

T.R.
BOLU ABANT İZZET BAYSAL UNIVERSITY
INSTITUTE OF GRADUATE STUDIES
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**ESTIMATING CO-OCCURRENCE PATTERNS AND
ECOLOGICAL CHARACTERISTICS OF OSTRACODA
(CRUSTACEA) SPECIES IN ESKİŞEHİR PROVINCE
(TURKEY)**

DOCTOR OF PHILOSOPHY

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BOLU, JUNE - 2024

APPROVAL OF THE THESIS

ESTIMATING CO-OCCURRENCE PATTERNS AND ECOLOGICAL CHARACTERISTICS OF OSTRACODA (CRUSTACEA) SPECIES IN ESKİŞEHİR PROVINCE (TURKEY) submitted by **Filiz BATMAZ** and defended before the Examining Committee Members listed below in partial fulfillment of the requirements for the degree of **Doctor of Philosophy** in **Department of Biology, Institute of Graduate Studies of Bolu Abant İzzet Baysal University** in **24.06.2024** by

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“It was the best of times, it was the worst of times, it was the age of wisdom, it was the age of foolishness, it was the epoch of belief, it was the epoch of incredulity, it was the season of Light, it was the season of Darkness, it was the spring of hope, it was the winter of despair, we had everything before us, we had nothing before us, we were all going direct to Heaven, we were all going direct the other way—in short, the period was so far like the present period, that some of its noisiest authorities insisted on its being received, for good or for evil, in the superlative degree of comparison only.”

The Tale of Two Cities by Charles Dickens

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ABSTRACT

ESTIMATING CO-OCCURRENCE PATTERNS AND ECOLOGICAL CHARACTERISTICS OF OSTRACODA (CRUSTACEA) SPECIES IN ESKİŞEHİR PROVINCE (TURKEY)

PHD THESIS

FİLİZ BATMAZ

BOLU ABANT İZZET BAYSAL UNIVERSITY

INSTITUTE OF GRADUATE STUDIES

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This study aimed to understand co-occurrence patterns and ecological characteristics of ostracod species in Eskişehir province. A total of 118 sampling sites were visited and 36 ostracod species were collected from the area during 11-17 July 2020. Twenty four of 36 species were new reports for the province. Including the previously known 20 species, numbers of ostracods are elevated to 44 species. A new species, *Eucypris durlionensis*, was found in the area. The most effective ecological variables on the species occurrences were determined as elevation, nitrite, and pH from the Canonical Correspondence Analysis. Species co-occurrence showed different patterns based on habitat types in the area. Accordingly, *Ilyocypris bradyi* co-occurred with *Herpetocypris intermedia* and *Prionocypris zenkeri* in the all-sampling sites. *Heterocypris salina* and *I. bradyi* were generally found together in the lentic waters while *P. zenkeri* was found with *I. bradyi* in the lotic habitats. According to C2 analysis results, some species have different tolerance for ecological variables both in the lentic and lotic habitats. Indicator species analysis suggested that *Heterocypris incongruens* seems to prefer a wide range of artificial and lentic habitats when *Ilyocypris inermis* preferred lotic and natural habitats. We determined sink and source habitats based on the numbers of species per site. Distribution of ostracod species in the province was modeled with Adespatial analysis. Accordingly, 10 groups were determined in the distribution model that was created based on the distance and species richness between the sampling sites. Results suggested that cosmopolitan species with similar preferences tend to co-occur in a variety of habitats.

KEYWORDS: Ostracod, Diversity, Co-occurrence, Sink and Source Habitats, Distribution.

ÖZET

ESKİŞEHİR (TÜRKİYE) BÖLGESİNDEKİ OSTRAKODA (CRUSTACEA) TÜRLERİNİN BİRLİKTE BULUNMA DURUMLARININ VE EKOLOJİK KARAKTERLERİNİN BELİRLENMESİ

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Bu çalışma, Eskişehir bölgesindeki ostrakod türlerinin birlikte bulunma şekillerini ve ekolojik özelliklerini anlamayı amaçlamıştır. Onbir-onyedi Temmuz 2020 tarihleri arasında toplam 118 örnekleme alanı ziyaret edilmiş ve bölgeden 36 ostrakod türü toplanmıştır. Bu 36 türden 24 tanesi bölge için yeni türlerdir. Önceden bilinen 20 türle birlikte bölgenin ostrakod kompozisyonu 44'e çıkmıştır. Bölgede yeni bir tür olan *Eucypris durlionensis* keşfedilmiştir. Kanonik karşılaştırma analizi sonuçlarına göre türlerin dağılımı üzerinde en etkili ekolojik faktörler yükseklik, nitrit ve pH olarak belirlenmiştir. Türlerin birlikte bulunma durumlarının habitat türüne göre farklılık gösterdiği görülmüştür. Buna göre *Ilyocypris bradyi*, tüm örnekleme alanlarında *Herpetocypris intermedia* ve *Prionocypris zenkeri* ile birlikte bulunmaktadır. *Heterocypris salina* ve *I. bradyi* genellikle lentik sularda bir arada bulunurken, *P. zenkeri* ise lotik habitatlarda *I. bradyi* ile birlikte bulunmaktadır. C2 analiz sonuçlarına göre türlerin farklı ekolojik değişkenlere olan toleransları lentik ve lotik habitatlarda değişkenlik göstermektedir. İndikatör tür analizi, *Ilyocypris inermis*'in lotik ve doğal habitatları tercih ettiğini gösterirken, *Heterocypris incongruens*'in çok çeşitli yapay ve durgun su habitatlarını tercih ettiğini ortaya koymuştur. Fakir ve zengin habitatlar örnekleme alanında bulunan tür sayısına bakılarak belirlenmiştir. Adespatial analizi ile Eskişehir bölgesindeki ostrakod türlerinin dağılımı modellenmiştir. Buna göre, örnekleme noktaları arasındaki masafe ve tür zenginliği baz alınarak oluşturulan dağılım modelinde 10 grup belirlenmiştir. Elde ettiğimiz sonuçlar gösteriyor ki, benzer tercihlere sahip kozmopolitan türler çeşitli habitatlarda birlikte bulunma eğilimindedirler.

ANAHTAR KELİMELEER: Ostrakod, Çeşitlilik, Birlikte bulunma, Fakir ve Zengin Habitatlar, Dağılım.

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magnesium (mgL^{-1}); Ca^{+2} , calcium (mgL^{-1}); NO_2 , nitrite (mgL^{-1}); $\text{NO}_2\text{-N}$, nitrite nitrogen (mgL^{-1}); $\text{NO}_3\text{-N}$, Nitrate nitrogen (mgL^{-1}); NO_3 , nitrate (mgL^{-1}); Tot N, total nitrogen (mgL^{-1}); Spp, abbreviations of species (see Table 4.1); Count, Numbers of species occurrence; Max, Maximum members of individuals; N2, Hill's coefficient; Opt, optimum level; Tol, Tolerance level.....35

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LIST OF ABBREVIATIONS AND SYMBOLS

A1	: The First Antenna
A2	: Second Antenna
Md	: Mandible
Mx	: Maxillula
T1	: The First Thoracopod
T2	: Second Thoracopod
T3	: Third Thoracopod
UR	: Uropod
BOD₅	: Biochemical Oxygen Demand
DO	: Dissolved Oxygen
Tw	: Water Temperature
EC	: Electrical Conductivity
TDS	: Total Dissolved Solid
Sal	: Salinity
Ta	: Air Temperature
EL	: Elevation
PO₄	: Phosphate
PO₄-P	: Phosphorus phosphate
Tot P	: Total Phosphorus
NO₂	: Nitrite
NO₂-N	: Nitrite Nitrogen
NO₃	: Nitrate
NO₃-N	: Nitrate Nitrogen
Tot N	: Total nitrogen
Ca⁺²	: Calcium
Mg⁺²	: Magnesium

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1. INTRODUCTION

The living world is magnificent, we can observe different creatures everywhere we look. The diversity of organisms can be seen everywhere. As stated in Brown et al. (2007) species diversity, the number of species per unit area but biodiversity is mostly related with full variety of life on the ecosystem. Besides the number of species, relative abundance is also important for defining diversity, the numerical supremacy of species defines dominance (Smith & Smith, 2012). Alpha (number of species in a habitat or region), beta (difference in species diversity between two or more habitat or region), and gamma (total number of species in an area containing more than one habitat or region) diversity indices are giving idea to which species are distributed in different habitats, and habitat functionality (Whittaker, 1972). So, we can see above, species interactions in a habitat start with distribution in a spatial space.

Co-occurrence studies started in the early 1900's, and it is still a hot topic for community researchers. According to Clements (1936), co-occurrence is an association of species, and can be positive, negative, or random. This association occurs when the presence of one species has some influence on the occurrence of another. In other words, co-occurrence is a way to determine community dynamics based on frequency of presence/absence data of species (Blanchet et al., 2020). Researchers have proposed and discussed statistical methods to infer relationships among species based on presence/absence data (Forbes, 1907; Michael, 1920; Gotelli & McCabe, 2002; Veech, 2014). We know that ecological and biological interactions can also affect species distribution. According to Cazelles et al. (2016) when interactions between two species increase, their co-occurrence state decrease. This outcome supports the Gause Law that two species that compete for same resource cannot co-occur at the same time/space (Hardin, 1960). In a competition system, stable co-occurrence requires interspecific interactions to be weaker than intraspecific interactions (Chesson, 2000). This assertion brought us to importance of spatial scale or habitat size. As stated in Dufour et al. (2015) partition of the habitat is important for interspecific competition and co-occurrence of the species. Another important point is that many of the co-occurrences are driven by shared environmental preference rather than species interactions (Freilich et al., 2018).

In a province, various habitat types can be seen. There is a general expectation that habitats closer to one another should have similar dynamics because they share various environmental conditions (Evans et al., 2022). Closer habitats facilitate species migration from one to another. The sink and source concept proposed by Pulliam (1988) related to species composition in a patchy environment. Accordingly, source habitats contain populations with high reproduction rate and low extinction rates. Sink habitats, on the other hand, contain populations with a low reproduction rate and a high risk of extinction. In other words, source habitats can contain relatively high habitat quality (in ecological sense) and populations with high persistence rate while sink habitats contain poor quality habitats and populations with low persistence rate. Therefore, migration from outside is necessary for the continuity of the sink habitats. So, this concept emphasizes that the dispersal rate is important for species' spatial and environmental process of structuring communities (Gansfort & Traunspurger, 2019). Since arthropods show faster response to environmental changes due to their wide diversity, numerous dispersal ways, and high fecundity abilities, they are very suitable organisms to study community structure, and diversity modelling (Schröder, 2006).

1.1 Ostracoda

Ostracods are small aquatic crustaceans with a length of 0.3 to 5 mm (Meisch, 2000) with low magnesium calcite valves (Perez et al., 2010). They can sometimes be called “seed shrimp” or “mussel shrimp” (Meisch, 2000; Martens et al., 2008). They are very common in all kinds of aquatic environments including fresh, brackish, and marine waters, including streams, springs, ponds, lakes, estuaries, and oceans. Also, some species are found in groundwaters, semi-terrestrial environments, or even in terrestrial plants that accumulate water, such as bromeliads (Perez et al., 2010).

After years of study worldwide there are approximately 65 000 ostracod species detected from marine and freshwater environments, and almost 20 000 of them estimated as living species (Ikeya et al., 2005). Among them more than 2300 living freshwater species observed and this number assumed to be more (Meisch et al., 2019).

Ostracods are the most abundantly preserved microfauna in the fossil records due to their calcific carapace (Delorme, 1991). The oldest fossil ostracods are recognized from rocks of the Ordovician Period, 485 to 443 million years ago (Almeida-Lima et al., 2022).

The class Ostacoda under the Phylum Arthropoda, and Subphylum Crustacea. Ostracoda is divided into two subclasses: Podocopa and Myodocopa. The subclass Podocopa is divided into three Orders: Podocopida, Platycopida, and Paleocopida whereas Myodocopida divides into two Orders: Myodocopida and Malocyprida. Among them Platycopida, Myodocopida, and Podocopida include living ostracods. Only Podocopida includes freshwater and brackish water ostracods (Meisch, 2000).

1.2 Ostracod Morphology

Ostracods laterally compressed crustaceans and the body is enclosed entirely in a bivalve carapace. The carapace shape can be ovate, kidney-shaped, or bean-shaped, and some are elongated or triangular, commonly with a fringe of hairs and with fine surface sculpturing in some cases (Knight & Mori, 2022). The shell structure of Ostracoda is made by low magnesium calcium carbonate. Two valves of carapace connected each other with a structure called “hinge” on the medio-dorsal side (Delorme, 1991).

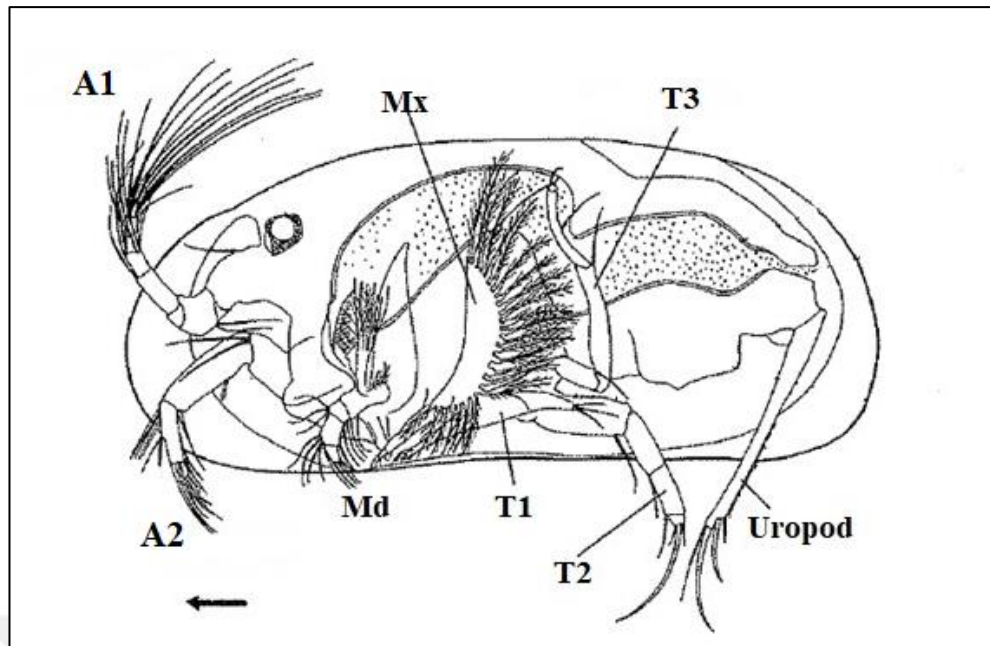


Figure 1.1. Ostracod morphology, modified from Meisch (2000). *Herpetocypris reptans*, LV, Female. A1, Antenna; A2, Antennula; Md, Mandible; Mx, Maxillula; T1, The first thoracopod; T2, Second thoracopod; T3, Third thoracopod. Arrow shows the anterior side.

The soft body of ostracod have eight pairs of appendages (Table 1.1): Antennula (A1), Antenna (A2), Mandible (Md), Maxillula (Mx), First thoracopod (T1, Clasping organ in male) or Fifth limb (L5), Second thoracopod (T2) or Sixth limb (L6 = walking leg), Third thoracopod (T3) or Seventh limb (L7 = cleaning leg), Uropod (Furca (Ur)) (Meisch, 2000; Karanovic 2012) (Figure 1.1).

Table 1.1. Ostracod appendages and their functions adapted from Delorme (1991), Meisch, (2000), Karanovic (2012).

Body Part	Abbreviation	Function
Antennula	A1	Swimming, crawling, sensory
Antenna	A2	Swimming, crawling, sensory, copulation, feeding
Mandible	Md	Feeding
Maxillula	Mx	Feeding and respiration
The first Thoracopod	T1 or L5	Feeding, copulation, walking
Second Thoracopod	T2 or L6	Walking
Third Thoracopod	T3	Cleaning, walking, climbing
Uropod	Ur	Locomotion, copulation

The body of ostracods does not have a clear segmentation like the other arthropods, but the head and abdomen can be separated by the appendages position (Delorme, 1991). A pair of median eyes can be seen on the antero-dorsal side of the body. Each appendage can be used for taxonomic identification of Ostracoda (Meisch, 2000).

Ostracod species growing by moulting like other Crustaceans. They generally pass through eight stages to reach adulthood. An ostracod's life cycle may last a few months or > 2 years (Horne et al. 2002, Smith & Horne 2002). The hatched larvae have a fully developed carapace already. A total of eight moults between the egg and adult. The last moults is adult and sexually matured (Meisch, 2000). The ostracod egg can survive in harsh conditions due to their double walled structure. This feature protects the egg from desiccation and freezing (Delorme, 1991). Sexual, asexual (parthenogenesis) and mixed (sexual and parthenogenesis) reproduction types can be seen in Ostracoda. Although parthenogenetic reproduction type is common in freshwater ostracods, in some cases sexual reproduction may be a preferred mode of reproduction of parthenogenetic species in extreme environmental conditions (Ozawa, 2013).

Although some ostracod species can move actively (swimming setae on A2), they are mostly transported in passive way over long distances (i.e. between habitats) by hosts such as flowing water (Havel et al., 2000), wind (Moreno et al., 2016), aquatic birds (Proctor et al., 1967), fish (Vinyard, 1979), frog and snakes (Lopez et al., 1999), mammals (Wanschoenwinkel et al., 2008) and humans (Valls et al., 2017).

Ostracod species have wide tolerance levels to biotic and abiotic factors (Benson, 1990) and so they are used as indicator species for estimating the environmental deterioration (Benson, 1990; Delorme, 1991; Klkylođlu, 1999). Previous studies showed that, water quality and ecological variables can affect ostracods distribution, most effective properties are pH, water temperature, salinity, elevation, dissolved oxygen, and sediment type (Mezquita et al, 1999; Klkylođlu et al., 2005a, b; Prez et al., 2010), but many species have broad tolerance range to variety of ecologic variables (cosmopolitan species) (Klkylođlu, 2003). On a recent study Klkylođlu et al. (2020) pinpointed that ostracod species can be used as indicator organisms for water quality.

When we look at the literature, we can see numerous studies about ostracod distributions and determining the factors that affect species distribution in Türkiye and abroad (e.g., Mezquita et al., 1999; Pieri et al., 2009; Klkylođlu et al., 2012a, b; Akdemir & Klkylođlu, 2014). Also, we can see information about the co-occurrence of many species in studies investigating the distribution of ostracods (e.g., Ganning 1971; Yavuzatmaca et al., 2018; Klkylođlu et al., 2020). Ganning (1971) mentioned the negative co-occurrence of *Heterocypris salina* and *H. incongruens* in a previous study. Recently, Klkylođlu et al. (2020) found that *Psychrodromus olivaceus* has positive co-occurrence with *Ilyocypris inermis* and *I. bradyi* in Artvin province.

Ostracods studies in Türkiye started with German scientists H. W. Schfer in 1952 and G. Hartman in 1964. Afterward D. Glen who was the first Turkish nonmarine ostracod worker (Glen, 1975), and his colleagues made various studies on non-marine ostracods. Ostracod composition in Türkiye (Altınsaçlı & Griffiths, 2002; Klkylođlu et al., 2015; zuluđ et al., 2018) is revealing with the new studies in every year.

2. AIMS OF THE STUDY

The thesis will be dealing with questioning the ostracods species distribution and co-occurrence patterns along with applying presence/absence data and species ecological characteristics, including their habitat preferences within and among their distribution patterns in the Eskişehir province (Türkiye). Unlike previous studies, using species as ecological groups makes us see their co-occurrence patterns in a different way. In addition, the extraction of the distribution model of the region to better determine the ostracod species occurrence in the region is another aspect of this study. As known anthropogenic factors (e.g., habitat destruction, creating new habitats (such as dams), creation of corridors or barriers, preventing species migration, movement of species from one place to another by humans) frequently change characteristics of natural habitats and ecosystems that eventually influence species distribution. However, if there is a model that can show the species distribution in a region, at least its outlines (such as the distribution directions of the species or the transportation routes), it will allow us to save time and energy for the sink/source habitats in that region, and the measures to be taken to protect the species diversity, and take the necessary precautionary actions for the future activities. Thus, this can reduce or limit possible damage to species and habitat diversity and richness.

In line with the main objectives of the thesis, our hypotheses below will be discussed:

Hypothesis 1: Habitat types (lotic or lentic) make no difference on species co-occurrence.

Aim 1: Species that have the same habitat preferences may have same ecological selection.

Rationality 1: If habitat preferences make no difference, species with similar occurrences can be found in similar conditions. Thus, these species of populations can be used as “group-indicator” (Külköylüoğlu et al., 2020).

Hypothesis 2: There is no difference in the average number of species between natural and artificial aquatic habitats.

Aim 2: Determining the effects of artificial and/or natural environments on the number of species.

Rationality 2: if this is provided, it can be determined which environments are included in priority protection programs. Thus, economical, and temporal losses can be determined and eliminated in advance.

Hypothesis 3: There is no difference in the density of species with asexual reproduction in source (rich) and sink (poor) habitats.

Aim 3: It will be tested whether there is a difference in the number of species with sexual and asexual reproduction in source and sink habitats.

Rationality 3: If the reproduction type of species in source/sink habitats are determined, the reproduction type of species that can be found in sink/source habitats will also be determined. Because it is known that species with parthenogenetic reproduction by passive transport are advantageous, and therefore it is expected that asexual/parthenogenetic species will emerge more intensely in source habitats.

Hypothesis 4: Species richness in sink habitats is not affected by the distance between that habitat and source habitat.

Aim 4: Determination of whether the distance between habitats affects the distribution in ostracods dispersed by passive transport.

Rationality 4: If the effect of distance is determined, predictions can be made about how far the species can be distributed by looking at the transporting vectors in a new study area, and this will provide precious data for modeling studies. For this purpose, the distance between each sampling site and possible ways that may affect the species distribution will be measured in the field study.

Hypothesis 5: There is no difference in the ecological tolerance and optimum levels of the species between source and sink habitats.

Aim 5: Estimating tolerance levels of species and comparing between the habitats.

Rationality 5: Since the sink habitats are facing more disturbance than source habitats, the species that are sited there should have wider tolerance.

3. MATERIALS AND METHODS

3.1 Site Description

The Eskişehir province is in the northwest of the Central Anatolia Region, between 39°46'15.1752" North latitude and 30°30'56.1744" East longitude. Surrounded by natural borders such as Bozdağ and Sündiken Mountains from the north, Emirdağ Mountain from the south, Central Asia Valley from the east, and Türkmen Mountain from the west, the province area is approximately 13,653 km². The altitude of the city center from sea level is 792 m. The share of plains in landforms of the province, of which 22 % is composed of mountains, is around 26 %.

