W	EC	SAL	PH	SPEC	DO	DO%	TDS	ATM	COORD	SPP,
93	th	50	0.2	0.7	5	0.70	1292	18.1	46.6	12.9	381.10	0.24	7.41	496.10	6.01	52.00	0.3224	651.0	N39°26'428" E32°38'084"	Hi, Is
94	th	13	0.2	0.5	1	0.10	1204	16.0	50.0	14.0	757.00	0.48	7.33	958.00	1.33	13.80	0.6240	657.8	N39°29'903" E32°33'872"	Hi, Ib, Pc
95	cr						1153	16.4	52.6	15.3	374.00	0.22	8.25	458.50	7.49	74.90	0.2983	662.1	N39°35'880" E32°32'989"	Ib, Pf
96	th		0.2	0.4	14	1.12	1048	15.8	52.8	14.6	656.00	0.40	7.74	819.00	6.38	61.40	0.5330	670.6	N39°32'785" E32°42'381"	
97	wb						499	22.3	38.4	17.5	943.00	0.55	7.73	1101.00	6.24	66.50	0.7150	716.2	N40°07'077" E31°37'922"	Ev, Hs, Ib, Pc, Po
98	th	54	0.3	0.3	15	1.35	840	27.9	27.9	16.9	765.00	0.45	7.96	907.00	8.66	90.00	0.5915	687.2	N40°11'556" E31°32'461"	Hi, Hs
99	th		0.1	0.3	2	0.06	895	21.4	31.3	18.9	622.00	0.34	8.09	703.00	8.74	96.70	0.4550	682.4	N40°11'875" E31°32'927"	Ev, Hs, Cc, Hi, Is
100	cr						861	16.9	50.2	14.1	616.00	0.38	8.36	778.00	9.41	91.90	0.5070	686.2	N40°17'663" E31°30'543"	Hi
101	th	60	0.3	0.5	5	0.68	895	16.4	64.8	15.7	373.80	0.22	8.11	654.50	10.27	104.40	0.2958	677.6	N40°17'102" E31°28'455"	Hi
102	th		0.5	0.7	2	0.70	960	16.4	55.7	15.3	481.50	0.29	7.89	590.70	8.57	84.00	0.3842	703.8	N40°17'102" E31°28'458"	Hi, Is

ST. NUMB	ST. TYPE	age	dep. (m)	wid. (m)	heig (m)	VOL (m^3)	ELEV (m)	T^oC_A	MOI	T^oC_W	EC	SAL	PH	SPEC	DO	DO%	TDS	ATM	COORD	SPP,
103	th		0.2	0.2	2.5	0.08	1269	15.9	50.0	14.0	472.40	0.29	8.02	597.40	7.20	70.40	0.3881	654.2	N40°12'874" E31°12'611"	Ev, Ib
104	th	15	0.3	0.4	1.5	0.18	1269	15.9	50.0	13.8	467.30	0.29	7.36	595.00	8.28	80.80	0.3868	654.4	N40°12'874" E31°12'611"	Ev, Is, Hi, Pf
105	th	15	0.2	0.2	14.5	0.58	1265	21.1	35.5	13.7	506.00	0.32	7.47	647.00	9.04	87.10	0.4225	669.0	N40°12'873" E31°12'632"	Po, Pf
106	th	52	0.45	0.5	6	1.22	442	20.0	42.3	20.9	597.00	0.32	8.16	648.00	9.31	111.10	0.4225	720.3	N40°08'994" E30°55'550"	Hi
107	th	45	0.4	0.5	3	0.60	751	23.4	38.9	16.7	952.00	0.57	7.88	1132.00	11.21	118.10	0.7345	696.5	N40°07'126" E31°07'037"	Hi, Hs, Ee
108	cr						612	21.6	36.2	14.6	468.30	0.29	8.24	585.70	9.68	95.50	0.3802	706.3	N40°10'648" E31°20'528"	Is, Pm
109	th	12	0.2	0.2	1.5	0.06	566	21.3	43.7	18.4	677.00	0.37	7.97	7.63	7.58	81.30	0.4940	709.8	N40°08'135" E31°20'648"	Is, Hi, Pz
110	th	3	0.3	0.4	3.75	0.39	482	19.7	43.3	17.2	832.00	0.49	8.12	977.00	8.85	91.60	0.6370	717.4	N40°04'750" E31°25'736"	Ib, Hi, Ig
111	cr						545	23.8	36.6	14.6	2890.00	1.91	8.45	3608.00	9.12	90.90	2.3465	711.7	N40°06'849" E32°03'615"	Ib, Pm
112	th	62	0.25	0.5	6	0.75	765	27.2	26.1	15.9	1066.00	0.65	7.57	1291.00	7.70	78.20	0.8385	692.7	N40°09'154" E32°05'744"	El, Hi
113	th	11	0.3	0.5	24	3.60	798	30.4	26.1	18.2	578.00	0.32	8.50	666.00	19.05	202.30	0.4355	689.1	N40°15'146" E32°05'078"	Es, Pm