The province is rich with aquatic bodies. Sakarya river, one of the most important rivers of Türkiye, is also the main river in the province. It has many arms. Its most important branch is Porsuk Stream. In addition, Sakarya river's branches in the province are Sarısu, Seydisuyu and Bardakçı waters. The Porsuk Stream has separate branches within the province. These are Kargın Stream, Ilıcasu, Mollaoğlu Stream, Sarısu, Keskin Water and Pürtek Stream. The total length of Sakarya is 627 km, and its length within the province is 400 km. The total length of the Porsuk Stream is 255 km, and its length within the province is 225 km.

Although there is no natural lake in Eskişehir, there are 6 dams. These are Porsuk Dam, Gökçekaya Dam, Musaözü Dam, Kunduzlar Dam, Çatoren Dam, and Kaymaz Dam. Porsuk Dam is used for irrigation, flood protection, supply of drinking water and utility water (Eskişehir Provincial Directorate of Agriculture and Forestry, 2023).

Eskişehir has a unique climate because it is within the influence of Central Anatolia, Western Black Sea and Mediterranean climates. It is bordered by the Black Sea in the north, the Marmara in the northwest, and the Aegean Region in the west and southwest. A small part of Han and Seyitgazi, which are counties of Eskişehir, are under the influence of the Black Sea Region, while all Sarıcakaya and Mihalgazi Districts and a part of Merkez and Mihalıççık districts are in the Aegean. Although Eskişehir contains different variables in terms of climate, it carries the character of the Central Anatolian climate more intensely. Summers are hot and dry; winters are cold and rainy. 70 % of the annual precipitation occurs

during the cold period from October to March. Average annual precipitation is between 379 - 553 mm. The highest and lowest temperature values in the province are 39.1 °C and - 26.3 °C (ETOM, 2018).

3.2 Sampling and Measurements

In the Eskişehir province, samples were collected from 118 randomly including seven different aquatic habitats (river, dam pond, stream, pond, pool, canal, and trough) between 11 - 17 July 2020 (Figure 3.1). The sampling was done in such a way that there was at least 15-20 km distance between the sampling sites. Four different types of samples (ostracod, water, BOD₅, and turbidity samples) were collected *in situ*. At each sampling site, some of the environmental variables (dissolved oxygen concentration (DO, mgL⁻¹), percent oxygen saturation (% sat.), water temperature (Tw, °C), electrical conductivity (EC, µScm⁻¹), total dissolved solids (TDS, mgL⁻¹ and it is calculated from EC and Tw), salinity (Sal, ppt), pH, atmospheric pressure (mmHg)) were recorded before ostracods sampling to prevent possible results of “Pseudoreplication” (Hurlbert, 1984) by a YSI-Professional Plus. The air temperature (Ta, °C), wind speed (kmh⁻¹) and air moisture (%) were obtained by a Testo 410 - 2 model of anemometer and the basic geographical data (elevation (EL), coordinates) were recorded with a geographical positioning system (GARMIN etrex Vista H GPS) *in situ*. The samples were taken at different times of the day and the measured values may be affected by timing.

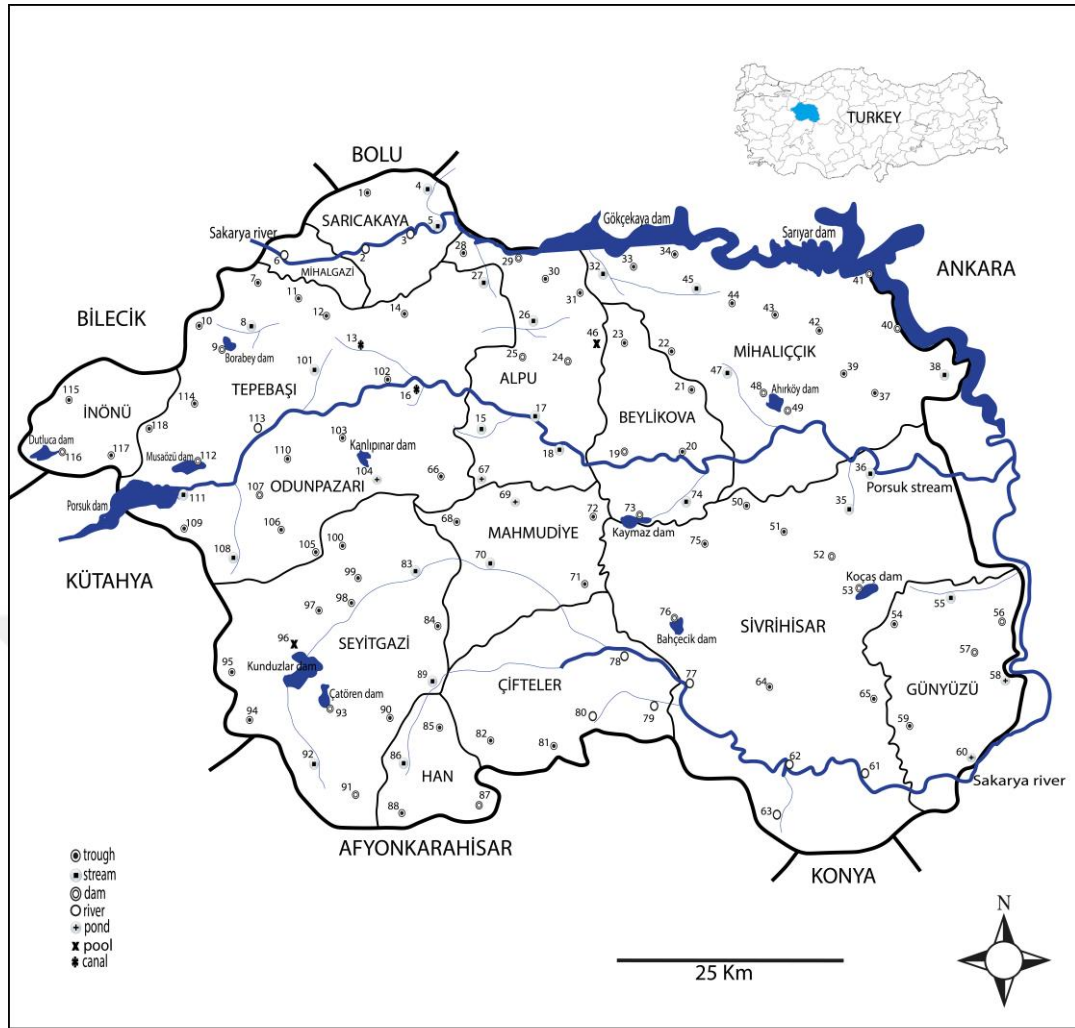


Figure 3.1. Distribution of randomly selected 118 sampling sites from Eskişehir province, Türkiye.

Ostracod samples were collected from each site with a standard hand net (200 μm in mesh size). Samples were stored in 250 ml plastic bottle and fixed with 70 % alcohol to prevent deterioration of samples *in situ*. In the laboratory, each sample was filtered through three standard sieves (1.0, 1.5-, and 2.0- mm mesh size) under tap water and then kept in 70 % alcohol. Ostracod species were sorted from sediments under a stereomicroscope (Olympus ACH 1X) and dissected in lactophenol solution for taxonomic identification. Carapace and valves were kept in micropaleontological slides for further studies in Bolu Abant İzzet Baysal University Limnology Laboratory. The valves of each identified species were taken to micropaleontological slides SEM photography and sent to Hacettepe University, Department of Geological Engineering for SEM shots. The taxonomic key of

Meisch (2000) was primarily used for taxonomic classification and species identification but some other taxonomic keys (e.g., Bronhstein, 1947; Karanovic, 2012) were also used when needed. Species identification was done under the light microscope (Olympus BX-51).

Water samples were collected from each sampling site in 250 ml bottles for water anion-cation analyses and appropriate acids (Nitric and Hydrochloric acids) were added to preserve their proper state. After the field study was completed, water samples were sent to the Bursa Uludağ University, Biology Department, Limnology Laboratory with cooler freezers. Phosphorus phosphate ($\text{PO}_4\text{-P}$), total phosphorus (Tot P), nitrite nitrogen ($\text{NO}_2\text{-N}$), nitrate nitrogen ($\text{NO}_3\text{-N}$), total nitrogen (Tot N), Kjeldal nitrogen., calcium (Ca^{+2}), magnesium (Mg^{+2}) and total hardness analyses were performed according to APHA (1998) method (Table 3.1). Nitrite (NO_2), nitrate (NO_3), and phosphate (PO_4) concentrations were found based specific equations. Accordingly, NO_2 was calculated by $\text{NO}_2\text{-N} * 3.28443$, NO_3 was calculated by $\text{NO}_3\text{-N} * 4.42664$, and PO_4 calculated by $\text{PO}_4\text{-P} * 3.0661$ (Assumed atomic weights: H = 1.008, N = 14.007, O = 15.999)

Table 3.1. Methods used for anion-cation analysis.

Chemicals	Abbreviations	Units	References	Methods
Phosphorus phosphate	$\text{PO}_4\text{-P}$	mg L^{-1}	APHA 4500-P E.	Spectrophotometric, ascorbic acid method
Total phosphorus	Tot P	mg L^{-1}	APHA 4500-P B.	Spectrophotometric, ascorbic acid method following persulfate degradation
Nitrite nitrogen	$\text{NO}_2\text{-N}$	mg L^{-1}	APHA 4500- NO_2^- B.	Colorimetric method
Nitrate nitrogen	$\text{NO}_3\text{-N}$	mg L^{-1}	APHA 4500- NO_3^- E.	Cadmium reduction method
Total nitrogen	Tot N	mg L^{-1}	APHA 4500-N C.	Spectrophotometric, cadmium reduction method following alkaline persulfate digestion
Kjeldal nitrogen		mg L^{-1}		Calculation method ($\text{TN} - (\text{NO}_2\text{-N} + \text{NO}_3\text{-N})$)
Calcium	Ca^{+2}	mg L^{-1}	APHA 3500-Ca B.	EDTA titrimetric method
Magnesium	Mg^{+2}	mg L^{-1}	APHA 3500-Mg B.	Calculation method
Total hardness	TH	$\text{mgCaCO}_3 \text{ L}^{-1}$		Calculation method

Biochemical Oxygen Demand (BOD₅) measurements were done in every sampling point. After the oxygen saturation measurement for the BOD₅ from sampling point, the water samples taken into 500 ml plastic containers were kept at an average temperature of 20 °C in the dark, and at the end of the 5th day, the oxygen saturation was measured again and the difference between the first and the last oxygen saturation value was taken into BOD₅.

Turbidity (suspended organic material) samples were taken in 100 ml bottles from each sampling site. To determine the turbidity of the water, the water samples were measured 10 times with a turbidity meter (WPA Turbidity Meter TU1100) and the average value was taken.

At each sampling point, the structure of the area/site (artificial, natural, etc.), habitat type (lake, trough, stream, spring, etc.), and animal species (bird, etc.) observed around the site, livestock activities, wind direction, type of area (steppe, mountainous, woodland, etc.), possible barriers (road, forest, water body, etc.) that may restrict the migration path of animals and possible vectors to passive transport of ostracods were noted in details.

Drawings of the soft body parts of the new species (*E. dorlionensis*) were prepared with a camera lucida (Olympus U-DA) attached to an Olympus BX-51 microscope. Then all drawings were digitized using the Adobe Illustrator CC 2015 program. Also, Adobe Illustrator CC 2015 program was used to prepare all the maps and figures.

3.3 Statistical Analysis

The samples taken analyzed with multi-dimensional statistical methods at the end of biological (Ostracoda), physio-chemical measurements, geographical location, and evaluations. Some basic statistical analyses and the programs to be used for these are as follows:

Shannon Wiener (alpha) Diversity Index was used to the determine diversity among all Eskişehir province, and comparisons between natural/artificial habitats and lentic/lotic habitats based on species diversity (Magurran, 1988). This analysis was done in the Species Diversity & Richness 4 software (Seaby and Henderson, 2006).

Whittaker beta diversity index value was calculated for pairwise comparisons between natural/artificial, lotic/lentic habitats in the Eskişehir province. This analysis was done in the Species Diversity & Richness 4 software (Seaby and Henderson, 2006).

Non-parametric Mann-Whitney U test was used to compare species diversity among natural and artificial habitats (IBM SPSS version 21).

Spearman Correlation analysis was used for determining the degree of relationship among the species and the environmental variables (IBM SPSS version 21).

Multivariate Statistical Package (MVSP) version 3.1 was used for applying Unweighted Pair Group Method with Arithmetic Mean (UPGMA) (Kovach, 1998) to analyzing clustering dendrogram between 19 ostracod species in Eskişehir. UPGMA was applied based on Bray Curtis similarity and data was log transformed.

To examine the relationship between 19 species that occurred in 3 or more sampling sites and the 11 environmental and chemical variables (BOD₅, Biochemical oxygen demand; NO₂, Nitrite; PO₄, Phosphate; Mg⁺², Magnesium; Ca⁺², Calcium; EL, Elevation; EC, Electrical conductivity; DO, Dissolved oxygen; NO₃, Nitrate; pH, Tw; water temperature), a Canonical correspondence analysis (CCA) was applied with Monte Carlo Tests (449 permutations). Before performing CCA, suitability of data for CCA was tested with Detrended Correspondence Analysis (DCA), if length of DCA is 3 or more the data is suitable to use for CCA (Birks et al., 1990; Ter Braak, 1986).

Indicator species analysis (De Cáceres and Legendre, 2009) was used to calculate indicator values of 19 species for different habitats (lentic/lotic, natural/artificial habitats) or environmental variables at different percentages (Indicspecies package in R statistics).

To estimate species (3 or more occurrence) tolerance (tol) and optimum (opt) levels with 23 ecological and chemical variables (pH, atmospheric pressure, salinity, total dissolved solid, water temperature, air temperature, moisture, oxidation reduction potential, biological oxygen demand, dissolved oxygen, electrical conductivity, elevation, orthophosphate, phosphate, total phosphate, magnesium, calcium, nitrite nitrogen, nitrite, nitrate nitrogen, nitrate, total nitrogen), C2 Software Program was used. C2 Analysis Program includes a transfer function

of weighted averaging regression (Juggins, 2003). Tolerance values express the standard deviation of the optimum value.

Cooccur analysis (Veech, 2013) was used to calculate the probability of co-occurrence patterns of the species in all sampling area (94 sampling sites with 36 species), and lentic (66 sampling sites with 29 species) and lotic (28 sampling sites with 25 species) habitats separately (Species co-occurrence probabilistic model) (Cooccur package in R statistics).

Adespatial analysis (Guénard & Legendre, 2022) was used to make a hierarchical clustering to determine ostracod distribution model based on species (36 species) abundance and distances amid sampling sites (94 sampling sites with ostracod). A total of 118 sampling sites coordinates, and 36 species binomial data were used for the analysis. To compute the dissimilarity matrix, the Hellinger distance was used, which is a double-zero asymmetrical co-efficient appropriate for the analysis of community composition data. It is obtained by computing the Euclidean distance of the square-rooted relative abundance data (Adespatial package in R statistics).

Two tailed t-test with un/equal variance analyses was applied to determine if there is a difference between mean values of average number of species in natural and artificial habitats; the species with a/sexual reproduction in sink and source habitats; and species' tolerance and optimum levels for environmental variables that obtained from C2 test results in source and sink habitats (in MS Office Excell).

Variance Analysis (ANOVA) was used for comparing of species numbers in the natural and artificial habitats, and density of species with asexual reproduction in source and sink habitats (Manly et al., 1993) (IBM SPSS version 21).

4. RESULTS

Descriptive statistical results of the obtained physico-chemical data are given in Table 4.2. The average salinity value (0.568 ppt) showed that the sampled aquatic environments were from fresh to brackish waters (Table 4.2). Detailed data about ecological variables (see Appendix 1), water ion concentrations (see Appendix 2), sampled sites habitat type and coordinates (see Appendix 3), and notes taken from the sampling area (see Appendix 4) are given in the appendix section.

Table 4.1. Descriptive statistical results of the physico-chemical data obtained from 118 ostracod sampling sites in Eskişehir province.

Environmental variables	Minimum	Maximum	Mean	Standard deviation
pH	6.400	9.000	7.537	0.568
Dissolved Oxygen (mg L ⁻¹)	0.690	12.600	5.973	1.814
Percentage Oxygen Saturation (%)	7.400	150.000	67.936	21.299
Salinity (ppt)	0.080	11.560	0.568	1.092
Electrical Conductivity (μS cm ⁻¹)	9.600	20460.000	1052.911	1935.128
Specific Electrical Conductivity (μS cm ⁻¹)	173.900	20017.000	1109.422	1899.314
Water Temperature (°C)	11.800	31.900	21.380	4.703
Air Temperature (°C)	18.100	35.000	27.889	3.823
Atmospheric Pressure (mm Hg)	592.900	741.500	678.992	20.538
Oxidation Reduction Potential (mv)	-220.000	511.600	-19.033	68.065
Total Dissolved Solid (mg L ⁻¹)	112.450	13091.000	719.652	1245.073
Moisture (%)	16.100	91.000	49.020	9.448
Wind Speed (m s ⁻¹)	0.000	4.100	0.631	0.768
Altitude (m)	182.000	1414.000	922.845	245.153
Turbidity	0.340	3183.000	40.694	296.602
Biological Oxygen Demand (mg L ⁻¹)	-0.740	10.480	2.338	1.908
Calcium (mg L ⁻¹)	22.044	881.760	139.886	94.468
Magnesium (mg L ⁻¹)	1.216	3064.320	117.521	284.952
Nitrite (mg L ⁻¹)	0.003	0.263	0.041	0.044
Nitrate (mg L ⁻¹)	0.258	127.576	11.365	17.702
Phosphate (mg L ⁻¹)	0.022	4.934	0.435	0.713
Kjeldal Nitrogen	0.777	51.337	6.709	5.903
Total Nitrogen (mg L ⁻¹)	3.745	161.784	20.695	22.385
Total Phosphate (mg L ⁻¹)	0.021	5.436	0.403	0.776
Total Hardness (mgCaCO ₃ L ⁻¹)	112.024	7250.080	542.695	657.556

During this study a total of 21367 individuals belonging to 51 taxa (36 species and 15 subfossil) were reported from 94 of 118 sampling sites from Eskişehir (Figure 4.1 and 4.2). The new species *Eucypris dorlionensis* is the first new report

of the genus *Eucypris* from Türkiye. The most frequent species were *Heterocypris salina* (38 times), *Ilyocypris bradyi* (32 times), and *Prionocypris zenkeri* (29 times).

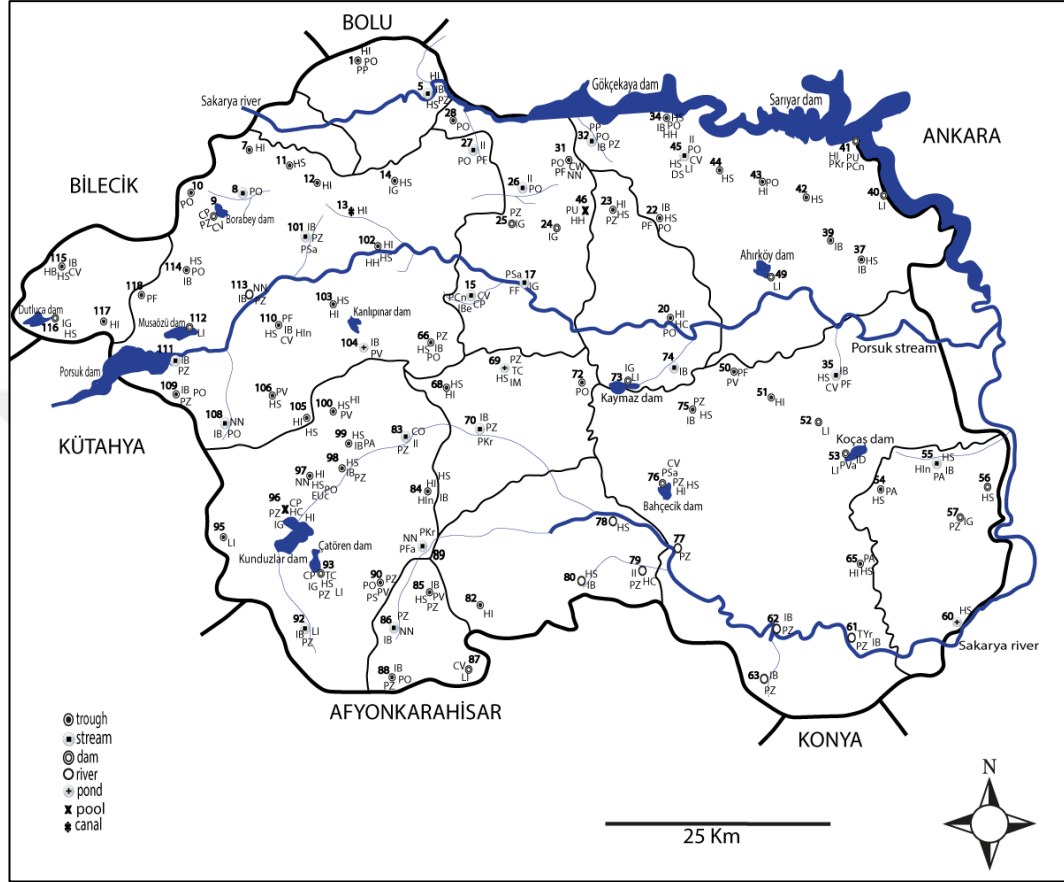


Figure 4.1. A total of 94 sampling sites with 36 ostracod species were found in the Eskişehir province. Species abbreviations given in Table 4.1.

Seven types of habitats; 53 troughs, 24 streams, 21 dams, 11 rivers, five ponds, two canals, and two pools were visited on the field study. Lentic habitats were more abundant than lotic habitats at our sampling in Eskişehir province. While 29 ostracod species were found in 66 of the 81 lentic habitats sampled, 25 ostracod species were found in 28 of the 37 lotic habitats sampled. Additionally, artificial habitats (78 sampling sites) outnumber natural habitats (40 sampling sites) at our sampling area (Table 4.2).

Table 4.2. Ostracod species and their habitat types that were found in Eskişehir province. Abbreviations: Abb, Species abbreviation; Fr, Frequency; Tot.I, Total individual number; Sx, sexually reproductive species; Asx, asexually reproductive species; Nat, Natural habitat; Art, Artificial habitat.

Species	Abb	Fr	Tot.I	Sx	Asx	Lotic	Lentic	Nat	Art
<i>Candona weltneri</i>	CW	1	50	+			50		50
<i>Cypria ophthalmica</i>	CO	1	9	+		9		9	
<i>Cypridopsis vidua</i>	CV	8	231		+	64	167	64	167
<i>Cypris pubera</i>	CP	4	29	+		21	8	21	8
<i>Darwinula stvensoni</i>	DS	1	1		+	1		1	
<i>Eucypris dorlionensis</i>	EUC	1	20				20		20
<i>Fabaeformiscandona fabaeformis</i>	FF	1	2	+		2		2	
<i>Herpetocypris brevicaudata</i>	HB	1	1	+			1		1
<i>Herpetocypris chevreuxi</i>	HC	3	52		+	1	51	1	51
<i>Herpetocypris helenae</i>	HH	3	111		+		111		111
<i>Herpetocypris intermedia</i>	HIn	3	680		+	150	530	150	530
<i>Heterocypris incongruens</i>	HI	22	908	+		11	897	10	898
<i>Heterocypris salina</i>	HS	38	4504	+		1109	3395	1116	3388
<i>Ilyocypris bradyi</i>	IB	32	3145	+		973	2172	974	2171
<i>Ilyocypris decipiens</i>	ID	1	1	+			1		1
<i>Ilyocypris gibba</i>	IG	9	189	+		3	186	3	186
<i>Ilyocypris inermis</i>	II	5	217	+		217		217	
<i>Ilyocypris monstifica</i>	IM	1	3	+			3	3	
<i>Isocypris beauchampi</i>	IBe	1	50		+	50		50	
<i>Limnocythere inopinata</i>	LI	10	123	+		19	104	19	104
<i>Neglecandona neglecta</i>	NN	6	78	+		17	61	17	61
<i>Physocypris kraepelini</i>	PKr	3	70	+		55	15	55	15
<i>Plesiocypridopsis newtoni</i>	PCn	2	202	+		200	2	200	2
<i>Potamocypris arcuata</i>	PA	4	3289		+	100	3189	100	3189
<i>Potamocypris fallax</i>	PFa	1	6		+	6		6	
<i>Potamocypris pallida</i>	PP	2	15		+	7	8	7	8
<i>Potamocypris similis</i>	PS	1	30		+		30		30
<i>Potamocypris unicaudata</i>	PU	2	8		+		8		8
<i>Potamocypris variegata</i>	PVa	1	41		+		41		41
<i>Potamocypris villosa</i>	PV	6	2739		+		2739	45	2694
<i>Prionocypris zenkeri</i>	PZ	29	3209	+		1308	1901	1309	1900
<i>Pseudocandona albicans</i>	PSa	3	11	+		10	1	10	1
<i>Psychrodromus fontinalis</i>	PF	7	806	+		129	677	129	677
<i>Psychrodromus olivaceus</i>	PO	22	443	+		139	304	139	304
<i>Trajancypris clavata</i>	TC	2	57	+			57	4	53
<i>Tyrrhenocythere amnicola</i>	TYr	1	37	+		37		37	

4.1 Systematic Descriptions

PHYLUM: ARTHROPODA

SUBPHYLUM: CRUSTACEA Pennat, 1777

CLASS: OSTRACODA Latreille, 1802

SUBCLASS: PODOCOPA Müller, 1894

ORDER: PODOCOPIDA Sars, 1866

Suborder Podocopina Sars, 1866

Infraorder Cypridacopina Jones, 1901

Superfamily Darwinuloidea Brady and Norman, 1889

Family Darwinulidea Brady and Norman, 1889

Genus Darwinula Brady and Robertson, 1885

Darwinula stevensoni (Brady and Robertson, 1870)

Superfamily Cypridoidea s. str. Baird, 1845

Family Candonidae Kaufmann, 1900

Subfamily Candoninae Kaufmann, 1900

Genus Candona s. str. Baird, 1845

Candona weltneri Hartwig, 1899

Genus Neglecandona Krstić, 2006

Neglecandona neglecta (Sars, 1887)

Genus Fabaeformiscandona Krstić, 1972

Fabaeformiscandona fabaeformis (Fischer, 1851)

Genus Pseudocandona Kaufmann, 1900

Pseudocandona albicans (Brady, 1864)

Subfamily Cyclocypridinae Kaufmann, 1900

Genus Cypria Zenker, 1854

Cypria ophtalmica (Jurine, 1820)

Genus Physocypria Vávra, 1897

Physocypria kraepelini G.W. Müller, 1903

Family Ilyocyprididae Kaufmann, 1900

Subfamily Ilyocypridinae Kaufmann, 1900

Genus Ilyocypris Brady & Norman, 1889

Ilyocypris bradyi Sars, 1890

Ilyocypris decipiens Masi, 1905

Ilyocypris gibba (Ramdohr, 1808)

Ilyocypris inermis Kaufmann, 1900

Ilyocypris monstifica (Norman, 1862)

Family Cyprididae Baird, 1845

Subfamily Cypridinae Baird, 1845

Genus *Cypris* O.F. Müller, 1776

Cypris pubera O.F. Müller, 1776

Subfamily Eucypridinae Bronstein, 1947

Genus *Eucypris* Vávra, 1891

Eucypris dorfionensis Batmaz et al., 2024

Genus *Prionocypris* Brady & Norman, 1896

Prionocypris zenkeri (Chyzer & Toth, 1858)

Genus *Trajancypris* Martens, 1989

Trajancypris clavata (Baird, 1838)

Subfamily Herpetocypridinae Kaufmann, 1900

Genus *Herpetocypris* Brady & Norman, 1889

Herpetocypris brevicaudata Kaufmann, 1900

Herpetocypris chevreuxi (Sars, 1896)

Herpetocypris helenae G.W. Müller, 1908

Herpetocypris intermedia Kaufmann, 1900

Genus *Psychrodromus* Danielopol & McKenzie, 1977

Psychrodromus fontinalis (Wolf, 1920)

Psychrodromus olivaceus (Brady & Norman, 1889)

Subfamily Cyprinotinae Bronstein, 1947

Genus *Heterocypris* Claus, 1892

Heterocypris incongruens (Ramdohr, 1808)

Heterocypris salina (Brady, 1868)

Subfamily Isocypridinae Rome, 1965

Genus *Isocypris* G.W. Müller, 1908

Isocypris beauchampi (Paris, 1920)

Subfamily Cypridopsisinae Kaufmann, 1900

Genus *Cypridopsis* Brady, 1867

Cypridopsis vidua (O.F. Müller, 1776)

Genus *Plesiocypridopsis* Rome, 1965

Plesiocypridopsis newtoni (Brady & Robertson, 1870)

Genus *Potamocypris* Brady, 1870

Potamocypris arcuata (Sars, 1903)

Potamocypris fallax Fox, 1967

Potamocypris pallida Alm, 1914

Potamocypris similis G.W. Müller, 1912

Potamocypris unicaudata Schäfer, 1943

Potamocypris variegata (Brady & Norman, 1889)

Potamocypris villosa (Jurine, 1820)

Superfamily CYTHEROIDEA Baird, 1850

Family Limnocytheridae Klie, 1938

Subfamily Limnocytherinae Klie, 1938

Genus *Limnocythere* s. str. Brady, 1867

Limnocythere inopinata (Baird, 1843)

Family Hemicytheridae Puri, 1953

Genus *Tyrrhenocythere* Ruggieri, 1955

Tyrrhenocythere amnicola (G.O. Sars, 1888)

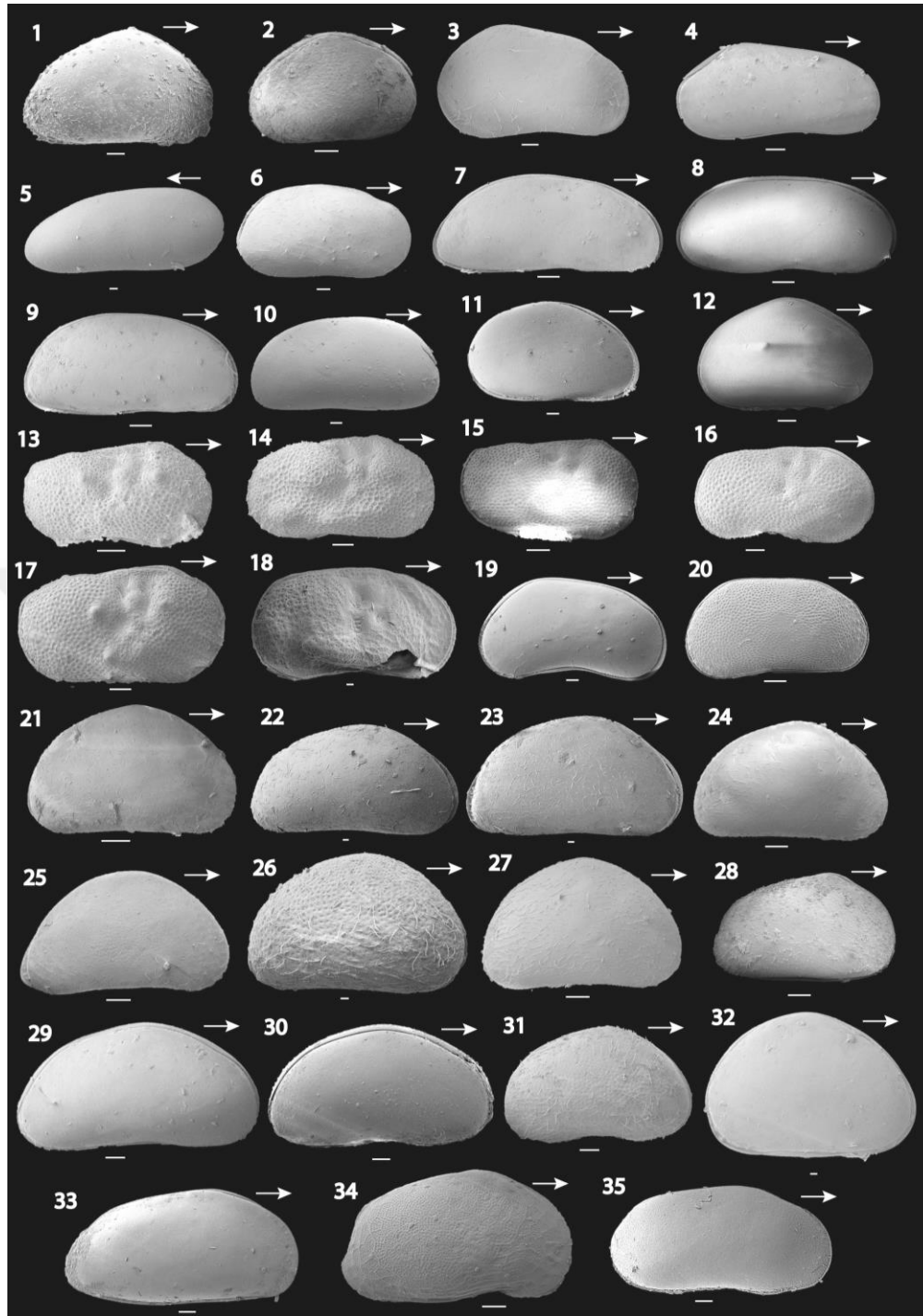


Figure 4.2. SEM images of 35 ostracod species found in Eskişehir. 1) *Cypris pubera*; 2) *Cypridopsis vidua*; 3) *Candona weltneri*; 4) *Fabaeformiscandona fabaeformis*; 5) *Darwinula stvensoni*; 6) *Isocypris beauchampi*; 7) *Herpetocypris chevreuxi*; 8) *H. helenae*; 9) *H. intermedia*; 10) *H. brevicaudata*; 11) *Heterocypris incongruens*; 12) *H. salina*; 13) *Ilyocypris bradyi*; 14) *I. decipiens*; 15) *I. gibba*; 16) *I. inermis*; 17) *I. monstifica*; 18) *Limnocythere inopinata*; 19) *Neglecandona neglecta*; 20) *Pseudocandona albicans*; 21) *Potamocypris arcuata*; 22) *P. fallax*; 23) *P. pallida*; 24) *P. similis*; 25) *P. unicaudata*; 26) *P. variegata*; 27) *P. villosa*; 28) *Prionocypris zenkeri*; 29) *Psychrodromus fontinalis*; 30) *P. olivaceus*; 31) *Plesiocypridopsis newtoni*; 32) *Physocypris kraepelini*; 33) *Trajancypris clavata*; 34) *Tyrrhenocythere amnicola*; 35) *Eucypris dorlionensis*. Scale bar is 200µm for 1, 7, 8, 9, 28, and 33; 100µm for 2, 3, 4, 6, 11, 12, 13, 14, 15, 16, 17, 19, 20, 21, 24, 25, 27, 29, 30, 31, 32, 34, and 35; 20 µm for 5, 18, 22, 23, 26, and 32. Arrows show the anterior side.

4.1.1. The New Species: *Eucypris dorlionensis*

A total of 19 individuals and 30 carapaces collected from the sampling site of this species, and five specimens (one holotype, four paratype) dissected for description of the species. The type locality was a through (sampling site 97) in the in Yukarısoğut village, Seyitgazi county of the Eskişehir province. The species is named after the former name (Dorlion) of the Eskişehir province (Batmaz et al, 2024).

The species is medium sized species with elliptical carapace. Valves almost straight with slightly rising on the dorsal side, and concave on the ventral side. In external view of the valves, valve margin with small, pitted area anteriorly and posteriorly. Carapace surface has fine hair-like setae and porenwarzen absent. Left valve larger than right valve on the anterior side. In dorsal view of the valves, the anterior end of the valves thinner with a slightly beak-shape, and posterior end rounded. The greatest height of carapace on the frontal side of the middle point (Figure 4.3). Calcareous inner lamella (CIL) of both valves broad and have vertical lines. Selvage peripheral. Simple pores are present. Hinge adont. The species has short swimming (natatory) setae on the second antenna (A2), and the longest setae barely reaching the middle of penultimate segment (Figure 4.4 B). On the mouth area, maxillular palp of distal segment cylindrical and slightly curved, teeth on the third segment smooth (Figure 4.4 C). The species's walking leg (T2) terminal claw (h2) as long as the last three segments (Figure 4.4 G). Uropodal attachment long and slender with broad basal segment (Figure 4.4 J). Anterior claws slightly serrated. All the specimens collected were female. (Batmaz et al. 2024).

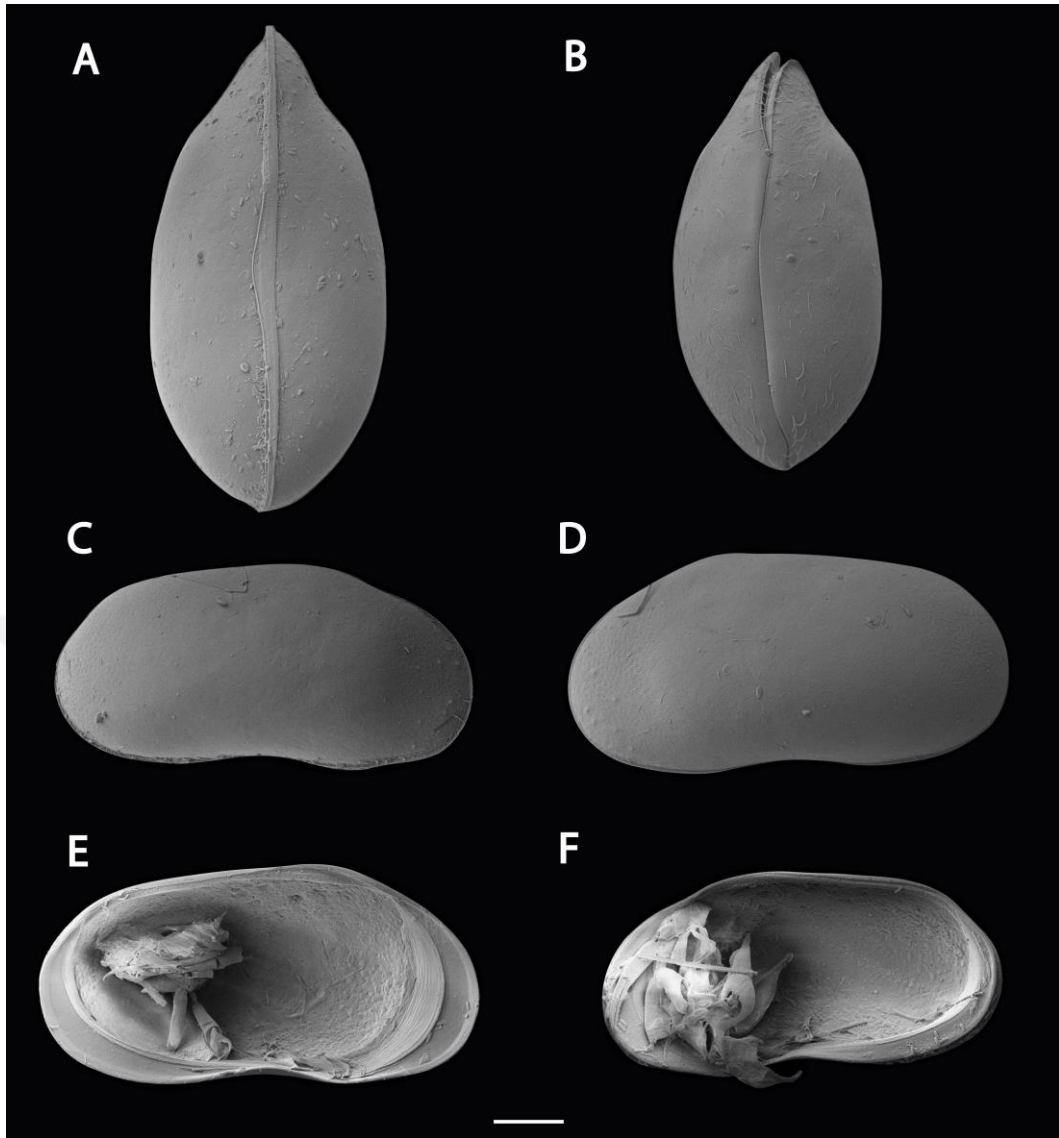


Figure 4.3. SEM images of *Eucypris dorlionensis*. Female, A) Ventral view; B) Dorsal view; C) Right valve (RV) external view; D) Left valve (LV) external view; E) LV internal view; F) RV internal view. Scale: 182 μ m for A; 200 μ m for B, C, D, E, and F.

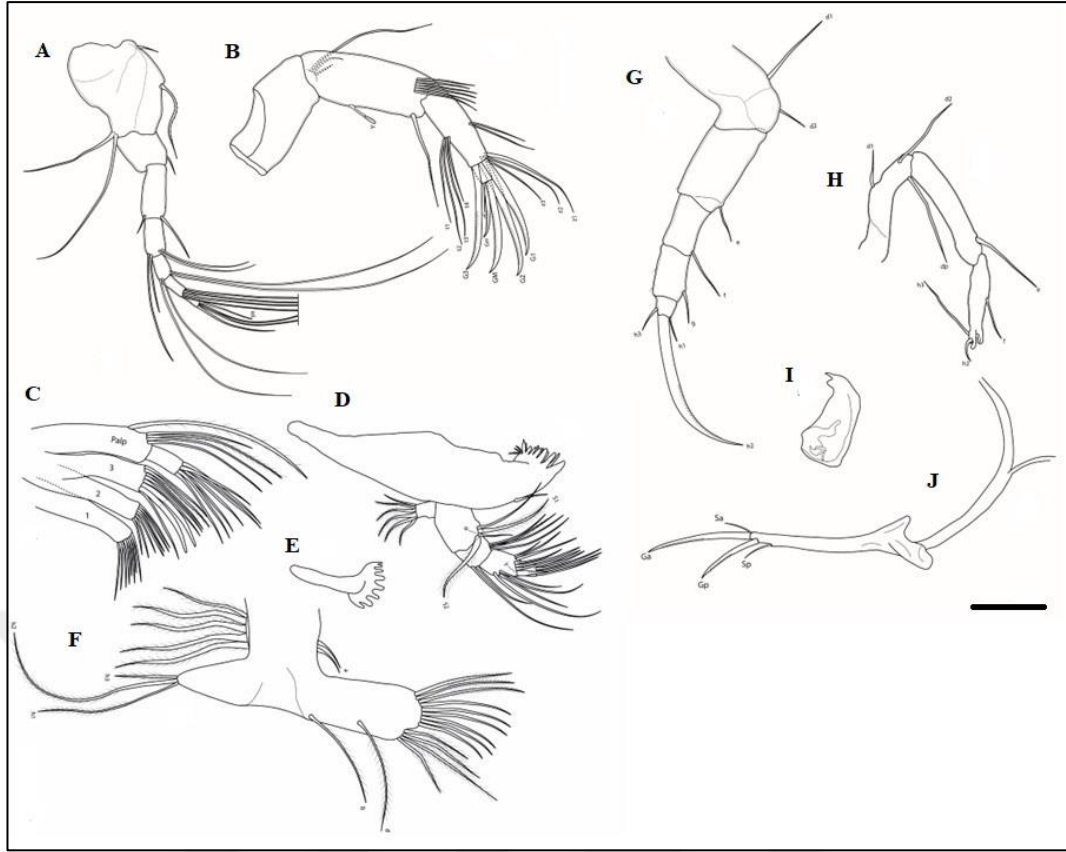


Figure 4.4. *Eucypris dorrionensis* drawings modified from Batmaz et al, 2024. A) A1; B) A2; C) Mxl; D) Md; E) rake like organ; F) T1; G) T2; H) T3; I) Genital organ; J) Uropod and uropodal attachment. Scale: 25µm for A, B, C, G, H, I, and J; 50µm for C, D, E, and F.

4.2 Determining Source and Sink Habitats

To determine source and sink habitats in our sampling area we used species richness in the sampling site and how old the habitat. In this study, a maximum of six species were found at one sampling site. Accordingly, we determined rich habitats as sampling sites hosting six, five and four species, and poor habitats as sampling sites hosting three, two and one species. 73 sampling sites include 26 species (nine species asexually reproduce; 17 species sexually reproduce) selected as sink habitats, and 21 sampling sites include 30 species (12 species asexually reproduce; 18 species sexually reproduce) selected as source habitats (Table 4.3).

Table 4.3. Sink and Source habitats and their species occurrences. Abbreviations: Site, Sampling site; Spp, Species. *See Table 4.1 for species abbreviations.