ST. NUMB	ST. TYPE	age	dep. (m)	wid. (m)	heig (m)	VOL (m^3)	ELEV (m)	T^oC_A	MOI	T^oC_W	EC	SAL	PH	SPEC	DO	DO%	TDS	ATM	COORD	SPP,
114	th		0.35	0.5	13	2.05	1316	27.7	26.5	17.3	300.40	0.17	9.02	353.50	18.84	196.30	0.2294	647.9	N40°14'144" E31°55'532"	Hi, Hs, Pi
115	th	10	0.4	0.5	14	2.80	1330	24.2	30.0	15.3	11.04	0.68	7.69	13.56	9.52	96.00	0.8775	645.3	N40°16'405" E31°52'164"	Hi
116	wb						1500	30.9	28.7	24.8	245.90	0.12	8.62	246.80	7.24	89.00	0.1605	632.2	N40°17'286" E31°51'598"	Tl
117	th	13	0.25	0.5	9	1.13	1235	26.9	24.7	22.1	253.70	0.13	9.27	268.40	18.40	211.20	0.1748	653.0	N40°17'434" E31°46'257"	Hs
118	sp						1240	24.4	30.6	13.0	317.00	0.20	7.52	413.00	9.25	87.60	0.2685	706.6	N40°17'435" E31°46'250"	Ib, Pz, Pc, Po, Pf
119	th		0.1	0.4	8	0.28	840	25.1	28.4	15.1	417.50	0.25	8.00	516.00	10.63	106.60	0.3361	685.2	N40°11'845" E31°45'216"	Hs, Ph
120	th		0.3	0.4	40	4.80	519	26.0	26.1	24.8	2775.00	1.44	8.70	2786.00	12.13	148.00	1.8135	710.6	N40°04'435" E31°48'121"	Hi, Hs
121	th	13	0.2	0.5	9	0.90	906	24.1	29.5	15.7	412.00	0.24	7.68	504.30	8.69	87.10	0.3276	678.9	N40°02'998" E31°56'816"	Is, Hs
122	th	12	0.45	0.6	7	1.89	939	20.6	39.8	17.4	368.20	0.21	7.45	431.10	8.66	93.10	0.2802	676.4	N40°03'504" E32°00'246"	
123	th	60	0.2	0.4	6	0.48	1060	22.0	42.0	15.8	275.00	0.16	7.40	334.00	7.24	74.40	0.2165	667.9	N40°05'998" E32°24'148"	