Sink habitats						Source Habitats	
1 spp		2 spp		3 spp		6 spp	
Site	Spp	Site	Spp	Site	Spp	Site	Spp
7	HI	14	HS, IG	1	HI, PO, PP	45	HS, PO, II, CV, LI, DS
8	PO	25	IG, PZ	9	PZ, CV, CP	93	HS, IG, PZ, LI, CP, TC
10	PO	26	PO, II	17	IG, FF, PSa	5 spp	
11	HS	37	HS, IB	20	HI, PO, HC	Site	Spp
12	HI	43	HI, PO	23	HI, HS, PZ	76	HI, HS, PZ, CV, PSa
13	HI	46	HH, PU	27	PO, PF, II	96	HI, IG, PZ, HC, CP
24	IG	50	PF, PV	53	ID, PVa, LI	97	HI, HS, PO, NN, EUc
28	PO	54	HS, PA	61	IB, PZ, TYr	110	HS, PF, IB, CV, HIn
39	IB	57	IG, PZ	65	HI, HS, PA	4 spp	
40	LI	62	IB, PZ	70	IB, PZ, PKr	Site	Spp
42	HS	63	IB, PZ	75	HS, IB, PZ	5	HI, HS, IB, PZ
44	HS	68	HI, HS	79	II, PZ, HC	15	CV, CP, PCn, IBe
49	LI	73	IG, LI	83	II, PZ, CO	22	HS, PO, PF, IB
51	HI	80	HS, IB	86	IB, PZ, NN	31	PO, PF, CW, NN
52	LI	87	CV, LI	88	PO, IB, PZ	32	PO, IB, PZ, PP
56	HS	103	HI, HS	89	PFa, NN, PKr	34	HS, PO, IB, HH
60	HS	104	IB, PV	92	IB, PZ, LI	35	HS, PF, IB, CV
72	PO	105	HI, HS	98	HS, IB, PZ	41	HI, PU, PKr, PCn
74	IB	106	HS, PV	99	HS, IB, PA	55	HS, IB, HIn, PA
77	PZ	111	IB, PZ	100	HI, HS, PV	66	HS, PO, IB, PZ
78	HS	116	HS, IG	101	IB, PZ, PSa	69	HS, IM, PZ, TC
82	HI			102	HI, HS, HH	84	HI, HS, IB, HIn
95	PO			108	PO, IB, NN	85	HS, IB, PZ, PV
112	LI			109	PO, IB, PZ	90	PO, PZ, PV, PS
117	HI			113	IB, PZ, NN	115	HS, IB, CV, HB
118	PF			114	HS, IB, PO		

4.3 Data Analysis and Statistical Results

The Shannon index value (H') of the general population of Eskişehir was calculated as 2.299. However, the index value did not show significant correlation with the environmental variables.

Shannon index value of artificial habitats ($H' = 2.143$) was higher than the value of natural habitats ($H' = 1.877$) (The Shannon index value for both habitats (natural and artificial) did not show a significant correlation with any environmental

variable). A relatively low beta diversity ($\beta = 0.33$) was found between the two habitats (lentic and lotic). Twenty-five species from lotic habitats, and 29 species from lentic and 18 species from both lentic and lotic habitats were also collected (Table 4.1). Shannon index value ($H' = 2.208$; 66 sites) of lentic habitats was higher than that of lotic habitats ($H' = 2.04$; 28 sites). Correlation results showed a significant negative correlation between Shannon index value and elevation for lotic habitats ($R^2 = 0.489$, $p < 0.01$). Similar to natural and artificial habitats, a low value of beta diversity ($\beta = 0.29$) was also found between lotic and lentic habitats.

Mann Whitney U test applied to make comparison based on species diversity. According to test results, there was no statistically significant difference ($p > 0.05$) in the average number of species between natural (30 sites) and artificial (64 sites) habitats.

Among the species (with three or more occurrence), only six of them (*Heterocypris salina*, *Psychrodromus fontinalis*, *Ilyocypris inermis*, *I. gibba*, *Cypridopsis vidua*, *Potamocypris villosa*) showed significant correlations with different environmental variables. In addition, the correlation values of environmental variables with each other are given in Table 4.4. In example, *H. salina* ($p < 0.05$) and *P. villosa* ($p < 0.01$) were showed positive correlation with Dissolved Oxygen (DO). Biochemical Oxygen Demand (BOD_5) showed a positive correlation with DO.

Table 4.4. Statistically significant correlations between ostracod species-environmental variable and environmental variables themselves Abbreviations: HS: *Heterocypris salina*; PF: *Psychrodromus fontinalis*; II: *Ilyocypris inermis*; IG: *I. gibba*; CV: *Cypridopsis vidua*; PV, *Potamocypris villosa*; DO: Dissolved Oxygen; EC: Electrical Conductivity; Tw; Water temperature; TDS: Total Dissolved Oxygen; EL: Elevation; TotP: Total Phosphate; Ca⁺²: Calcium; TotH; Total hardness; NO₃: Nitrate; PO₄: Phosphate; Turb: Turbidity; BOD₅: Biochemical oxygen demand; TotN: Total nitrogen; Mg⁺², Magnesium; NO₂, Nitrite; Corr. Coeff.: Correlation coefficient; Sig.: Significant; N: Sample size. * and ** indicate that the correlation is significant at 0.05 and 0.01 levels, respectively (2 tailed).

		HS	PF	II	IG	CV	PV	DO	EC	Tw	TDS	EL	TotP	Ca ⁺²	TotH	NO ₃	PO ₄
pH	Corr.Coeff.			.900*		.770*										-.227*	
	Sig. (2 tailed)			0.037		0.026										0.013	
	N			5		8										118	
DO	Corr.Coeff.	.356*					.943**									.186*	
	Sig. (2 tailed)	0.028					0.005									0.044	
	N	38					6									117	
EC	Corr.Coeff.									.309**	.950**	.628**	.263**	.373**	.695**		.242**
	Sig. (2 tailed)									0.001	0	0	0.004	0	0		0.008
	N									118	117	116	118	118	118		118
TDS	Corr.Coeff.								.950**			.616**	.286**	.381**	.723**		.246**
	Sig. (2 tailed)								0			0	0.002	0	0		0.008
	N								117			115	117	117	117		117

Table 4.4. (Continued)

Turb	Corr.Coeff.		-.821*					.314**	.403**	.272**	-.343**	.482**		.228*	-.287**	.434**
	Sig. (2 tailed)		0.023					0.001	0	0.003	0	0		0.013	0.002	0
	N		7					117	117	116	115	117		117	117	117
BOD ₅	Corr.Coeff.						.859**									.191*
	Sig. (2 tailed)						0									0.041
	N						115									115
EL	Corr.Coeff.		.857*					-.628**	-.318**	-.616**		-.275**		-.373**		-.183*
	Sig. (2 tailed)		0.014					0	0.001	0		0.003		0		0.05
	N		7					116	116	115		116		116		116
TotN	Corr.Coeff.								-.276**						.576**	
	Sig. (2 tailed)								0.002						0	
	N								118						118	
TotP	Corr.Coeff.						-.829*	.263**		.286**	-.275**					.888**
	Sig. (2 tailed)						0.042	0.004		0.002	0.003					0
	N						6	118		117	116					118

Table 4.4. (Continued)

Mg ⁺²	Corr.Coeff.								.666**		.671**	-.463**			.453**		.191*
	Sig. (2 tailed)								0		0	0			0		0.038
	N								118		117	116			118		118
TotH	Corr.Coeff.								.695**		.723**	-.373**		.792**		.215*	
	Sig. (2 tailed)								0		0	0		0		0.019	
	N								118		117	116		118		118	
NO ₂	Corr.Coeff.				.894**								.288**			-.224*	.364**
	Sig. (2 tailed)				0.001								0.002			0.015	0
	N				9								118			118	118
NO ₃	Corr.Coeff.							.186*		-.418**				.260**	.215*		
	Sig. (2 tailed)							0.044		0				0.004	0.019		
	N							117		118				118	118		

The UPGMA test was used to determine the relationship among the species based on habitat similarity. Accordingly, there are 3 main clustering groups in dendrogram for 19 species (three or more occurrence).

In the first group there are five species (*H. salina*, *I. bradyi*, *P. zenkeri*, *C. vidua*, *H. intermedia*) which were the most frequently occurred species. In the second group, species mostly have sexual reproduction type except *P. villosa*. Group three includes species found from all habitat types (lentic, lotic, natural, and artificial habitats) (Figure 4.5).

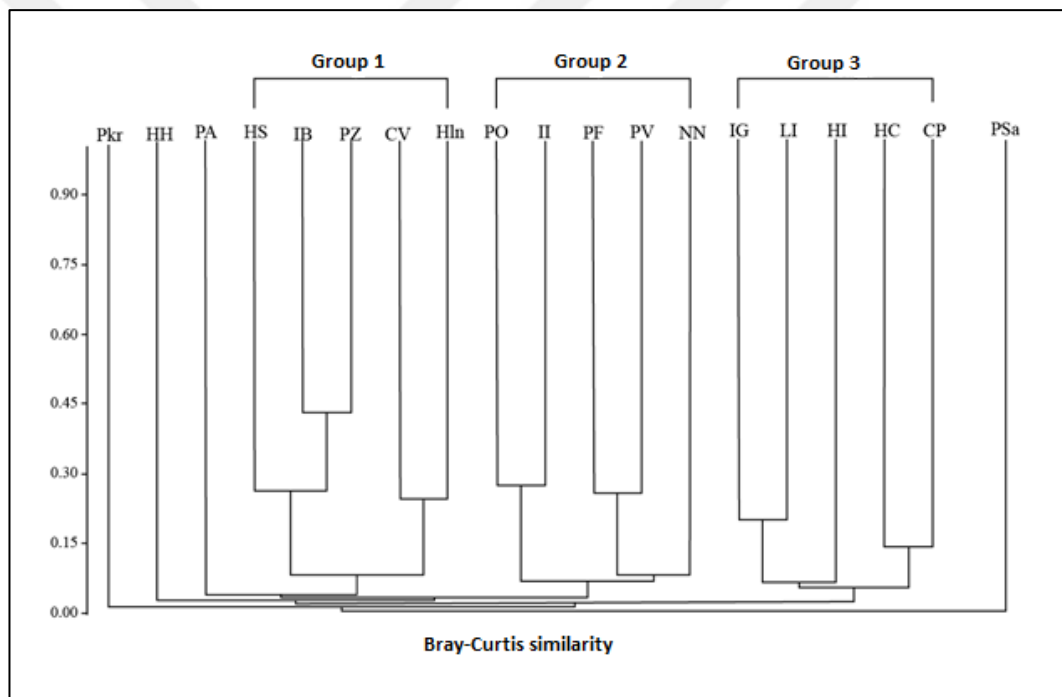


Figure 4.5. UPGMA result diagram for 19 species according to Bray-Curtis similarity. For species abbreviation see Table 4.1.

Canonical Corresponding Analysis (CCA) applied to define relationships between 11 variables (pH, BOD₅, NO₂, PO₄, Mg⁺², Ca⁺², elevation, EC, DO, NO₃, and water temperature) and 19 species.

According to Table 4.5 the first two axes of the CCA explained 51% of the association between ostracod species and environmental variables.

Table 4.5. CCA results summary table with 11 effective environmental variables (* shows DCA results).

Axes	1	2	3	4	Total inertia
Eigenvalues	0.64	0.40	0.36	0.25	8.84
*Lengths of gradient	5.59	4.37	5.56	3.22	
Species-environment correlations	0.84	0.69	0.74	0.63	
Cumulative percentage variance					
of species data	7.20	11.70	15.80	18.50	
of species-environment relation	31.30	51.00	68.40	80.50	
Sum of all eigenvalues					8.84
Sum of all canonical eigenvalues					2.04

CCA results show that, the most effective factors on the distribution of ostracod species in the Eskişehir province are: Elevation ($p = 0.002$, $F = 4.08$), NO_2 ($p = 0.004$, $F = 3.26$), pH ($p = 0.008$, $F = 2.57$), BOD_5 ($p = 0.02$, $F = 2.31$), water temperature ($p = 0.028$, $F = 2.29$) and DO ($p = 0.032$, $F = 1.97$).

On the CCA diagram, four well known cosmopolitan species like *H. incongruens*, *H. salina*, *P. zenkeri*, and *P. olivaceus* were located closer to the center of diagram. *Cypridopsis vidua* shows a positive relation with Mg^{+2} , *I. inermis* shows a positive relation with water temperature, *I. gibba* shows a positive relation, while *P. arcuata* shows a negative relation with PO_4 (Figure 4.6).

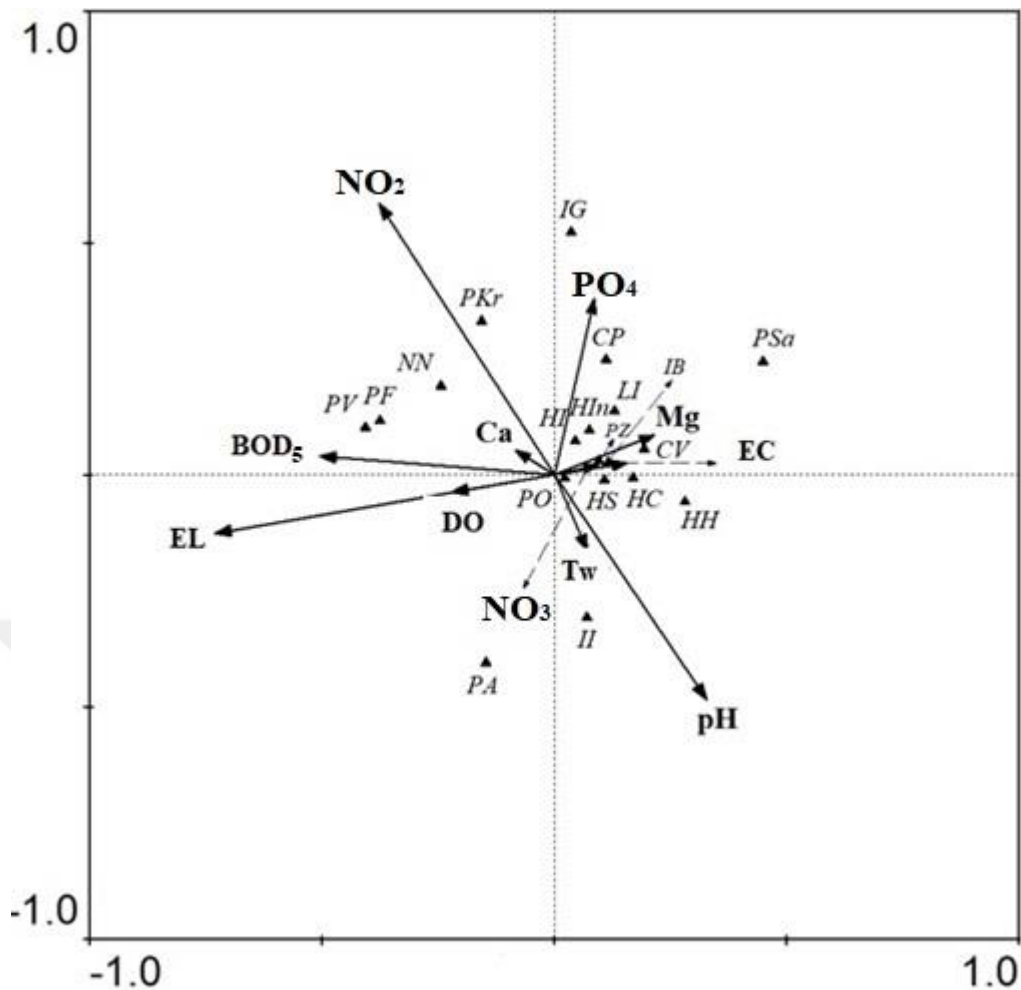


Figure 4.6. CCA Result diagram. Ordination of ostracod species according to the effects of different environmental variables. Abbreviations; BOD₅, Biochemical oxygen demand; NO₂, Nitrogen dioxide; PO₄, Phosphate; Mg⁺², Magnesium; Ca⁺², Calcium; EL, Elevation; EC, Electrical conductivity; DO, Dissolved oxygen; NO₃, Nitrate; Tw, water temperature. See Table 4.1 for species abbreviations.

According to indicator species analysis results, statistically significant indicator percentage values for different environmental variables of ostracod species are given in Table 4.6. According to indicator species test results, *I. monsrifica* was found to be an indicator of high pH value ($p < 0.05$). *Cypris pubera* showed a significant indicator value of calcium at 50 % (134.27 mg L⁻¹) while *P. villosa* showed significant indicator value at 75 % (160.32 mg L⁻¹). When the indicator species values are examined, it is seen that *I. inermis* prefers natural and lotic habitats, while *H. incongruens*, which is one of the most common species, prefers artificial and lentic habitats.

Table 4.6. Indicator species test results. * and ** indicate the degree of statistical significance at 0.05 and 0.01, respectively. See Table 4.1 for ostracod species abbreviations.

Environmental variables and habitats	IM	TC	PV	LI	PZ	PF	PKr	CP	PA	PCn	HS	II	HI
pH (> % 75 → > 7.93)	98*	34.6*											
Dissolved Oxygen (> % 75 → > 6.87 mg L ⁻¹)			23.7*										
T Water (% 75 + > % 75 → 25.2 + > 25.2 °C)				26.1*									
Total Dissolved Solid (% 50 → 520 mg L ⁻¹)					31.8**								
Turbidity (% 25 → 1.24)						30.1*							
Nitrite (% 75 → 0.046 mg L ⁻¹)							23.8*						
Nitrite (> % 75 → > 0.046 mg L ⁻¹)								23.8*					
Nitrate (% 25 → 1.94 mg L ⁻¹)				32.2*									
Kjendahl N (% 25 → 3.88 mg L ⁻¹)									19.8*				
Phosphate (% 50 → 0.17 mg L ⁻¹)						26.2*							
Phosphate (> %75 → > 0.39 mg L ⁻¹)		20.9*						25.1**		19.7*			
Total P (% 25 + % 75 → 0.08 + 0.30 mg L ⁻¹)											27.8*		
Total P (> % 75 → > 0.30 mg L ⁻¹)		21.5*						25.7**		20.2*			
Ca ⁺ (% 50 → 134.27 mg L ⁻¹)								24.4**					
Ca ⁺ (% 75 → 160.32 mg L ⁻¹)			22.9*										
Lotic habitats												20.2**	
Lentic habitats													21.8*
Artificial habitats													22.5**
Natural habitats												19.5*	

Nineteen species (3 or more occurrences) and 22 ecological variables were used on analysis to find optimum/tolerance levels (Table 4.7). According to the results *H. salina* has maximum tolerance for salinity, Mg^{+2} , and Ca^{+2} values in the water. *Physocypria kraepelini* has maximum tolerance for water temperature, dissolved oxygen, and elevation. *Cypridopsis vidua* has maximum tolerance for pH level, and *I. Inermis* has maximum tolerance for air temperature changes. *Ilyocypris gibba* can tolerate a very wide level of changes total phosphate levels in the habitat.

Table 4.7. C2 analysis results show species tolerance and optimum levels for ecological variables. Abbreviations and units: AtmP, atmospheric pressure (mmHg); TDS, total dissolved solid (mgL^{-1}); T water, water temperature ($^{\circ}C$); T air, air temperature ($^{\circ}C$); ORP, oxidation reduction potential (mV); BOD₅, biochemical oxygen demand (mgL^{-1}); DO, dissolved oxygen (mgL^{-1}); EC, electrical conductivity ($\mu S cm^{-1}$); PO₄-P, phosphorus phosphate (mgL^{-1}); PO₄, phosphate (mgL^{-1}); Tot P, total phosphorus (mgL^{-1}); Mg^{+2} , magnesium (mgL^{-1}); Ca^{+2} , calcium (mgL^{-1}); NO₂, nitrite (mgL^{-1}); NO₂-N, nitrite nitrogen (mgL^{-1}); NO₃-N, Nitrate nitrogen (mgL^{-1}); NO₃, nitrate (mgL^{-1}); Tot N, total nitrogen (mgL^{-1}); Spp, abbreviations of species (see Table 4.1); Count, Numbers of species occurrence; Max, Maximum members of individuals; N2, Hill's coefficient; Opt, optimum level; Tol, Tolerance level.

				pH		AtmP		Salinity		TDS		Turbidity		T water		T air		ORP		BOD ₅		DO		EC	
Spp	Count	Max	N2	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol
HI	22	250	6.50	7.34	0.34	674.95	18.51	0.35	0.14	465.78	150.43	24.65	54.13	20.99	3.38	24.63	3.67	21.58	29.19	1.43	2.01	5.21	1.63	667.93	195.43
HS	38	712	12.15	7.55	0.57	657.93	96.79	0.54	1.25	693.50	1186.24	9.49	20.86	21.03	3.88	27.22	3.30	15.61	21.77	2.36	1.02	6.57	1.38	1005.04	1479.31
PO	22	100	9.08	7.60	0.40	582.47	173.77	0.34	0.12	455.11	126.13	5.75	10.45	19.19	4.63	28.71	2.80	22.23	13.44	2.37	0.92	6.44	1.08	626.94	169.88
PF	7	429	2.71	7.21	0.54	658.26	8.73	0.26	0.13	352.82	116.61	0.70	1.96	19.40	1.83	26.74	5.99	26.43	11.88	3.53	1.00	6.79	0.76	487.19	133.85
IB	32	1000	6.29	7.65	0.47	552.43	203.51	0.39	0.13	511.57	133.71	9.55	16.58	17.96	3.99	26.00	3.81	20.70	16.59	2.30	1.19	6.34	1.53	686.51	164.64
II	5	140	2.19	8.11	0.50	673.67	13.11	0.48	0.08	635.41	66.32	23.81	20.53	24.94	4.84	30.50	6.07	38.53	18.02	1.56	1.20	5.21	1.32	979.46	115.36
IG	9	95	2.94	7.92	0.71	667.32	13.69	0.30	0.16	404.92	149.16	265.08	235.00	25.75	2.63	24.56	3.49	49.99	16.83	3.29	2.24	4.93	0.71	635.40	184.91

Table 4.7. (Continued)

PZ	29	800	8.63	7.60	0.48	577.09	182.62	0.41	0.15	542.80	160.01	12.23	62.94	18.95	4.79	27.39	3.68	37.31	55.64	2.45	2.09	6.69	3.01	755.22	200.55
CV	8	104	3.23	7.27	0.74	686.91	11.45	0.29	0.14	384.64	139.88	3.12	3.50	24.35	4.75	28.12	3.38	94.35	111.73	1.40	0.74	5.36	1.57	596.14	200.96
HIIn	3	380	2.44	7.18	0.32	682.16	4.89	0.32	0.12	423.50	108.72	3.31	3.62	19.39	2.48	22.81	2.76	15.44	29.98	2.80	1.30	7.07	1.22	578.65	117.87
HH	3	96	1.32	7.99	0.52	696.72	21.19	0.51	0.20	669.66	113.89	3.59	0.73	25.01	2.19	29.84	3.88	9.78	18.33	1.76	0.96	6.04	1.00	1032.66	145.62
HC	3	42	1.46	7.93	0.27	686.77	21.72	0.29	0.10	381.51	59.87	27.27	95.79	24.51	1.14	26.89	4.47	35.68	15.40	1.24	0.38	4.75	0.32	585.16	76.72
PV	6	2000	1.76	7.07	0.47	659.01	8.20	0.26	0.09	358.01	63.82	4.92	30.39	18.91	3.02	23.38	2.28	42.65	139.22	4.00	1.26	7.42	1.53	485.49	58.60
PA	4	3000	1.20	7.92	0.67	663.31	11.08	0.24	0.13	321.86	58.53	1.51	2.89	21.33	2.35	30.50	4.87	50.76	34.41	3.04	1.21	6.71	1.04	459.16	59.29
NN	6	60	1.64	7.33	0.40	652.27	13.85	0.19	0.10	262.36	68.47	4.83	13.44	17.85	1.55	30.52	4.28	20.19	7.88	2.48	0.71	6.35	0.56	349.45	73.30
LI	10	29	5.44	7.57	0.73	681.52	19.72	0.34	0.16	449.52	162.03	101.97	203.46	25.76	2.56	27.90	3.23	45.13	13.20	1.91	1.98	5.00	0.68	711.79	214.03
CP	4	21	1.79	7.69	0.40	683.91	18.27	0.37	0.13	486.04	93.05	60.63	177.49	19.09	5.65	21.56	3.51	46.66	10.46	2.65	1.17	4.90	0.34	656.86	83.48
PSa	3	6	2.28	7.60	0.39	636.54	63.85	0.60	0.22	779.42	183.51	7.49	2.27	21.37	7.01	28.55	4.07	49.10	97.45	1.13	0.45	2.91	1.39	1131.82	259.17
PKr	3	50	1.78	6.72	0.34	682.88	25.81	0.45	0.24	586.86	182.84	16.60	19.79	20.46	7.77	28.71	3.80	69.08	91.60	3.43	4.79	6.70	4.05	852.43	293.42
				Elevation		PO₄-P		PO₄		Tot P		Mg⁺²		Ca⁺²		NO₂		NO₂-N		NO₃-N		NO₃		Tot N	
Abb	Count	Max	N2	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol
HI	22	250	6.50	983.65	240.59	0.07	0.09	0.22	0.26	0.24	0.32	58.98	22.77	123.48	44.53	0.05	0.07	0.01	0.02	2.27	3.21	10.04	14.19	19.17	18.69
HS	38	712	12.15	924.55	184.58	0.06	0.08	0.18	0.24	0.15	0.23	112.30	336.63	139.13	96.92	0.03	0.02	0.01	0.01	4.04	4.82	17.90	21.35	27.16	25.52
PO	22	100	9.08	1024.13	147.74	0.07	0.05	0.20	0.16	0.16	0.14	86.57	62.14	108.64	54.88	0.03	0.02	0.01	0.01	1.86	1.71	8.21	7.59	14.78	10.38
PF	7	429	2.71	1199.15	111.71	0.06	0.03	0.17	0.10	0.11	0.10	46.50	83.98	108.39	53.17	0.07	0.02	0.02	0.01	1.58	1.22	6.97	5.39	12.94	6.89
IB	32	1000	6.29	941.00	145.09	0.04	0.03	0.13	0.10	0.10	0.10	99.37	49.22	108.46	38.55	0.03	0.04	0.01	0.01	3.76	2.57	16.64	11.37	25.95	13.95
II	5	140	2.19	998.12	168.60	0.10	0.06	0.31	0.17	0.24	0.12	86.17	91.10	132.69	72.68	0.04	0.02	0.01	0.00	1.19	0.55	5.26	2.44	11.55	4.23

Table 4.7. (Continued)

IG	9	95	2.94	1050.42	96.29	0.87	0.92	2.67	2.82	2.44	2.48	173.81	151.22	100.33	31.26	0.15	0.08	0.05	0.02	0.29	0.31	1.23	1.20	9.47	5.46
PZ	29	800	8.63	973.08	113.42	0.10	0.25	0.32	0.77	0.25	0.69	106.07	75.30	125.48	57.06	0.02	0.03	0.01	0.01	2.68	2.38	11.86	10.53	20.36	13.12
CV	8	104	3.23	822.94	149.73	0.06	0.05	0.20	0.21	0.17	0.12	97.56	97.45	103.05	67.22	0.03	0.02	0.01	0.01	1.65	0.73	7.31	3.23	14.35	4.33
HIn	3	380	2.44	901.53	60.84	0.05	0.03	0.15	0.09	0.11	0.10	49.82	15.39	113.82	50.65	0.01	0.01	0.00	0.00	5.57	4.73	24.63	20.92	35.63	26.51
HH	3	96	1.32	699.92	268.15	0.03	0.01	0.10	0.02	0.07	0.03	113.92	55.13	122.21	40.74	0.04	0.08	0.01	0.02	1.47	0.73	6.53	3.22	13.91	5.04
HC	3	42	1.46	830.73	264.08	0.07	0.09	0.21	0.29	0.23	0.31	71.21	27.53	83.67	66.03	0.07	0.09	0.02	0.03	2.09	1.34	9.24	5.92	17.01	1.59
PV	6	2000	1.76	1188.98	97.32	0.05	0.04	0.14	0.12	0.07	0.10	24.35	21.36	149.92	22.45	0.06	0.04	0.02	0.01	3.44	3.34	15.22	14.80	23.06	17.72
PA	4	3000	1.20	1127.53	126.60	0.03	0.03	0.08	0.08	0.05	0.08	33.86	14.25	112.14	32.14	0.01	0.02	0.00	0.01	2.51	6.11	11.09	27.05	16.31	32.81
NN	6	60	1.64	1272.95	181.28	0.06	0.04	0.18	0.13	0.16	0.11	14.67	34.51	92.67	39.07	0.07	0.03	0.02	0.01	0.69	1.12	3.07	4.97	9.22	13.50
LI	10	29	5.44	913.63	253.74	0.38	0.72	1.17	2.21	1.04	1.99	150.77	121.89	101.32	58.47	0.06	0.07	0.02	0.02	0.32	0.42	1.43	1.84	7.09	3.18
CP	4	21	1.79	875.14	214.03	0.38	0.52	1.37	1.57	0.99	1.43	82.52	87.25	98.20	10.28	0.08	0.08	0.04	0.02	0.68	0.32	3.05	1.45	13.42	3.51
PSa	3	6	2.28	772.82	52.52	0.44	0.30	1.62	1.24	1.04	0.73	105.24	16.89	120.60	35.35	0.02	0.01	0.03	0.03	1.59	0.48	4.69	4.76	22.52	5.05
PKr	3	50	1.78	876.93	322.48	0.15	0.21	0.46	0.65	0.50	0.84	78.08	33.39	137.56	21.59	0.03	0.01	0.01	0.00	2.47	1.61	10.92	7.11	32.29	19.79

A total of 13 species (three or more occurrences) found in lentic water bodies (66 sampling sites) were used for the analysis with 11 effective environmental variables (the ones used on the CCA) to find tolerance and optimum levels. According to results (Table 4.8) *C. vidua* has maximum tolerance for pH and water temperature, *H. salina* has maximum tolerance for salinity and Mg^{+2} , and *C. pubera* has minimum tolerance for dissolved oxygen in lentic water habitats.

Table 4.8. C2 analysis results show species found in lentic water bodies tolerance and optimum levels for 11 effective ecological variables. Abbreviations: DO, dissolved oxygen; EC, Electrical conductivity; T water, water temperature; NO₂, nitrite; NO₃, nitrate; PO₄, phosphate; Mg⁺², magnesium; BOD₅, Biochemical oxygen demand. Code, abbreviations of species (see Table 4.1); Count, Numbers of species occurrence; Max, Maximum members of individuals; N2, Hill's coefficient; Opt, optimum level; Tol, Tolerance level.

				pH		DO		Salinity		EC		T water		Elevation		NO ₂		NO ₃		PO ₄		Mg ⁺²		BOD ₅	
Code	Count	Max	N2	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol
HI	20	250	6.35	7.33	0.31	5.198	1.639	0.348	0.142	659.67	188.82	20.882	3.19	993.2	223.8	0.045	0.066	10.14	14.28	0.225	0.266	58.99	22.95	1.42	2.01
HS	32	500	11.09	7.43	0.43	6.716	1.558	0.545	1.445	1012.18	1703.23	21.440	4.20	970.6	179.9	0.026	0.019	21.30	23.61	0.171	0.277	110.70	388.82	2.33	1.17
PO	16	100	5.29	7.54	0.25	6.893	0.932	0.339	0.086	593.40	120.71	17.876	4.34	1021.0	146.1	0.022	0.022	10.55	8.30	0.189	0.196	85.28	48.07	2.70	0.76
PF	5	429	2.05	7.04	0.27	7.009	0.527	0.220	0.061	409.47	53.51	19.110	1.91	1201.9	133.0	0.074	0.020	7.83	5.79	0.172	0.126	18.60	29.04	3.64	1.15
IB	16	1000	3.65	7.53	0.27	6.427	1.709	0.350	0.068	604.71	95.86	16.885	4.14	959.1	106.1	0.020	0.038	21.17	10.61	0.100	0.055	96.28	47.55	2.37	1.23
IG	8	95	2.85	7.92	0.72	4.979	0.553	0.298	0.148	622.21	171.42	25.784	2.65	1055.1	86.1	0.153	0.077	1.22	1.22	2.676	2.866	174.73	153.43	3.33	2.25
PZ	15	800	4.11	7.51	0.28	6.175	1.509	0.358	0.058	634.06	91.43	16.777	4.36	1030.8	87.8	0.025	0.048	15.58	9.23	0.264	0.950	94.25	64.37	2.10	1.18
CV	5	104	2.12	7.39	0.92	5.180	2.052	0.268	0.181	572.37	233.22	25.253	5.78	884.9	114.2	0.024	0.009	8.23	3.58	0.186	0.073	51.18	33.36	1.11	0.63
HH	3	96	1.32	7.99	0.52	6.037	1.003	0.505	0.201	1032.66	145.62	25.011	2.19	699.9	268.1	0.035	0.079	6.53	3.22	0.097	0.018	113.92	55.13	1.76	0.96
PV	6	2000	1.76	7.07	0.47	7.416	1.526	0.264	0.087	485.49	58.60	18.905	3.02	1189.0	97.3	0.062	0.045	15.22	14.80	0.145	0.115	24.35	21.36	4.00	1.26
PA	3	3000	1.13	7.95	0.61	6.740	1.193	0.228	0.102	446.81	34.25	21.361	2.84	1136.1	50.2	0.009	0.029	11.28	33.05	0.078	0.065	32.67	7.61	3.07	1.38
LI	8	29	4.41	7.69	0.74	4.844	0.603	0.340	0.174	724.20	231.67	26.329	2.32	958.2	248.5	0.067	0.081	0.81	0.97	1.357	2.409	137.77	129.17	1.89	2.20
CP	3	5	2.13	7.93	0.58	4.699	0.498	0.244	0.087	509.50	102.93	24.850	3.11	1090.8	129.1	0.163	0.073	1.59	0.88	1.525	2.705	101.23	148.13	2.54	2.02

A total of 7 species (three or more occurrences) found in lotic water bodies (26 sampling sites) were used for the analysis with 11 effective environmental variables to find tolerance/optimum levels. According to results (Table 4.9) *H. salina* has maximum tolerance for pH, *I. inermis* has maximum tolerance for water temperature, *C. vidua* has maximum tolerance for magnesium, but minimum tolerance for water temperature in lotic water bodies in the Eskişehir province.

Table 4.9. C2 analysis results show species found in lotic water bodies tolerance and optimum levels for 11 effective ecological variables. Abbreviations: DO, dissolved oxygen; EC, Electrical conductivity; T water, water temperature; NO₂, nitrite; NO₃, nitrate; PO₄, phosphate; Mg⁺², magnesium; BOD₅, Biochemical oxygen demand. Code, abbreviations of species (see Table 4.1); Count, Numbers of species occurrence; Max, Maximum members of individuals; N2, Hill's coefficient; Opt, optimum level; Tol, Tolerance level.

				pH		DO		Salinity		EC		T water		Elevation		NO ₂		NO ₃		PO ₄		Mg ⁺²		BOD ₅	
Code	Count	Max	N2	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol
HS	6	712	1.950	7.92	1.01	6.136	0.331	0.541	0.086	983.20	164.36	19.793	3.090	783.71	147.26	0.0280	0.023	7.523	2.884	0.203	0.030	117.22	50.29	2.45	0.49
PO	6	41	4.655	7.74	0.64	5.461	0.654	0.354	0.178	700.31	382.84	22.178	4.239	1031.01	174.73	0.0380	0.009	3.101	1.974	0.232	0.084	89.37	93.34	1.63	0.88
IB	16	487	3.394	7.93	0.73	6.150	1.501	0.472	0.196	869.11	355.12	20.363	3.207	900.61	227.89	0.0440	0.034	6.541	5.489	0.210	0.145	106.27	63.58	2.14	1.40
II	5	140	2.192	8.11	0.50	5.206	1.317	0.480	0.078	979.46	223.71	24.942	4.843	998.12	168.60	0.0393	0.016	5.264	2.438	0.308	0.174	86.17	91.10	1.56	1.20
PZ	14	400	5.457	7.73	0.69	7.439	4.450	0.488	0.211	931.32	390.60	22.118	3.814	889.15	96.03	0.0171	0.008	6.452	10.911	0.397	0.583	123.26	94.18	2.95	3.03
CV	3	58	1.208	7.02	0.88	5.858	0.422	0.340	0.089	661.52	132.40	22.272	1.751	660.08	90.45	0.0491	0.005	4.924	1.509	0.246	0.745	218.96	100.99	2.16	0.42
NN	4	8	2.919	7.42	0.65	5.786	0.470	0.264	0.107	473.58	179.518	18.612	2.221	1092.35	147.99	0.0687	0.052	6.172	6.237	0.235	0.196	45.64	30.63	1.68	0.34

A total of 9 species found in source habitats (21 sampling sites) were used for the analysis with 11 effective environmental variables to find tolerance/optimum levels. According to results (Table 4.10) *C. vidua* has maximum tolerance for pH, *H. incongruens* has maximum tolerance for salinity and water temperature, and *H. salina* has minimum tolerance for biological oxygen demand.

Table 4.10. C2 analysis results show species found in source habitats tolerance and optimum levels for 11 effective ecological variables. Abbreviations: DO, dissolved oxygen; EC, Electrical conductivity; T water, water temperature; NO₂, nitrite; NO₃, nitrate; PO₄, phosphate; Mg⁺², magnesium; BOD₅, Biochemical oxygen demand. Code, abbreviations of species (see Table 4.1); Count, Numbers of species occurrence; Max, Maximum members of individuals; N2, Hill's coefficient; Opt, optimum level; Tol, Tolerance level.

				pH		DO		Salinity		EC		T water		Elevation		NO ₂		NO ₃		PO ₄		Mg ⁺²		BOD ₅	
Code	Count	Max	N2	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol
HI	6	130	1.902	7.52	0.54	5.881	3.753	0.328	0.313	692.41	721.58	24.543	5.169	971.02	452.50	0.136	0.102	4.579	12.097	0.498	0.345	48.52	27.49	3.19	4.28
HS	15	712	5.762	7.72	0.65	6.328	0.601	0.458	0.134	851.27	261.10	20.166	3.876	839.83	159.61	0.024	0.018	10.163	8.747	0.180	0.263	100.77	50.14	2.35	0.68
PO	8	100	3.597	7.39	0.33	6.596	0.654	0.323	0.082	561.66	161.05	16.989	3.394	1011.48	192.91	0.025	0.027	11.616	8.794	0.224	0.228	106.31	64.93	2.64	0.87
PF	4	194	1.490	7.29	0.19	6.599	0.480	0.198	0.118	355.73	195.14	17.636	1.990	1260.16	245.79	0.064	0.030	3.164	4.009	0.225	0.237	17.81	48.24	2.77	0.74
IB	11	1000	3.291	7.73	0.52	6.654	0.763	0.400	0.136	699.72	277.21	17.371	3.693	912.97	153.86	0.015	0.020	18.056	12.940	0.120	0.083	115.09	45.90	2.66	0.77
PZ	9	800	1.966	7.57	0.35	6.243	1.226	0.341	0.032	596.29	116.47	15.696	4.310	1019.14	128.33	0.016	0.058	18.806	7.098	0.333	1.474	112.68	88.77	2.50	1.28
CV	6	104	2.993	7.26	0.77	5.392	1.628	0.293	0.144	607.72	353.11	24.415	4.786	808.41	125.75	0.031	0.016	7.547	3.021	0.207	0.212	101.38	98.45	1.23	1.15
HIn	3	380	2.441	7.18	0.32	7.068	1.224	0.320	0.121	578.65	219.37	19.388	2.482	901.53	60.84	0.010	0.013	24.635	20.918	0.147	0.092	49.82	15.39	2.80	1.30
CP	3	21	1.668	8.03	0.34	5.128	0.514	0.368	0.126	692.57	212.92	21.321	3.224	862.93	239.04	0.087	0.088	3.094	1.503	1.415	1.626	87.51	91.58	2.63	1.20

A total of 12 species found in sink habitats (72 sites) were used for the analysis with 11 effective environmental variables to find tolerance/optimum levels. According to results (Table 4.11) *P. zenkeri* has maximum tolerance for dissolved oxygen, *I. inermis* has maximum tolerance for water temperature, and *P. arcuata* has minimum tolerance for magnesium concentration in sink habitats in Eskişehir province.

Table 4.11. C2 analysis results show species found in sink habitats tolerance and optimum levels for 11 effective ecological variables. Abbreviations: DO, dissolved oxygen; EC, Electrical conductivity; T water, water temperature; NO₂, nitrite; NO₃, nitrate; PO₄, phosphate; Mg⁺², magnesium; BOD₅, Biochemical oxygen demand. Code, abbreviations of species (see Table 4.1); Count, Numbers of species occurrence; Max, Maximum members of individuals; N2, Hill's coefficient; Opt, optimum level; Tol, Tolerance level.

				pH		DO		Salinity		EC		T water		Elevation		NO ₂		NO ₃		PO ₄		Mg ⁺²		BOD ₅	
Code	Count	Max	N2	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol
HI	16	250	4.80	7.30	0.31	5.032	1.106	0.357	0.112	661.63	130.35	20.077	2.464	988.22	210.83	0.022	0.029	11.449	15.362	0.154	0.212	61.68	23.14	0.98	1.15
HS	23	500	6.41	7.38	0.46	6.813	1.896	0.628	1.822	1155.04	2076.47	21.881	4.021	1007.19	180.17	0.029	0.020	25.456	27.738	0.178	0.240	123.56	490.64	2.36	1.35
PO	14	54	6.45	7.83	0.36	6.283	1.437	0.365	0.149	708.68	206.35	21.599	4.763	1037.54	115.01	0.030	0.014	4.603	4.989	0.179	0.094	65.63	59.59	2.08	1.01
PF	3	429	1.59	7.18	0.82	6.875	1.122	0.288	0.172	543.26	134.03	20.167	1.098	1173.12	36.68	0.069	0.033	8.598	6.366	0.149	0.020	58.74	121.88	3.85	1.14
IB	21	300	5.46	7.49	0.43	5.681	2.385	0.362	0.135	658.55	169.72	19.209	4.871	1000.33	136.02	0.052	0.048	13.654	9.829	0.163	0.138	66.08	44.43	1.44	1.70
II	4	140	1.90	8.21	0.22	5.151	1.434	0.492	0.058	1005.92	99.04	25.137	5.285	1026.00	113.86	0.039	0.017	5.288	2.708	0.320	0.183	74.55	80.01	1.52	1.31
IG	7	23	3.11	7.22	0.72	4.706	1.377	0.311	0.262	624.01	294.50	24.675	2.299	965.00	93.76	0.036	0.014	1.989	1.551	0.313	0.705	83.19	102.73	1.19	0.58
PZ	20	400	8.75	7.61	0.58	6.957	3.703	0.453	0.176	850.16	225.75	20.901	4.349	945.56	113.00	0.025	0.028	7.710	10.392	0.309	0.470	102.13	79.89	2.46	2.56
PV	4	2000	1.15	6.91	0.14	7.114	1.489	0.241	0.111	456.10	48.15	19.937	0.641	1164.04	83.27	0.076	0.042	10.990	15.343	0.160	0.210	19.21	19.19	3.99	2.01
PA	3	3000	1.13	7.95	0.61	6.740	1.193	0.228	0.102	446.81	34.40	21.361	2.838	1136.14	50.24	0.009	0.029	11.278	33.048	0.078	0.065	32.67	7.61	3.07	1.38
NN	4	8	2.92	7.42	0.65	5.786	0.470	0.264	0.107	473.58	102.24	18.612	2.221	1092.35	147.99	0.069	0.052	6.172	6.237	0.235	0.196	45.64	30.63	1.68	0.34
LI	8	29	3.52	7.44	0.67	4.700	0.638	0.336	0.209	713.86	268.62	25.882	2.582	932.92	292.12	0.025	0.013	0.946	1.148	0.104	0.062	84.40	96.36	0.77	0.58

Cooccur test applied for all species (36 species) in the Eskişehir province, 630 species pair combinations were used, 569 pairs (90.32 %) were removed from the analysis because expected co-occurrence was < 1 and 61 pairs were analyzed. According to analyze results, there are 56 random pairings (8.2 % of them classifiable) among 36 species in 94 sampling sites and three positive and two negative co-occurrence patterns revealed.