ST. NUMB	ST. TYPE	age	dep. (m)	wid. (m)	heig (m)	VOL (m^3)	ELEV (m)	T^oC_A	MOI	T^oC_W	EC	SAL	PH	SPEC	DO	DO%	TDS	ATM	COORD	SPP,
124	th	40	0.4	0.4	20	3.20	1062	18.8	43.0	14.5	361.70	0.22	8.15	453.00	7.90	79.30	0.2931	668.7	N40°10'872" E32°28'527"	Ib, Pz
125	th	44	0.2	0.3	2	0.12	1039	22.4	42.8	16.5	1850.00	0.10	7.40	221.30	7.03	72.80	0.1437	672.0	N40°11'723" E32°27'420"	Pm
126	st						1043	26.6	40.7	13.0	482.40	0.31	8.30	627.80	8.35	80.20	0.4082	672.5	N40°11'702" E32°27'426"	Hi, Py
127	da						962	28.9	35.2	20.8	323.70	0.17	9.18	302.90	8.15	94.20	0.2294	681.3	N40°08'533" E32°23'139"	Hi, Hs, Ig
128	th	50	0.5	0.5	8	2.00	1079	21.8	38.5	18.3	175.10	0.10	7.67	201.40	9.08	93.00	0.1313	668.0	N40°05'568" E32°19'788"	El, Pi, Hi, Tl
129	th	30	0.2	0.4	18	1.44	726	24.4	39.6	20.8	536.00	0.28	7.89	582.00	6.93	78.20	0.3770	696.5	N40°03'769" E32°15'600"	Hc, Is, Pm
130	th		0.3	0.6	20	3.60	794	26.0	28.5	14.7	489.60	0.30	7.54	609.40	5.40	54.10	0.3965	691.1	N39°59'734" E32°16'123"	Hh, Hs, Ib
131	pd						795	29.5	30.5	22.3	483.30	0.25	8.80	509.30	9.90	116.30	0.3302	680.5	N39°59'734" E32°16'122"	
132	th		0.5	1	2	1.00	1166	23.0	28.4	19.1	294.30	0.16	9.62	329.60	16.02	176.00	0.2139	661.2	N39°57'826" E32°23'591"	Hi
133	th		0.2	0.3	30	1.50	1184	28.0	28.1	13.2	446.50	0.28	7.56	577.10	9.70	93.00	0.3751	659.8	N40°03'220" E32°22'774"	Cp, Ev, Hi, Pu
134	th	55	0.3	0.6	10	1.80	1029	28.6	27.2	17.7	763.00	0.44	7.50	884.00	6.16	64.80	0.5720	671.3	N39°46'914" E32°50'246"	Hi, Hs

ST. NUMB	ST. TYPE	age	dep. (m)	wid. (m)	heig (m)	VOL (m^3)	ELEV (m)	T^oC_A	MOI	T^oC_W	EC	SAL	PH	SPEC	DO	DO%	TDS	ATM	COORD	SPP,
135	th		0.1	0.6	2	0.12	1029	28.3	26.0	17.7	390.80	0.22	7.87	455.20	7.31	78.70	0.2958	666.6	N39°46'104" E32°43'413"	Hs
136	th		0.7	0.4	15	4.20	1193	25.3	38.4	18.7	98.90	0.05	7.33	112.50	10.89	117.00	0.0744	659.0	N40°27'502" E32°28'638"	Pi
137	th		0.4	0.6	25	6.00	1376	20.2	53.1	13.4	89.20	0.05	7.17	114.70	4.48	43.70	0.0748	645.9	N40°32'721" E32°31'633"	Pm
138	th	65	0.6	0.6	24	8.64	1297	24.9	47.2	18.1	89.90	0.05	7.22	104.50	10.03	110.00	0.0682	651.4	N40°31'425" E32°25'861"	
139	th		0.2	0.4	4	0.32	1148	22.9	41.7	14.7	75.80	0.04	8.57	95.00	11.69	113.00	0.0618	662.5	N40°29'577" E32°18'045"	Pi
140	th	200	0.2	0.4	5	0.40	1025	23.8	43.5	12.8	538.00	0.35	7.43	70.20	8.15	79.30	0.4550	672.3	N40°25'643" E32°21'027"	Hi, Hs, Es, Pi
141	th	48	0.1	0.6	20	1.20	1196	25.6	38.0	14.2	557.00	0.34	7.41	701.00	6.93	68.50	0.4550	658.9	N40°27'503" E32°28'638"	
142	th		0.2	0.4	3	0.24	994	31.3	28.3	19.9	344.80	0.18	8.58	382.00	10.74	117.80	0.2483	673.7	N39°52'972" E33°16'657"	Hs, Ib
143	th	10	0.2	0.4	5	0.40	932	29.1	33.5	15.2	574.00	0.35	7.67	708.00	3.92	38.70	0.4615	678.7	N39°46'111" E33°12'663"	Es, Is
144	th	33	0.2	0.4	10	0.80	926	26.5	32.3	18.7	588.00	0.33	8.11	670.00	10.90	117.10	0.4355	668.4	N39°51'343" E33°13'053"	Hi, Hs
145	th	52	0.2	0.3	8	0.48	1335	25.7	32.1	15.1	387.20	0.23	7.50	478.60	9.27	91.10	0.3107	646.6	N39°48'580" E33°03'820"	Cc, Ev, Hi

ST. NUMB	ST. TYPE	age	dep. (m)	wid. (m)	heig (m)	VOL (m^3)	ELEV (m)	T^OC_A	MOI	T^OC_W	EC	SAL	PH	SPEC	DO	DO%	TDS	ATM	COORD	SPP.
146	th		0.4	0.6	4	0.88	998	24.4	56.1	18.1	686.00	0.39	7.35	792.00	5.77	61.30	0.5135	673.8	N40°03'815" E33°00'443"	Pm, Ts
147	wb						1268	24.8	51.6	23.0	374.50	0.19	8.62	389.80	4.74	58.40	0.2542	658.8	N40°04'272" E33°06'219"	
148	th		0.4	0.8	10	3.20	1118	28.3	44.9	14.8	586.00	0.36	7.75	728.00	7.50	74.30	0.4745	664.5	N40°05'003" E33°05'024"	Hi
149	th		0.4	0.3	20	2.40	1118	26.0	62.0	13.2	284.60	0.18	7.53	398.00	9.53	92.00	0.2392	663.4	N40°05'004" E33°05'024"	
150	th	200	0.3	0.5	4	0.60	1309	21.1	58.2	12.0	484.50	0.32	7.30	647.20	6.10	57.20	0.4200	629.7	N40°08'134" E33°10'160"	Hi, Ig, Pz, Px
151	th	45	0.2	0.4	11	0.88	1304	20.2	86.4	13.8	720.00	0.46	7.55	919.00	8.02	60.90	0.5980	649.2	N40°08'135" E33°10'141"	Hi, Pz
152	th	42	0.2	0.5	12	1.20	1304	19.1	84.6	13.6	358.40	0.22	7.47	458.20	9.23	88.60	0.2977	658.0	N40°08'135" E33°10'161"	Pm, Pz
153	th		0.5	0.4	3	0.60	990	19.7	73.2	16.5	430.70	0.25	7.78	512.70	8.67	88.10	0.3335	675.1	N40°05'288" E33°22'651"	
154	ri						997	25.7	78.7	19.7	149.70	0.81	8.13	1597.00	6.85	75.40	1.0400	701.9	N40°05'291" E33°22'652"	
155	th	20	0.5	0.4	3	0.60	840	30.9	39.5	22.6	600.00	0.31	8.11	629.00	9.14	106.30	0.4095	683.0	N40°04'021" E33°28'006"	Hi
156	th		0.5	0.3	6	0.90	681	30.5	34.3	18.7	648.00	0.36	7.97	737.00	7.82	84.40	0.4810	698.8	N40°06'724" E33°30'381"	Hs, Ib

ST. NUMB	ST. TYPE	age	dep. (m)	wid. (m)	heig (m)	VOL (m^3)	ELEV (m)	T^oC_A	MOI	T^oC_W	EC	SAL	PH	SPEC	DO	DO%	TDS	ATM	COORD	SPP,
157	th	9	0.4	0.8	6	1.92	980	31.1	39.2	13.7	3866.00	0.23	7.79	470.70	7.48	76.40	0.3055	674.6	N40°10'572" E33°30'256"	Hs, Ib, Ps, Pf
158	th	64	0.1	0.4	8	0.32	980	33.8	38.6	23.6	701.00	0.35	9.89	720.00	10.10	120.30	0.4680	692.5	N40°14'160" E33°31'343"	Hs, Ib
159	th		0.4	0.5	8	1.60	705	28.8	42.5	23.4	15.94	0.83	8.22	16.43	9.89	114.80	1.7660	696.3	N40°18'245" E33°34'961"	Hs, Is, Pz
160	th		0.6	0.5	16	4.80	967	23.7	51.6	20.2	562.00	0.30	7.74	618.00	8.72	97.70	0.4030	675.9	N40°16'755" E33°25'501"	Hc, Ib, Hs
161	th	11	0.4	0.2	10	0.80	815	23.6	56.0	19.8	899.00	0.49	7.96	999.00	7.57	83.30	0.6500	689.1	N40°19'755" E33°19'428"	He, Ib, Hs
162	th	12	0.2	0.3	8	0.48	998	22.3	57.8	15.7	841.00	0.51	7.64	10.25	3.68	38.10	0.6695	673.7	N40°13'627" E33°20'359"	Pm
163	th		0.4	0.3	2	0.24	1066	29.8	40.2	13.8	582.00	0.36	7.62	742.00	8.16	77.70	0.4810	670.1	N40°09'423" E32°51'871"	Hs
164	th		0.4	0.3	15	1.80	1048	29.9	60.4	20.8	700.00	0.37	7.90	761.00	14.48	165.40	0.4940	678.0	N40°15'895" E32°54'555"	
165	la						1015	31.9	32.9	22.3	567.00	0.29	8.25	597.00	11.21	130.40	0.3900	673.5	N40°16'472" E32°54'504"	Hi, Tl
166	th	42	0.3	0.7	8	1.68	1297	33.4	26.8	15.0	736.00	0.04	6.49	90.80	7.99	79.50	0.0585	651.4	N40°19'120" E32°58'565"	Pi, Py
167	th		0.4	0.6	3	0.72	1420	36.2	26.0	12.9	503.00	0.32	7.93	658.00	8.48	81.10	0.4290	642.1	N40°27'288" E32°54'623"	Ig