Species Co-occurrence Matrix for Eskişehir

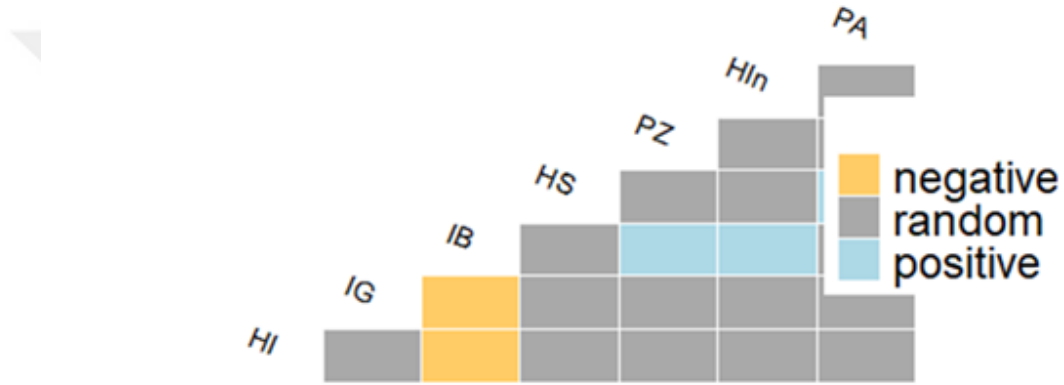


Figure 4.7. Cooccur analysis result for 36 species in 94 sampling sites with species in Eskişehir province. For species abbreviations see Table 4.1.

According to Cooccur test results (Figure 4.7) for all sampling sites with ostracod (36 ostracod in 94 sampling sites) showed that *I. bradyi* has positive co-occurrence with *P. zenkeri* and *H. intermedia*. Additionally, *I. bradyi* has negative co-occurrence with *I. gibba* and *H. incongruens*. *Ilyocypris bradyi* is one of the most frequent species with 32 occurrences in this study. This species was found in both lentic (trough, pond) and lotic (stream, river) waters. *Prionocypris zenkeri* is also another frequent species with 29 occurrences, both lentic (dam, trough, pond, pool) and lotic (stream, river) waters. These two cosmopolitan species (*I. bradyi* and *P. zenkeri*) were found in 17 sampling sites together in river, trough, and stream. *Herpetocypris intermedia* was found from only three sampling sites (through, stream) from the area, and found with *I. bradyi* from these three sampling sites.

Additionally, *I. bradyi* has negative co-occurrence with *I. gibba* and *H. incongruens* separately. *Ilyocypris bradyi* was not found together with *I gibba* (9 occurrence) but found from same sampling sites two times with *H. incongruens* (22 occurrence).

A total of 66 sampling sites (lentic habitat) and 29 ostracod species that were found from these sites were used to see co-occurrence patterns. There were 406 species pair combinations, 368 pairs (90.64 %) were removed from the analysis because expected co-occurrence was < 1 and 38 pairs were analysed. According to the results, there are 34 random pairings (10.5 % of them classifiable) among 29 species in 66 sampling sites and one positive and three negative co-occurrence patterns revealed.

Species Co-occurrence Matrix for Lentic Waters in Eskişehir

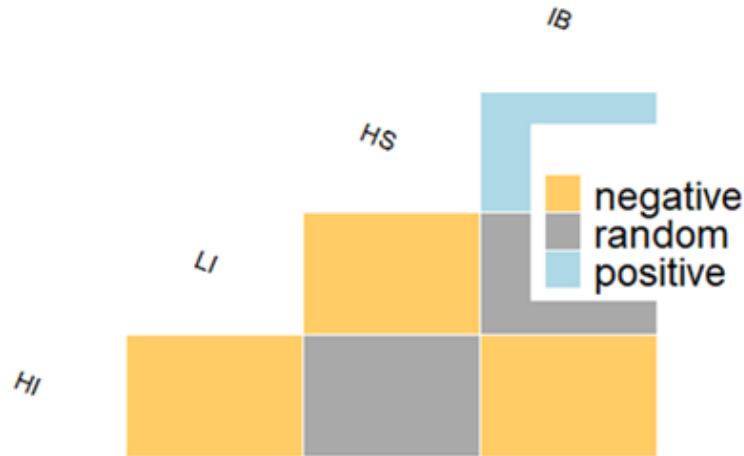


Figure 4.8. Cooccur results for 66 lentic habitats for 29 ostracod species. For species abbreviations see Table 4.1.

Cooccur results (Figure 4.8) for lentic habitats showed there is only *I. bradyi* (16 occurrence in lentic habitats) and *H. salina* (32 occurrences in lentic habitats) have positive co-occurrence. These species were found from 12 sampling sites together in lentic waters. Accordingly, *H. incongruens* (20 occurrences) showed negative occurrences with *L. inopinata* (eight occurrences) and *I. bradyi*, and *H. salina* negative occurrences with *L. inopinata* in lentic habitats this study.

A total of 28 sampling sites (lotic habitats) and 25 species that were found from these sites were used for this analysis. There were 300 species pair combinations, 276 pairs (92 %) were removed from the analysis because expected co-occurrence was < 1 and 24 pairs were analysed. According to analysis results, there are 22 random pairings (8.3 % of them classifiable) among 25 species in 28 sampling sites and one positive and one negative co-occurrence pattern revealed.

Species Co-occurrence Matrix for Lotic Waters in Eskişehir

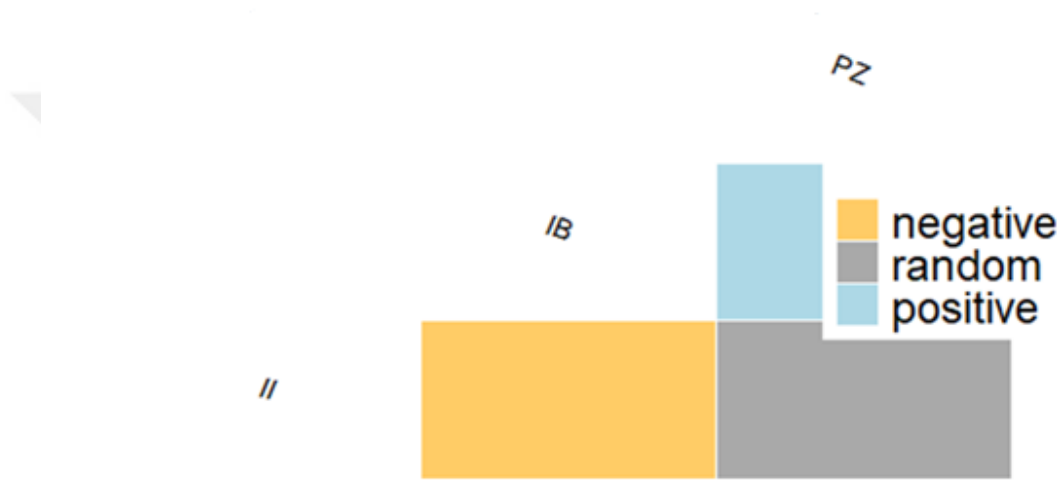


Figure 4.9. Cooccur results for 28 lotic habitats with 25 ostracods. For species abbreviations see Table 4.1.

According to cooccur results for lotic habitats (Figure 4.9) *P. zenkeri* (14 occurrence) and *I. bradyi* (16 occurrence) have positive co-occurrence on the area. These species were found from 11 lotic habitats together. Also, *I. bradyi* have negative occurrences with *I. inermis* (five occurrences) in the lotic habitats.

The adespatial analysis uses hierarchical cluster analysis that uses temporal and spatial data. Constrained clusters used for finding species' ecological boundaries. The firstly arranged the sampling sites on X/Y axis (Figure 4.10.A) figured and a network that each site connected to each other with using delauney triangulation figured (Figure 4.10.B) by analysis.

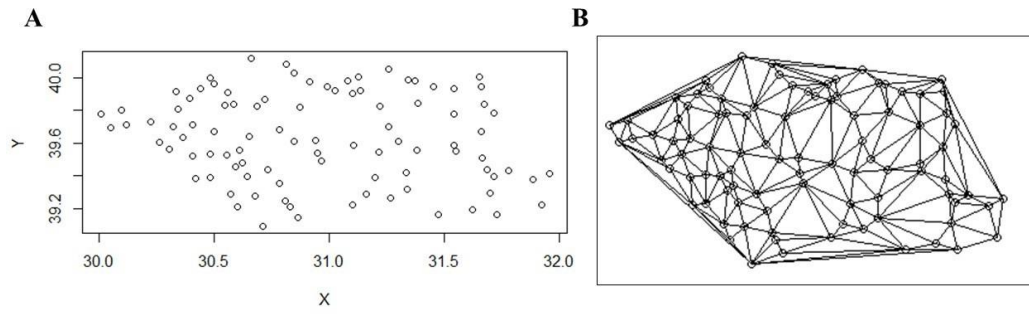


Figure 4.10. A) Plot image of sampling sites distribution of species on X/Y axis; B) Distribution network of every species on all area and all distance. Map with the spatial contiguity network of edges obtained by Delauney triangulation.

Accordingly sampling sites distribution based on weight (Figure 4.11 A) and based on distance (Figure 4.11 B) figured by analysis.

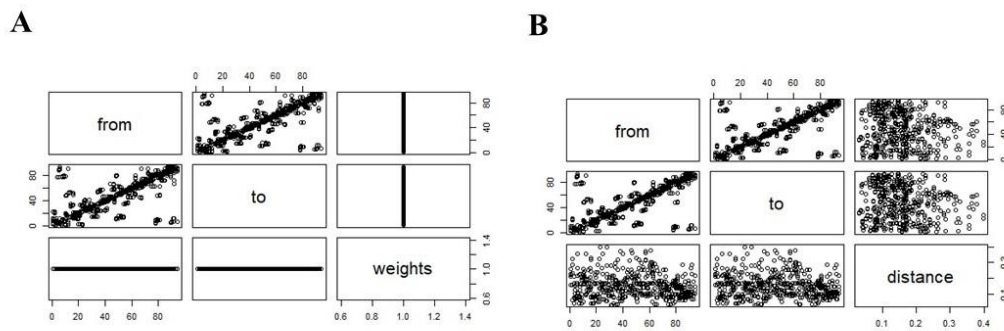


Figure 4.11. A) Plot graphic of sampling sites distribution based on weight.; B) Plot graphic of sampling sites distribution based on distance (0 to 0,4).

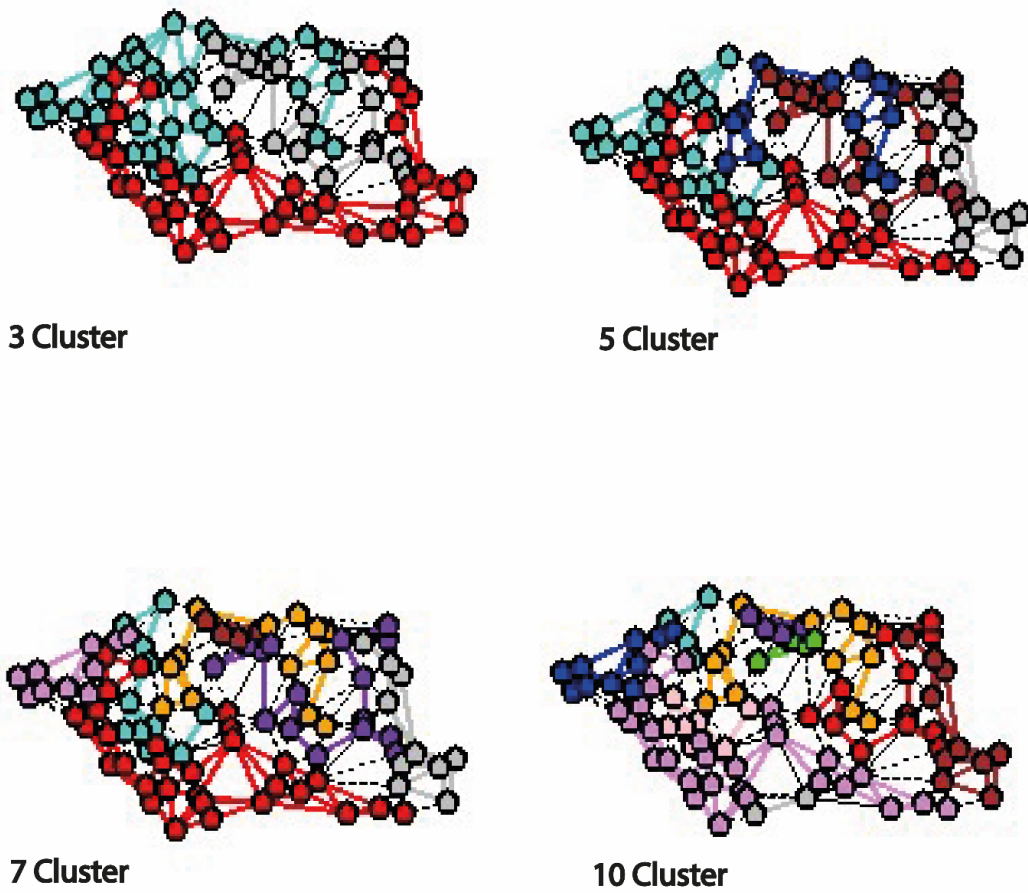


Figure 4.12. Distribution models of species, based on max 0,4 distance factor and 3,5,7,10 clusters. A set of four maps showing partitions of the sites into 3,5,7, and 10 clusters, with points and segments of different colors. Fine black dotted segments are edges with vertices in different groups.

The analysis uses the species richness, and their abundance on each sampling site, and distance between every sampling site to make grouping. Hence, the sampling sites with similar species and close distance are in the same group on this model. According to test results a distribution model (Figure 4.12) was developed with three, five, seven, and 10 groups of species based on distance and species similarity.

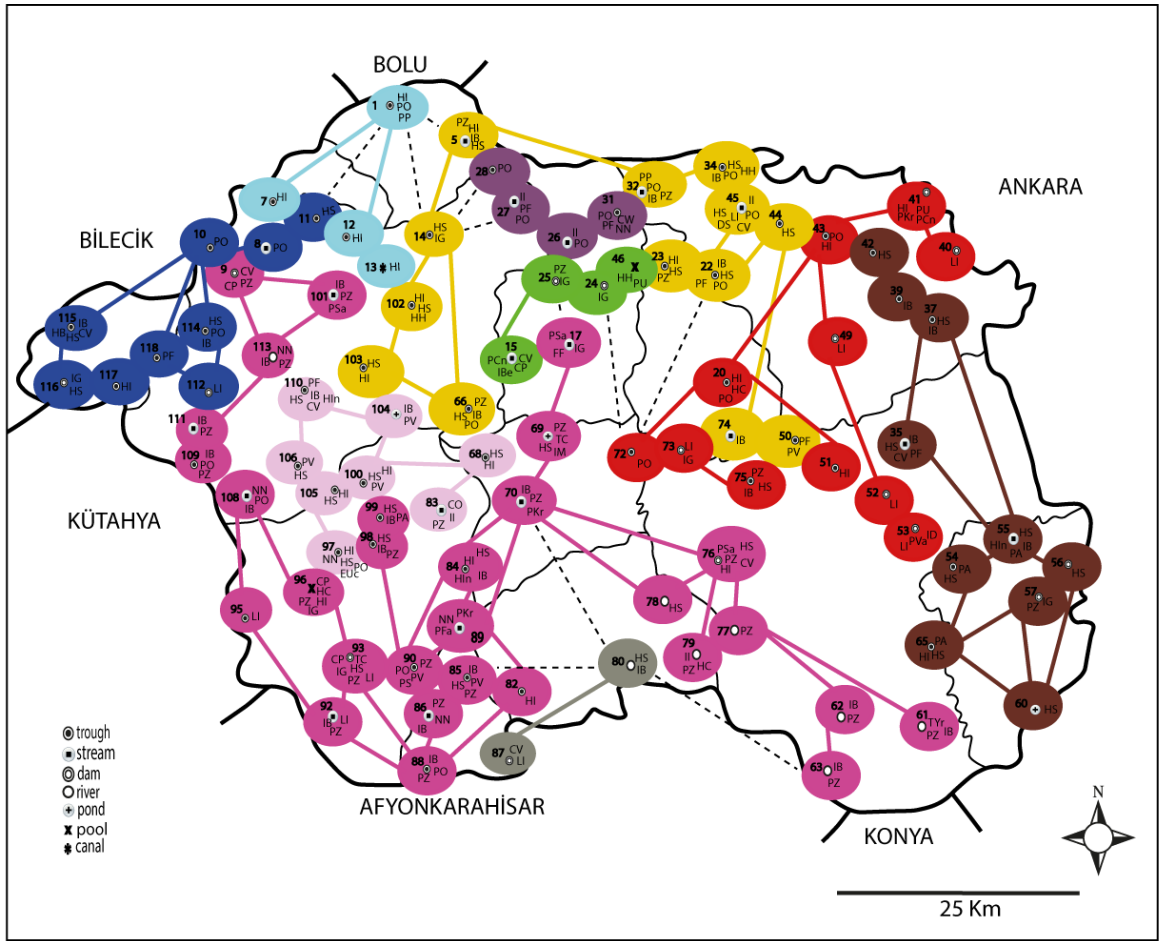


Figure 4.13. Distribution models of species, based on max 0,4 distance factor and 10 clusters combined with sampling sites on the Eskişehir province. For species abbreviations see Table 4.1.

Ten clustered species distribution model combined with sampling sites from Eskişehir and a new distribution model developed. Each group has potential rich habitats may be a source of species for poor ones via migration. Sampling site 1 for the group light blue; 66, and 45 for the group yellow; 31 for the group purple; 15 for the group green; 41 for the group red; 55, and 35 for the group brown; 76, 93, and 96 for the group magenta; 97, and 110 for the group lilac; 115 for the group navy (Figure 4.13).

t-Test unequal variance analysis (two-tailed $p = 0.05$) applied to determine if there is a significant difference. The first t-test application was used to test second hypothesis, if there is a significant difference between the average number of species in natural (64 natural habitats with 28 ostracod species) and artificial (30 artificial habitats with 28 ostracod species) habitats. According to t-test results ($p = 0.046$) there is a significant difference between natural and artificial habitats (see Appendix 5).

Another t-test application was used to test third hypothesis, if there is a significant difference between the density of species with asexual reproduction in source (21 sites, 12 ostracod species and a total of 1808 individuals) and sink (73 sites, eight ostracod species and a total of 5424 individuals) habitats. According to results ($p = 0.28$), species density between sink and source habitats has no significant difference (see Appendix 5). Additionally, sexual ostracod species density in sink and source habitats also has no significant difference ($p = 1.69$).

To test the fifth hypothesis, if there is a difference between tolerance and optimum levels for ecological variables of the species between source and sink habitats t-test was applied. To test this hypothesis, we used the data gained from C2 results for species inhabit in sink and source habitats variables (Table 4.8 and 4.9). There are six common species (*H. incongruens*, *H. salina*, *P. olivaceus*, *P. fontinalis*, *I. bradyi*, *P. zenkeri*) in sink and source habitats, and we compare these species tolerance and optimum values to each other with t-test. The results showed no significant difference for species optimum (pH ($p = 0.569$), DO ($p = 0.758$), Salinity ($p = 0.293$), EC ($p = 0.251$), T water ($p = 0.214$), BOD₅ ($p = 0.292$), Elevation ($p = 0.74$), Mg⁺² ($p = 0.849$), NO₂ ($p = 0.682$), NO₃ ($p = 0.837$), PO₄ ($p = 0.255$)), and tolerance (pH ($p = 0.546$), DO ($p = 0.315$), Salinity ($p = 0.348$), EC ($p = 0.564$), T water ($p = 0.851$), BOD₅ ($p = 0.94$), Elevation ($p = 0.144$), Mg⁺² ($p = 0.309$), NO₂ ($p = 0.37$), NO₃ ($p = 0.373$), PO₄ ($p = 0.311$)) levels for effective ecological between source and sink habitats (see Appendix 5).

Firstly, we tested the second hypothesis with ANOVA. According to test results there is not significant difference of the variance between the average number of species in natural (64 natural habitats with 28 ostracod species) and artificial (30 artificial habitats with 28 ostracod species) habitats ($p = 0.054$) (see Appendix 6).

Another ANOVA test used to test third hypothesis, see difference of the variance between the density of species with asexual reproduction in source (21 sites, 12 ostracod species and a total of 1808 individuals) and sink (73 sites, eight ostracod species and a total of 5424 individuals) habitats. The result showed ($p = 0.16$) no significant variance difference (see Appendix 6).



5. DISCUSSION

Ostracod studies in the Eskişehir province began with Gülen (1977 and 1985), and six and two ostracod species were reported, respectively. After Gülen (opt. cit.), 24 taxa (20 species, four subfossil) of both recent and fossil species were collected from the area (Table 5.1). The fossil ostracod species were reported from the Pliocene period (Tunoğlu & Temel, 1995) from the area.

Table 5.1. Previous recent and fossil ostracod studies in the Eskişehir province. Abbreviation: syn., synonym species.

Reference	Taxa	Notes
Gülen, 1977	<i>Prionocypris zenkeri</i>	
	<i>Stenocypris malcolmsoni</i>	syn. <i>Stenocypris cylindrical major</i>
	<i>Cypretta dubiosa</i>	syn. <i>Cypretta seurati</i>
	<i>Ilyocypris bradyi</i>	
	<i>Physocypris kliei</i>	syn. <i>Physocypris kraepelini</i>
	<i>Cypridopsis vidua</i>	
Gülen, 1985	<i>Prionocypris zenkeri</i>	
	<i>Cyprinotus inaequalis</i>	syn. <i>Heterocypris salina</i>
Tunoğlu & Temel, 1995	<i>Candona neglecta</i>	syn. <i>Neglecandona neglecta</i>
	<i>Pseudocandona compressa</i>	
	<i>Heterocypris ponticus</i>	
	<i>Cyprideis torosa</i>	
	<i>Candona parallela pannonica</i>	syn. <i>Pseudocandona albicans</i>
	<i>Candona altoides</i>	
	<i>Ilyocypris</i> sp.	
	<i>Cyprinotus</i> sp.	
	<i>Zonocypris</i> sp.	
Gülen & Altınsaçlı, 1999	<i>Psychrodromus olivaceus</i>	
	<i>Potamocypris zschokkei</i>	
	<i>Prionocypris zenkeri</i>	
	<i>Ilyocypris bradyi</i>	
	<i>Ilyocypris gibba</i>	
	<i>Ilyocypris decipiens</i>	
	<i>Cyprinotus inaequalis</i>	syn. <i>Heterocypris salina</i>
	<i>Heterocypris incongruens</i>	
	<i>Cypridopsis vidua</i>	
	<i>Eucypris virens</i>	

Table 5.1. (Continued)

Özuluğ & Kılıç, 2002	<i>Ilyocypris bradyi</i>	
	<i>Candona neglecta</i>	syn. <i>Neglecandona neglecta</i>
	<i>Cypria ophtalmica</i>	
	<i>Prionocypris zenkeri</i>	
	<i>Heterocypris incongruens</i>	
Yavuzatmaca, 2020	<i>Candona neglecta</i>	syn. <i>Neglecandona neglecta</i>
	<i>Cyprideis torosa</i>	
	<i>Ilyocypris bradyi</i>	
	<i>Prionocypris zenkeri</i>	
	<i>Ilyocypris</i> sp.	
	<i>Potamocypris</i> sp.	