ST. NUMB	ST. TYPE	age	dep. (m)	wid. (m)	heig (m)	VOL (m^3)	ELEV (m)	T^OC_A	MOI	T^OC_W	EC	SAL	PH	SPEC	DO	DO%	TDS	ATM	COORD	SPP,
168	la						1518	29.0	32.0	18.7	120.50	0.06	7.91	136.90	7.66	88.30	0.0870	634.9	N40^{O}24'659" E32^{O}54'822"	Ca, Es
169	th		0.3	0.4	11	1.16	1251	29.2	30.2	19.4	386.80	0.21	7.59	434.30	10.17	112.20	0.2821	654.6	N40^{O}20'963" E33^{O}03'858"	Hs, Pi
170	pd						1258	30.7	32.6	24.1	265.20	0.13	8.61	268.90	9.12	107.90	0.1755	656.1	N40^{O}21'574" E33^{O}09'038"	Is
171	th	62	0.5	0.4	7	1.40	910	28.7	37.5	15.2	506.00	0.30	7.58	624.00	6.05	59.90	0.4030	680.0	N40^{O}19'021" E33^{O}13'035"	Hi, Hs, Pm, Pc
172	th		0.3	0.4	7	0.84	1185	26.5	35.9	17.1	176.80	0.10	6.86	208.20	9.80	103.60	0.1352	661.8	N40^{O}17'039" E33^{O}07'012"	Hi, Is, Pi
173	th	100	0.1	0.3	4	0.12	1075	26.5	42.6	13.6	459.00	0.29	7.30	591.10	4.51	64.30	0.3842	657.7	N40^{O}12'031" E33^{O}07'048"	Pe

Appendix 2. The species and collected station numbers (St. No). Abbreviations were illustrated in Table 1.

St. No	Ca	Cn	Cs	Cy	Cp	Es	Ee	El	Ev	He	Hc	Hh	Hn	Hb	Hr	Hi	Hs	Is	In	Ig	Ib	Ii	Pm	Pa	Pp	Pt	Ps	Pv	Pi	Pu	Ph	Pz	Pc	Px	Pe	Py	Po	Pf	Ts	Tc	Tl	tot.
1																2																										2
2																																										0
3																14																										14
4																																										0
5												1				2						1																				4
6																1																1										2
7																19																										19
8															202	1																										203
9																																				1						1
10																19																										19
11														101		11								97																		209
12																1					24																					25
13																85																										85
14																																										0
15																																										0
16														91		8					7																					106
17																		2																								2
18																119																										119
19																																										0
20																103																										103
21																6																										6
22																																										0
23																8		1																								9
24																63																										63
25																																										0
26																15					4																					19
27															30	223					48																					301
28																7					2																					9
29																53					14																					67
30												332				45					7																					384

Continue of Appendix 2

66																																1										1
67																							1																			1
68																53	72																									125
69																	1																									1
70																3																										3
71																146																										146
72															113	46					24			98																		281
73												87							1					4																		92
74											2					27					32								7													68
75																66	57																									123
76																19	25				5																					49
77		4								1						30	27				32											11										105
78						1															3																					4
79																					53											2						3				58
80																1					2	3										2										8
81																																										0
82																		2																								2
83																		1																								1
84																																										0
85																18					10																					28
86								4							1	33	20				2											2										62
87																		1																						1		2
88																					36																					36
89																																										0
90																																										0
91																																										0
92									25							4																										29
93																2		2																								4
94																					24																					24
95																					14																	2				16
96																																										0
97									11								16				6												1				2					36
98																	29																									29
99									10							6	22																									38
100																1																										1