In the present study, a total of 21854 individuals belonging to 51 taxa were collected from the area. Including a new species, *E. dorleonensis*, 36 species were identified in the Eskişehir province. Hereby, recorded recent and fossil ostracod species from the area (36 species were found in present study and 20 species were recorded from previous studies) raised to 44 species (Table 5.1, Figure 5.1).

The number of reported species from the area, 36 species from 118 sampling sites (0.372 species per sampling site), is relatively high compared to the nearby provinces (e.g., Ankara, Kütahya). Previously, 29 species collected from 173 sampling sites from Ankara (0.233 species per sampling site) (Uçak et al., 2014), and 23 species collected from 121 sampling sites from Kütahya (0.252 species per sampling site) (Külköylüoğlu et al., 2018).

Among 36 species found from the sampling sites the most frequently occurring species were *H. salina* (38 sampling sites), *I. bradyi* (32 sampling sites), and *P. zenkeri* (29 sampling sites). These three species are considered cosmopolitan (Külköylüoğlu, 2013) due to their high tolerance and widespread distribution (Mezquita 1999; Meisch, 2000).

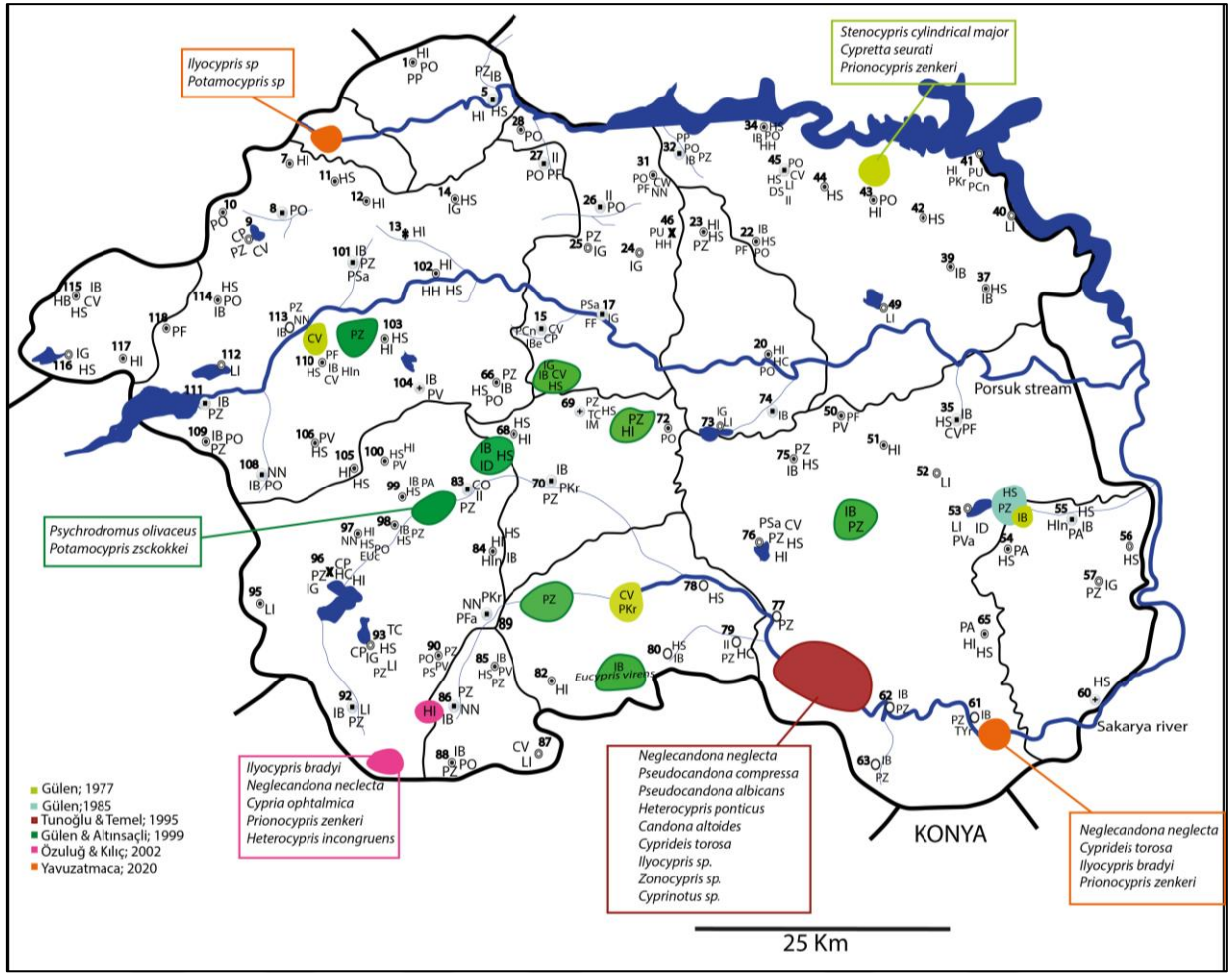


Figure 5.1. Figure shows all ostracod species reported from the Eskişehir province. Previous studies (Gülen, 1977; Gülen, 1985; Tunoğlu & Temel, 1995; Gülen & Altınsaçlı, 1999; Özuluğ & Kılıç, 2002; Yavuzatmaca, 2020) and the present study.

According to Shannon diversity index ($H' = 2.299$) Eskişehir province has moderate ostracod diversity, like one of the recent studies in Artvin ($H' = 2.945$) (Külköylüoğlu at al., 2020a) but lower than one of the closest provinces Kütahya ($H' = 3.64$) (Külköylüoğlu et al., 2018). The high abundance of cosmopolitan species in present study could suppress the presence and abundance of non-cosmopolitan species and affect habitat quality, so causing the low species diversity in the sampling area as mentioned in Hokkanen & Pimentel (1984). Additionally, high cosmopolitan species occurrence in the area may relate with low water quality, and habitat destruction (Külköylüoğlu, 2004).

In the first hypothesis we discussed if habitat types (lentic or lotic) make a difference on species co-occurrence on the area. According to the analysis results, different species co-occurred in different habitats. The results did not meet our

expectations in our first hypothesis. A possible reason for this may be that they have different ecological preferences in different habitats. As seen on the cooccur results (see Figure 4.7, 4.8, and 4.9) the three most frequent species have co-occurrence patterns in sampling area but *I. bradyi* has a center role for co-occurring different species in different habitat types. This cosmoeccious (Külköylüoğlu, 2013), non-swimmer species expected to be more frequent in lentic habitats (Akdemir et al., 2016), but we collected this species equally frequently from in both lentic (16 sampling sites) and lotic habitats (16 sampling sites). Lately, this species mentioned the most widespread ostracod (Mezquita et al., 1999). One of the accompanied species to *I. bradyi* positively co-occurred was *P. zenkeri*. This non-swimmer, sexual species prefers slow flowing streams and is mostly found from stagnant waters such as lakes is possibly related to passive dispersion from flowing waters (Meisch, 2000, Rosetti et al., 2005). The species found almost equal frequency from lentic (15 times) and lotic (14 times) in the present study. Recently, Akdemir et al. (2016), reported that this species found similar amount from lentic and lotic water bodies in Gaziantep. *Prionocypris zenkeri* and *I. bradyi* have positive co-occurrence on all water samples and lotic waters in Eskişehir province (see Figure 4.7, and 4.9). These non-swimmer cosmoeccious species differ in size (*P. zenkeri* 1.4-1.6 mm long; *I. bradyi* 0.8-1 mm long). According to Wiens (2011), morphological characters may be important to determine species habitat preference. Especially, size may be important to avoiding prey and reaching suitable resources. So, their size difference may ease their niche partitioning, and their co-occurring. In lentic waters *H. salina* co-occurs with *I. bradyi*. *Heterocypris salina* is a well-known swimmer species. Recently, Yavuzatmaca et al. (2024) reported, this species from all kinds of waters but it was more abundant in throughs in Amasya province. In the present study we see that this species is not successfully inhabited in lotic water bodies. We collect this species 32 different lentic waters, but only six times from lotic waters. This indicates that *H. salina* prefers standing waters more than flowing. Accordingly, C2 results showed that the species has high tolerance to salinity, and EC in lentic waters but has lowest tolerance for both in lotic waters (see Table 4.8 and 4.9). It is seen that this halophilic species (Meisch, 2000) limited its niche in unfavorable conditions (in lotic waters).

Heterocypris salina was not the only species that changed its tolerance levels in different habitat types. For example, *I. bradyi*, has low tolerance for pH levels in lentic waters, but in contrary in lotic waters (see Table 4.8), and low tolerance for

salinity and EC range in lotic waters, but high tolerance for both in lentic waters (see Table 4.9). The species found a narrow range of elevation in lentic waters but has maximum tolerance for elevation in lotic waters. Uçak et al. (2013) mentioned this species as habitat generalist, and recently Klkylođlu et al. (2020a) reported the species with minimum tolerance to pH, and maximum tolerance to elevation in Artvin. Another species, *P. zenkeri* arranged its salinity and EC tolerances to maximum in lotic waters while had low tolerance in lentic waters (see Table 4.8). This species was reported with low tolerance for EC in Mardin, and Muş area (Trkiye) (Klkylođlu et al., 2020b). Also, the species mentioned as poor water quality indicator in Yavuzatmaca et al. (2024). Additionally, species co-occurred together (*I. bradyi*, *P. zenkeri*, *Herpetocypris intermedia*, and *H. salina*) were grouped in the same cluster in UPGMA diagram (see Figure 4.5). Some previous studies focused on competition effects (e.g. Diamond, 1975) or prey-predator interactions (e.g. Englund et al., 2009) in co-occurrence studies, but in the present study, ecological requirements may also be important. It seems that the species' relationship with different environmental variables may change from different habitat types to fit that environment better (Yavuzatmaca, 2019).

The second hypothesis (no difference in the average number of species between natural and artificial habitats) was accepted. As indicated above, artificial habitats (78 sampling sites), especially troughs, overcome the natural ones (40 sampling sites). Klkylođlu et al. (2013) pinpointed that troughs are the most abundant artificial aquatic habitat in Trkiye. Although numbers of species (28 species) were similar, number of sampling sites was different where abundance values of the individual species were higher in the artificial habitats than natural habitats. As indicated above, t-test, and variance analysis results ($p = 0.046$, $p = 0.054$, respectively) were found close to 0.05. Indeed, Shannon index value ($H' = 2.143$) of artificial habitats was found to be higher than the index value of natural habitats ($H' = 1.877$). The difference of the index value may be created by species abundance difference between natural and artificial habitats. In comparison to species abundance importance, Klkylođlu et al. (2017) showed that Taşlıyayla-Seben reservoir had similar alpha Shannon diversity value ($H' = 2.079$) among few sampling sites (16 sites). As indicated before, β diversity index ($\beta = 0.33$) was low and Mann-Whitney U test results showed no statistically significant difference ($p > 0.05$) between natural and artificial habitats in the present study. Although, some previous studies from Trkiye reported that natural habitats

contain more ostracod diversity and abundance than artificial ones (Klkyl & Sarı, 2012; Uak et al, 2014; Yavuzatmaca et al., 2017; Klkylođlu et al., 2021), our study contrary to them. One possible explanation of finding similar species between the two habitats may be the abundance of cosmopolitan species in our study. As mentioned in Klkylođlu (2013) increase of the abundance of cosmopolitan species in the habitat may cause reduction in the number of native or non-cosmopolitan, so creates a false richness. Because the well-known cosmopolitan species *C. vidua*, *H. incongruens*, *H. salina* and *I. bradyi* have been found extensively in both natural and artificial habitats. Moreover, *H. incongruens* found an indicator species for artificial habitats according to indicator species analysis results (see Table 4.6). Thus, despite the species abundance is higher in artificial habitats, average number of species in natural and artificial habitats does not significantly differ from each other in the Eskiřehir province.

The third hypothesis (no difference of asexually reproductive species in sink and source habitats) this study was accepted according to test results. Among 36 species found from 94 sampling sites 22 ostracod species (61.1%) have sexual reproduction. As stated in Klkylođlu et al. (2020b) approximately 54.1% of the 146 ostracod species in found Trkiye have sexual reproduction type. The present study supports these previous results with 61.1% of sexually reproductive species found in the area. Besides, asexual species have more richness in the source habitats than sink ones (9 species in 73 sink habitats, but 12 species in 21 source habitats) in the study area (see Table 4.9). Since source habitats can be considered to have more species richness, abundance, and growth rate (Pulliam, 1988), these results do not surprise us. Moreover, Gilroy & Edwards (2017) pinpointed that source habitats can contain relatively high habitat quality (in ecological sense) and populations with high persistence rate while sink populations contain poor quality habitats and populations with low persistence rate. This assumption indicates that asexual species may be more advantageous to maintain continuity of both sink and source habitats. Supporting that, Horne & Martens (1999) suggested parthenogenetic species have more advantages than sexual ones for recolonizing in a habitat, so we can assume that asexual species gave more advantage to these habitats continuity. Additionally, some researchers also mentioned diapausing egg and parthenogenetic reproductions positive effects of establishing new populations after passive transport (Meisch, 2000; Boulton et al., 1991). This is a feature that makes it easier for ostracods to re-colonize in the habitats

that are facing destruction. Despite all these, contrary of the numerical difference of species in sink and source habitats, t-test, and variance analysis results ($p > 0.05$) showed that asexual species density in the source and sink habitats are similar. Also, sexual species density has no difference in the sink and source habitats according to t-test results ($p > 0.05$). Since the sink and source habitat concept were not studied on ostracods before we need more investigations for ostracods preferences in these kinds of habitats. Our results lead us to say, reproduction type is not important to inhabiting ostracods in sink and source habitats in the Eskişehir province.

The fourth hypothesis (species richness in the sink habitats is not effected by the distance between that habitat and source habitat) was rejected. To studying sink/source habitat structures and calculate contributions or effects demographic data such as survival rate, transition rate between habitat patches, and reproduction rate of the populations are important (Sample et al., 2019) but if there are limited or no demographic data is available like this study (one-time random sampling), the graph-based methods may be appropriate according to Nicol et al. (2016), and Bieri et al. (2018). Therefore, the adespatial analysis results gave us sufficient support to test this hypothesis since it calculates groups based on distance between sites, and species richness. This novel analysis recently proposed and already applied for mites (Guénard & Legendre, 2022), and fishes (Xia et al. 2022) hierarchical distribution modelling. This study will be the first use of the analysis on ostracods. Among the ten clusters the analysis result gave us, all groups have potential source habitats to maintain sink habitats continuity (see Figure 4-13). According to Pulliam (1988), sink habitats cannot maintain their survival without migration from source habitats. Despite their swimming ability, ostracods require a transport vector to carry them from one habitat to another (so call migration). It has been reported in the literature that the passive transport vectors of ostracods between habitats are humans, birds, fish, plants, wind (in the transport of eggs), insects and amphibians (McKenzie and Moroni, 1986; Horne and Martens, 1998; Rossi et al., 2003; Rodríguez-Lazaro and Ruiz-Muñoz, 2012). Notes taken during the sampling study (see Appendix 4) gave hints about ostracods transport vectors. When we compare the adespatial results (see Figure 4-13) with notes about sampling sites (Appendix 4) we can see the potential source habitats on the adespatial results all facing the harsh agricultural activity, intense farming, and migrating birds. Of the 94 sampling sites that include ostracods, 23 of them related to excessive farming activity, 24 of them facing harsh agricultural activity, and 53 of

them inhabit migrating birds. Also, phytoplankton and macrophyte density is another important factor for structuring ostracod communities, especially swimmer ostracods (de Campos et al., 2018). Species richness in sink habitats also may be affected by migrating from the source habitat nearby but in the adespacial results some distant potential sink habitats have more species than the closest ones to the source habitat. Another important distribution method is that the distribution of species is facilitated by farming animals, especially among trough habitats which is the most common habitat type in the area. Therefore, species that can easily adapt to their environment are distributed in each habitat patch, and these are cosmopolitan species which are abundant in the sampling area. As stated in Klkylođlu et al. (2020a) cosmopolitan species richness of the area shows us the density of anthropogenic activity and potential habitat disturbance. Morower, Gilroy & Edwards (2017) stated that human impact on animal distribution was important to study sink and source habitats. Another effective factor for ostracods transfers from one habitat to another is flowing waters. As stated in Lansac-Tha et al. (2004) lotic habitats make a connection between lentic habitats and carry their fauna one habitat to another. Since the sampling area rich from the lotic habitats (Sakarya river, Porsuk stream, etc.) these flowing waters also may consider another carrying vector for ostracods.

The increase in distance between habitats was discussed in Hanski and Gyllenber (1993) and it was stated that the "rescue effect" (Brown & Kodric-Brown, 1977) increased with increasing distance and the migration rate of species between habitats decreased. The rescue effect may be considered on the area while transporting vectors for ostracods is animals, such as birds. To summarize, since distance between habitats may not be very effective for ostracods, contrary it can be thought that transporting factors (water mobility, livestock, human influence) are more effective in transporting species than the distance between habitats. When we look at the groups on the adespacial result, some groups covered a wide area, and similar species were found in several groups. In addition, the abundance of cosmopolitan species found most of the groups and they ensure the continuity of habitats. Due to their wide tolerance, cosmopolitan species have greater ability to adapt to new habitats more easily than non-cosmopolitan species (Smith & Smith, 2011). Finally, we can say that the abundance of carrying factors for ostracods from one habitat to another, makes ostracod disperse widely, and cosmopolitan species abundance makes sink and source habitats continuity.

We accepted the fifth hypothesis (no difference in the ecological tolerance and optimum levels of the species between source and sink habitats) according to t-test results ($p > 0.05$) based on the findings of C2 results for sink and source habitats (Table 4.10 and 4.11). Although sink habitats have more sampling sites (26 species in 73 sites) in the study, species amount in source habitats have majority (30 species in 21 sites). Most of the species in the sink and source habitats are cosmopolitan ones as mentioned before, so they have high tolerance on ecological variables (see Table 4.11). It is assumed that since the sink habitats are facing more disturbance than the source ones, the species that sited there should have wider tolerance (Holt, 1997), but present study contrasts to this idea to having cosmopolitan species in both. Accordingly, test results and cosmopolitan species richness in sink habitats show that species tolerance on ecological factors are not different in sink and source habitats. Thomas et al. (2004) pinpointed that the survival and occurrence of species depends on their ecological tolerance, so cosmopolitan species has more advantage than the rare species to adapt to new environment. We collected non-cosmopolitan species more in source habitats than the sink habitats. As Freilich et al. (2018) pinpointed, rare species (non-cosmopolitan ones) affect more from biotic interactions than environmental ones. Since sink habitats are facing more disturbance than the source ones (Gilroy & Edwards, 2017) having more non-cosmopolitan species in the source habitats may be favor the acceptance of the hypothesis.

As seen in CCA diagram (see Figure 4.6) three variables (elevation, NO₂, and pH) were the most effective factors that distribution of ostracod species in the study area. Similarly, Yavuzatmaca (2019) found that elevation was the most important factor on species distribution in Konya, Antalya, and west mediterranean basins of Türkiye. Also, pH is considered the important variable to affect water quality (Boyd, 2020) and important for ostracod shell calcification (Higuti et al., 2010). The effectiveness of NO₂ level shows us that the water quality in the region is not good. This may be due to intensive agricultural activity seen in the province (see Appendix 4). Külköylüoğlu (2013) underlined that cosmeocious species and anthropogenic influence, disturbance or pollution on the habitats had a positive correlation. This outcome supports the majority of cosmopolitan species in the present study. As expected, most of the cosmopolitan species (*H. salina*, *H. incongruens*, *P. zenkeri*, *P. olivaceus*, *I. bradyi*) were close to the center of CCA diagram, since these species have wide tolerance ranges, they may not be affected by most of the ecological variables

(Ricklefs, 1990; Klkylođlu, 2013). Among them *H. salina* is the most frequent species in the sampling area. This halophile species (Meisch, 2000) was related to EC and NO₃ according to CCA results. Similarly, the species was found related with nitrate content in Iberian Peninsula (Mezquita et al., 1999), and highly correlated with EC (Rasouli et al., 2014). The species also correlated with DO (see Table 4.4) and seems to prefer waters with high phosphate concentrations (see Table 4.6.) in the study area. Similarly, the species found related with DO concentrations in waters in Burdur (Yavuzatmaca et al., 2017), and in Spain (Valls et al., 2014). Moreover, species had been associated with phosphate concentrations in water in urban park in Rome (Mazzini et al., 2014) and rice fields in Spain (Valls et al., 2014). The species showed maximum tolerance for Ca⁺² concentrations besides salinity in the present study. Supported that species found from waters with high Ca⁺² concentrations in Western Mongolia (Van der Meeren et al., 2010), and shallow waters in Sinop province (Yavuzatmaca et al., 2017).

Results of the indicator species analysis (see Table 4.6) showed that some species prefer some certain habitats, like *H. incongrues* prefers lentic and artificial habitats, in the sampling area. This species is a well know cosmopolitan species that has a wide range of tolerance for ecological variables (Mesich, 2000). Similarly, *H. incongruens* showed moderate tolerance to almost every ecological variable in the study area. The species can be found from every kind of habitats such as river sediment, groundwater, and stagnant and temporary waters in contact with soil, and is considered a keystone species for evaluating biotic changes produced by anthropogenic activities (Ruiz et al., 2013; Bellin et al., 2021). Moreover, the species was also considered a bioindicator of the toxicity of sediment and soil (Watanabe et al., 2008; Mariani et al., 2022).

Prionocypris zenkeri was another most frequent species in the study area. This bottom dweller cosmopolitan species prefers mostly slow flowing springs (Rosetti et al., 2005). We collect this species almost similar amount from lentic (15 occurrence) and lotic (14 occurrence) waters in the study area. The species had moderate tolerance for environmental variables as predicted on the center of CCA diagram. Some previous studies also reported this species without specific ecological preferences, for example Adiyaman (Yavuzatmaca et al., 2015), and Burdur (Yavuzatmaca et al., 2017). Moreover, the species tend to prefer high TDS values in the waters according to indicator species results. The optimum TDS value is 542.8 mgL⁻¹ of species in the

study area. Klkylođlu et al. (2013) reported this species maximum 615 mgL⁻¹ concentration of TDS value.