Continue of Appendix 2

101																63																										63
102																1																										1
103									85												11																					96
104									5							10																						2				17
105																																					63	18				81
106																127																										127
107							42									92	42																									176
108																							1																			1
109																																										0
110																19				13	61																					93
111																					7		2																			9
112								8								52																										60
113						17																	1																			18
114																12	58												11													81
115																8																										8
116																																									51	51
117																	144																									144
118																					40											1	1				40	13				95
119																	1														124											125
120																4	122																									126
121																	13	1																								14
122																																										0
123																																										0
124																					12											5										17
125																							1																			1
126																																										0
127																2	2			4																						8
128								6								52													48												25	131
129											63							1					1																			65
130												69					58				14																					141
131																																										0
132																17																										17
133					1				2							3														24												30
134																7	43																									50
135																	1																									1

Continue of Appendix 2

136																													13													13
137																							2																			2
138																																										0
139																													46													46
140						2										4	6												6													18
141																																										0
142																	2				20																					22
143																																										0
144																29	51																									80
145									19							9																										29
146																							2																			2
147																																										0
148																																										0
149																																										0
150																				3												1		1								5
151																4																1										5
152																							1									81										82
153																																										0
154																																										0
155																4																										4
156																	3				71																					74
157																	9				3						3											14				29
158																	126				7																					133
159																	3															1										4
160											13						24				52																					89
161										1							10				2																					13
162																							1																			1
163																	1																									1
164																																										0
165																4																									72	76
166																													13							1						14
167																				31																						31
168	3					1																																				1
169																	5												183													188
170																		2																								2
171																5	9						1										1									16
172																53		1											14													68
173																																			15							15
Total	3	30	17	0	1	21	42	18	157	2	78	537	73	345	350	2760	1050	15	1	51	779	4	14	236	33	1	3	42	341	31	124	311	3	1	15	2	143	52	0	7	203	7896

Appendix 3. Towns with station numbers (ST. NUMB). (*) referred to collect the samples from GÖLBAŞI and ŞEREFLİ KOÇHİSAR for the second times.

TOWN	ST. NUMB																		DATE	
GÖLBAŞI	1	30	31	34	35														22.06.2011	30.06.2011*
ŞEREFLİ KOÇHİSAR	2	3	4	5	6	13	14	15	16	17	18	19	20	21					22.06.2011	23.06.2011*
EVREN	7	8	9	10	11	12													22.06.2011	
BALA	22	23	24	25	26	27	28	29	32	33	36	37	38	39	40				23.06.2011	
KAZAN	41	42	43	44	45	46													24.06.2011	
KIZILCAHAMAM	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61				24.06.2011	
GÜDÜL	62	63	64																24.06.2011	
POLATLI	65	66	67	68	69	70	71	72	73	74	75	76	77	78					25.06.2011	
HAYMANA	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	26.06.2011	
NALLIHAN	97	98	99	100	101	102	103	104	105	106	107	108	109	110					27.06.2011	
BEYPAZARI	111	112	113	114	115	116	117	118	119	120	121	122							28.06.2011	
AYAŞ	123	124	125	126	127	128	129	130	131	132	133								30.06.2011	
ÇAMLIDERE	136	137	138	139	140														01.07.2011	
ELMADAĞ	141	142	143	144	145														01.07.2011	
AKYURT	146	147	148	149	150	151													01.07.2011	
KALECİK	152	153	154	155	156	157	158	159	160	161	162								02.07.2011	
ÇUBUK	163	164	165	166	167	168	169	170	171	172	173								03.07.2011	

PHOTOS

Photo 1. Station 40. Working at night with car lights on.

Photo 2. Station 41. Pond with difficult access.

Photo 3. Station 45. Alpağut Trough.

Photo 4. Station 46. Ova stream.

Photo 5. Station 68. A trough far from the Hacıtuğrul village.

Photo 6. Station 78. Chicken drinks water from the plastic trough.

Photo 7. Station 95. Dereköy creek.

Photo 8. Station 99. Çilingirler Wood Trough.

Photo 9. Station 118. Karasu Spring ‘A limnocrene spring.

Photo 10. Station 156. Satılmış Kavak Trough.

Photo 11. Station 142. Everybody works hard even our driver.

Photo 12. Station 150. Working under the rain.

Photo 13. Station 80. Soğulca stream.

Photo 14. Station 87. Water body with a rainy day.