Another non-swimmer species, *P. olivaceus*, was found from high altitudes (1024.13 m optimum for elevation in C2 results) in the present study. Similarly, Dalgakıran et al. (2020) mentioned the species that had maximum tolerance for altitudes in Mersin province. Mischke et al. (2014) stated that this species prefers low EC waters with stable ion concentrations, but the species had moderate tolerance to most of the ecological variables in present study.

Psychrodromus fontinalis showed positive correlation with elevation but negatively correlated with turbidity of waters in the present study. Similarly, the species tend to prefer less turbid waters, and have low tolerance to turbidity. There is limited information about this species and turbidity preferences, but Mezquita et al. (2001) mentioned this species as indicator for clean waters. Additionally, this species has high tolerance to elevation in the study area. Previously, Klkylođlu et al. (2018) reported the species with minimum tolerance in Ktahya province, and maximum tolerance in Artvin province (2019) for elevation.

The results of indicator species analysis showed that *I. inermis* prefers natural and lotic habitats. Meisch (2000) reported that *I. inermis* is mostly found in the waters connected with springs. The species does not have long swimming setae on A2, so lotic habitat preference is predictable as mentioned in Akdemir et al. (2017). Species generally have high tolerance to EC levels, but the species' ecological preference is not sufficient (Sarı et al., 2012) in the previous studies.

Ilyocypris gibba was correlated with NO₂, also CCA results supported this relation. This species had high tolerance to most of the water ions (PO₄, Mg⁺², NO₂, and NO₃) concentrations in the present study. Rosetti et al. (2004) reported this species in waters with high ionic concentrations, and Szlauer-Lkaszewska (2014) mentioned the correlation of species with phosphate content in waters. The species had the maximum optimum for water temperature with 25.75 °C (tolerance 2.63). Correspondingly, Hartmann & Hiller (1977) characterized the species as polythermophilic.

A well-known cosmopolitan species, *Cypridopsis vidua*, was related with Mg⁺² in CCA diagram. Additionally, the species showed maximum tolerance for ORP and pH, but negative correlation with pH in the sampling area. Similarly, Klkylođlu (2005b) reported this species positively correlated with ORP, and pH in Bolu. Batmaz

et al. (2020) found the species with minimum optimum levels for ORP and pH levels in Malatya.

Another cosmopolitan species *C. pubera* has wide tolerance to ecological variables (Meisch, 2000; Yavuzatmaca, 2019). Indicator species analysis showed that this species is also tolerant to eutrophic waters and tends to prefer PO_4 and Ca^{+2} concentration in waters. Similarly, the species related to PO_4 in CCA diagram.

Herpetocypris intermedia is another species that was located at the center of CCA diagram. The species found only three times in the sampling area, and had low tolerance for salinity levels, and altitudes. Batmaz et al. (2020), reported this species negatively related with salinity, and in the low altitudes in Malatya province similarly our results.

Indicator species results showed that *P. villosa* prefers well oxygenated waters and is sensitive to Ca^{+2} concentrations in the waters. The species positively correlated with DO, and negatively correlated with total phosphate concentrations in the water. Previous studies were also support the idea that the species prefers well oxygenated waters (Külköylüoğlu & Yılmaz, 2006).

Other species were not showed any ecological preference according to analysis results, or found small amounts (*I. mostrifica*, *I. decipiens*, *H. brevicaudata*, *P. pallida*, *P. unicaudata*, *P. similis*, *P. fallax*, *P. variegata*, *C. weltneri*, *F. fabaeformis*, *C. ophthalmica*, *T. clavata*, *P. newtoni*, *D. stevensoni*, *I. beauchampi*, *T. amnicola*) from the sampling area so, were not include to statistical analysis.

In the present study not only ostracod samples were collected from 118 water bodies, but also ecological data and water chemistry data were collected. These data are also important as they will have reference value for subsequent studies. According to the 2018 report of Eskişehir Provincial Directorate of Agriculture and Forestry (ETOM, 2018), the agricultural areas used in the region constitute 41% of the entire area. In order to see the effect of irrigation for agricultural purposes on the aquatic habitats of the region, we can compare the average nitrate (NO_3) values in the sampling habitats given in the 2018 Environmental Status Report (DSI, 2018) with the data we obtained in our study (Table 5.2). The fact that there is a large difference between the nitrate value we measured and the average value that reported before in some regions (Bardakçı stream, Porsuk stream, Bahçecik pond, Kümbet village fountain) shows that precautions should be taken regarding agricultural irrigation and waste management in that region. The agricultural activities were intense during the dates we conducted

our study (11-17 July) and may have contributed to the difference. At the same time, this study includes one-time sampling which may be one of the obstacles that prevent us from making a healthy comparison, but in general, nitrate data measured higher than the average values can be used as an indicator of the effect of uncontrolled agricultural activities (for example, artificial fertilization) in the aquatic environments in the region. As a result, *P. albicans* and *H. salina*, well-known cosmopolitan species with high tolerance (Meisch, 2000), were found in these regions and these species are among the species with high nitrate tolerance (see Table 4.7). The presence of cosmopolitan species in such environments is considered an indicator that the quality of the aquatic environment is low or declining (Külköylüoğlu, 2013).

Table 5.2. Comparison of previously reported annual average nitrate values with the values measured in the present study in some common sampling sites. Abbreviations: DSI, State Hydraulic Works; ETOM, Eskişehir Provincial Agriculture and Forestry Directorate.

Habitat type	County/Area name	Annual average Nitrate value (mg L ⁻¹)	The Nitrate value measured in this study (mg L ⁻¹)	Sampling site from present study	Reference
stream	Çifteler/Bardakçı stream	0.64	13.85	89	DSİ, 2018
stream	Orhangazi/Porsuk stream	1.05	0.96	111	DSİ, 2018
river	Sivrihisar/Aktaş village/Sakarya river	0.73	7.82	77	DSİ, 2018
stream	Mihalıççık/Gürleyik stream	0.47	0.49	45	DSİ, 2018
stream	Beylikova/porsuk stream	3.72	9.54	74	DSİ, 2018
dam	Keskin dam	0.91	1.84	9	ETOM, 2018
stream	Kızılınler/porsuk stream	3.57	3.44	113	ETOM, 2018
river	Sarıcakaya/Sakarya river	7.33 - 8.08	7.35 - 4.23	2 and 3	ETOM, 2018
dam	Çatören dam	0.62	0.48	93	ETOM, 2018
stream	Seyitgazi/Seydi stream	12.59	9.32	8,3	ETOM, 2018
dam	Musaözü dam	1.49	1.74	112	ETOM, 2018
dam	Bahçecik dam	0.9	11.19	76	ETOM, 2018
dam	Koçaş dam	7.77	0.42	53	ETOM, 2018
river	Çifteler/Körhasan village	8.08	5.28	78	ETOM, 2018
pond	Mahmudiye/Fahriye village	84.34	1.91	69	ETOM, 2018
stream	Alpu/Bahçecik village	19.84	3.61	15	ETOM, 2018
trough	İnönü/Kümbet village	17.4	29.96	117	ETOM, 2018

6. CONCLUSIONS AND RECOMMENDATIONS

With the present study, a total of 51 ostracods (36 live species and 15 taxa unidentified and/or subfossils) were reported. Of which, 24 ostracod species were recorded for the first time that this elevates numbers of ostracod species to 44 species. A new species, *Eucypris dorlionensis* was collected from the area. Nevertheless, reporting a total of 44 species reveals a rich species diversity. Thus, we believe that as sampling studies increase, more species can be found from the area. Comparison of the numbers of species between artificial and natural habitats did not exhibit a significant difference. However, abundance values of the cosmopolitan species were found to be in favor of artificial environments. Also, it was clearly seen that the co-occurrence patterns of the ostracod species in lentic and lotic habitats were different. After determining the source and sink habitats and their species compositions, it was found that reproduction type of ostracod species has no difference both in the sink and the source habitats. However, it was outlined that the ecological preferences of species located in sink and source habitats are not different from each other. In addition, the richness of cosmopolitan species in the sampling area may be related to the low water quality of the sampling sites. Therefore, some cautions should be taken as soon as possible for the protection of biodiversity in the area.

This study will contribute to many studies that our research group accomplished before and will do in future to the determination of the ostracod distribution, ecology, and biology in Türkiye.

7. REFERENCES

APA citation system was used in this thesis.

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8. APPENDICES

Appendix 1 Ecological variables and taxa were reported from different aquatic bodies in Eskişehir. Abbreviations and Units: Site, sampling site; DO, Dissolved Oxygen (mg L^{-1}); %DO, Percentage Oxygen Demand (%); Salinity (ppt); EC, Electrical Conductivity ($\mu\text{S cm}^{-1}$); Tw, Water Temperature ($^{\circ}\text{C}$); Ta, Air Temperature ($^{\circ}\text{C}$); Atmp, Atmospheric pressure (mm Hg); ORP, Oxidation Reduction Potential (mv); TDS, Total Dissolved Solid (mg L^{-1}); BOD₅, Biochemical Oxygen Demand (mg L^{-1}); Moisture (%); Wind (m s^{-1}); Elevation (m). CW, *Candona weltneri*; CO, *Cypria ophtalmica*; CV, *Cypridopsis vidua*; CP, *Cypris pubera*; DS, *Darwinula stevensoni*; EUc, *Eucypris dorlionensis*; FF, *Fabaeformiscandona fabaeformis*; HB, *Herpetocypris brevicaudata*; HC, *H. chevreuxi*; HH, *H. helenae*; HIn, *H. intermedia*; HI, *Heterocypris incongruens*; HS, *H. salina*; IB, *Ilyocypris bradyi*; ID, *I. decipiens*; IG, *I. gibba*; II, *I. inermis*; IM, *I. monstifica*; IBe, *Isocypris beauchampi*; LI, *Limnocythere inopinata*; NN, *Neglecandona neglecta*; PKr, *Physocypria kraepelini*; PCn, *Plesiocypridopsis newtoni*; PA, *Potamocypris arcuata*; PFa, *P. fallax*; PP, *P. pallida*; PS, *P. similis*; PU, *P. unicaudata*; PVa, *P. variegata*; PV, *P. villosa*; PZ, *Prionocypris zenkeri*; PSa, *Pseudocandona albicans*; PF, *Psychrodromus fontinalis*; PO, *P. olivaceus*; TC, *Trajancypris clavata*; TYr, *Tyrrhenocythere amnicola*.

Appendix 1 (Continued)

Site	pH	DO	%DO	Salinity	EC	Tw	Ta	Atmp	ORP	TDS	Turbidity	BOD ₅	Moisture	Wind	Elevation	Species
1	7.5	6.42	69.4	0.25	658.7	19.4	24.7	672.01	29.1	333.45	1.51	2.45	63.8	0.6	1225	HI, PO, PP
2	7.9	6.36	64.5	0.62	1008	15	30.2	741.5	12.5	806	5.73	2.81	61.2	0.6	201	—
3	8.2	7.11	76.2	0.67	1164	18	27.7	740.1	4.1	871	3183	3.82	66	0.4	218	—
4	8.5	0	0	0.61	1284	27.2	33.7	734	-5.8	799.5	15.24		48.4	0.5	284	—
5	8.6	5.49	74	0.62	1407	31.2	35	737.5	-29.2	819	15.1	1.7	48.4	0.3	239	HI, HS, IB, PZ
6	7.7	7.54	78.3	0.74	1245	16.7	32.2	741.1	-53.9	962	5.38	4.16	47	0.5	182	—
7	7.2	5.03	64.8	0.46	1014	28.5	35	699.1	-21	617.5	1.74	0.64	42.8	0.4	703	HI
8	8.1	6.6	71.2	0.27	494.9	19.2	28	663.7	-37.6	361.4	39.71	2.66	41.8	0.8	1154	PO
9	8.6	4.9	63.3	0.25	560	28.1	33	684.4	-45.7	344.5	5.17	1.57	43	0.8	881	PZ, CV, CP
10	7.6	6.88	66.9	0.26	414	13.6	30	672.1	-30.1	342.65	0.6	3.11	53.4	0.3	1040	PO
11	7.4	5.76	70.2	0.34	697	25.2	28.5	659.5	-3.5	448.5	2.02	1.36	49.7	0.8	1204	HS
12	7.1	5.59	59.7	0.26	460.7	18.1	26.4	655.5	-11.7	345.1	1.75	2.03	51	0.8	1255	HI
13	7.6	9.31	96.5	0.4	692	16.8	29.4	690.8	-19.5	533	0	8.77	45	0.9	790	HI
14	7.5	4.99	56.1	0.59	1111	21.4	24.8	673.5	-0.9	773.5	3.32	0.51	16.1	2.7	1013	HS, IG
15	8.1	5.28	59	0.41	756	20.3	25.6	691.9	-1.6	539.5	50.81	2.61	51.7	1.4	777	CV, CP, PCn, IBe
16	7.6	4.97	51.4	0.42	713	16.9	20.8	690.9	-48.7	546	6.21	2.7	69	2.1	793	—
17	7.3	1.06	12.2	0.53	1020	22.3	27	692.8	12.1	695.5	1.87	-0.74	56	0.5	760	IG, FF, PSa

Appendix 1 (Continued)

Site	pH	DO	%DO	Salinity	EC	Tw	Ta	Atmp	ORP	TDS	Turbidity	BOD ₅	Moisture	Wind	Elevation	Species
18	7.4	2.02	24.1	0.75	1453	23.8	30.5	592.9	-37.7	968.5	8.79	1.42	55	0.6	758	—
19	8.5	5.74	72.4	0.3	654	27	29.5	688.2	-33.1	409.5	3.67	2.34	46	0.5	819	—
20	8	4.84	58.4	0.3	611	24.8	28	692.5	-34.8	396.5	2.2	1.14	48	0.3	761	HI, PO, HC
21	6.9	7.1	72.3	0.35	585	16.1	28	679.6	-26.8	455	0.8	3.49	44	0.7	926	—
22	7.3	7.24	74.8	0.35	602	16.3	29.8	670.6	-8.6	468	0.53	3.54	44	0.5	1034	HS, PO, PF, IB
23	7.7	6.95	71.5	0.41	707	16.9	31.8	682.3	-8.8	546	1	3.34	45	0.6	885	HI, HS, PZ
24	6.9	4.73	57.7	0.14	298	25.5	29.5	674.6	-46.2	191.75	2.1	1.18	34	1.5	994	IG
25	6.9	4.22	53.3	0.22	469.1	27.1	30.6	673.9	49.4	293.15	17.43	0.72	43	0.8	987	IG, PZ
26	8.3	4.65	58.9	0.51	1084	27.4	32.3	672.6	-40.5	676	34.83	0.95	40	0.7	1011	PO, II
27	8.1	5.65	63.5	0.48	894	21	32.8	658.6	-43.5	630.5	0.8327	2.95	74	0	1188	PO, PF, II
28	8.2	8.56	83.2	0.48	757	14.2	32.8	670.1	-39.9	624	0.6	4.92	36.8	0.6	1040	PO
29	6.9	9.9	121.5	0.65	1313	25.6	31.2	730.5	-30.4	845	20.13	8.54	91	2.7	275	—
30	7.3	5.66	64.3	0.51	955	21.5	32.3	672.8	-17.6	663	1	2.04	41	0.5	1001	—
31	7.3	6.51	68.6	0.17	308.2	17.6	31.9	648.1	-21	232.7	1	2.71	41	0.3	1327	PO, PF, CW, NN
32	6.9	5.42	60.8	0.26	493.1	20.7	26.1	664.2		349.7	2.96	0.93	51	0.3	1138	PO, IB, PZ, PP
33	6.4	5.9	65.2	0.08	157.5	20.2	24.8	640.3	27.4	112.45	0.8	2.42	53	2	1414	—
34	8	6.2	75.8	0.54	1108	25.4	30.6	700.2	-7.4	715	3.57	1.88	50	0.3	656	HS, PO, IB, HH

Appendix 1 (Continued)

Site	pH	DO	%DO	Salinity	EC	Tw	Ta	Atmp	ORP	TDS	Turbidity	BOD ₅	Moisture	Wind	Elevation	Species
35	8.4	6.3	68	0.58	1031	18.9	23.3	691.5	25.4	760.5	42.61	2.7	54	0.5	776	HS, PF, IB, CV
36	6.9	8.05	92.5	2.42	4256	21.5	28.8	698.2	12.5	2938	18.58	6.32	46	0.7	683	—
37	7.3	4.5	45.7	0.46	758	16	28	672.8	15.7	604.5	0.7	1	40	0.1	196	HS, IB
38	6.9	5.73	63.9	2.84	4736	19.8	30	695.4	24.2	3412.5	1.43	1.82	40.1	0.6	727	—
39	8.3	2.69	27.6	0.46	779	16.9	23.1	655.5	-38	598	1	-0.51	50.6	2	1238	IB
40	6.9	4.22	54.5	0.5	1086	28.6	30.1	701.7	-44.7	663	7.15	0.45	45.3	1	643	LI
41	6.9	11.15	149	0.74	1640	30.3	33.5	715.2	140.7	968.5	41.56	9.45	37.2	0	471	HI, PU, PKr, PCn
42	7.2	4.88	55	0.48	902	21.2	30.6	676.7	-34.9	630.5	0.86	1.06	41	1	943	HS
43	7.9	6.6	78.3	0.3	595	23.7	32.2	660.9	-35.5	396.5	2.1	2.75	39	0	1153	HI, PO
44	7.5	8.53	104.5	0.56	1154	25.5	33.4	691	-19.8	741	1	4.03	54.2	0.4	767	HS
45	6.9	5.9	68.7	0.33	647	22.5	29	700.1	-35.8	442	1.03	2.1	42	0.4	648	HS, PO, II, CV, LI, DS
46	8.7	5.79	68.9	0.15	306.5	23.8	25	658.1	-44.6	204.1	2.64	1.99	42	2.4	1189	HH, PU
47	6.9	6.9	70.1	0.41	683	16	28	667.2	-31.7	539.5	6.57	3.47	40	1.4	1067	—
48	6.9	5.82	71.2	0.36	734	25.4	25.6	675.5	-31.5	474.5	4.31	1.82	39	0.3	957	—
49	6.9	6.39	78.7	0.67	1370	25.7	28.1	687.9	-29.5	877.6	9.6	2.51	38.5	0.3	809	LI
50	6.9	7.26	79.9	0.23	437.5	20	22.5	660.7	-24.9	314.6	0.34	4.19	50.3	4.1	1172	PF, PV
51	8.2	5.56	64	0.22	433.7	22.1	22.6	671.9	-22.1	298.35	0.43	0.96	53.8	0.5	1012	HI

Appendix 1 (Continued)

Site	pH	DO	%DO	Salinity	EC	Tw	Ta	Atmp	ORP	TDS	Turbidity	BOD ₅	Moisture	Wind	Elevation	Species
52	6.9	4.87	59.1	0.22	452.5	25.1	20.3	681.2	-1.1	293.8	4.94	0.82	66.9	1.1	928	LI
53	6.9	5.13	61.5	0.2	406.2	24.4	20.7	675.5	-14.5	266.5	10.98	1.18	64	1.3	1001	ID, PVa, LI
54	6.9	7.3	77.7	0.39	687	17.7	30.2	667.2	2.1	520	0.93	3.05	57.4	0.3	1105	HS, PA
55	6.9	5.88	65.5	0.46	853	20.4	24.2	687.5	-6.6	611	8.13	2.03	51.5	0.3	853	HS, IB, HIn, PA
56	6.6	3.19	41.7	11.56	20460	25.7	28.2	698.3	-143	13091	13.2	2.53	46.3	0	712	HS
57	6.6	6.61	84	0.78	1636	27.3	30.5	687.5	-55.4	1053	7.84	2.68	43	0	786	IG, PZ
58	8.5	5.25	64.7	2.35	4425	25.2	26.6	695.4	-47.7	2866.5	6.71	1.67	41.5	0.6	742	_
59	7.8	7.96	78	0.32	525	14.4	26	671.8	-48.6	429	0.44	3.92	46.8	1	1038	_
60	7.1	5.28	66.3	1.47	2928	26.7	32.6	692.4	-32.2	1852.5	16.67	3.18	43	0.5	770	HS
61	6.6	6.16	75.4	0.73	1476	25.1	31.9	690.7	-59.8	955.5	4.87	0	40.3	0.3	789	IB, PZ, TYr
62	6.6	6.8	75.7	0.57	1051	20.5	31.8	688.8	-45.7	747.5	3.28	2.67	40.1	0.5	802	IB, PZ
63	7.6	7.28	79	0.86	1510	19.3	33.7	686.5	-90.4	1105	5.07	3.26	47.4	0	830	IB, PZ
64	7.9	7.52	103	0.9	2029	31.8	33	683.6	10.1	0	1.76	2.76	36.1	0	863	_
65	8	6.79	76.9	0.22	435	21.6	31	662.2	-55.1	302.25	1.33	3.15	43	0.2	1140	HI, HS, PA
66	7.6	6.65	66.2	0.34	557	14.8	25.4	679.5	-22.5	448.5	1.81	2.65	60	0.5	977	HS, PO, IB, PZ
67	8.4	5.32	65	0.67	1367	25.6	27.5	678.6	-22.3	877.5	1.22	4.1	51.3	0.3	962	_
68	7.4	6.55	71.5	0.42	766	19.5	25.9	682.8	-33.8	559	1.51	2.01	51.4	0	907	HI, HS

Appendix 1 (Continued)

Site	pH	DO	%DO	Salinity	EC	Tw	Ta	Atmp	ORP	TDS	Turbidity	BOD ₅	Moisture	Wind	Elevation	Species
69	9	10.7	122.4	0.51	965	22.2	28.4	683.6	-34	663	137.56	10.48	49	0	897	HS, IM, PZ, TC
70	7.4	0.69	7.4	0.53	934	18.5	28.5	683.7	-220	695.5	4.97	0.19	52.4	0	894	IB, PZ, PKr
71	7.7	7.84	101.9	0.26	588	28.9	31.2	683.8	-63.1	357.5	2.95	3.57	43	0.5	885	_
72	7.1	3.35	38	0.48	906	21.5	31	676.5	-60	630.5	2.13	-0.3	42.1	0.3	972	PO
73	8.4	4.79	68.7	0.24	509	23.1	33.4	687	-60	325	2.83	0.82	46.6	0	1057	IG, LI
74	7.7	6.13	64	0.29	503	17.4	31.8	678.8	-66.4	383.5	2.83	1.97	44.5	0	940	IB
75	7.4	3.24	31.2	0.33	530	13.4	33.8	670.1	-49	442	0.6	-0.23	39	0	1045	HS, IB, PZ
76	8.4	2.86	39	0.47	1092	31.9	32.7	681.7	276.3	630.6	3.18	-0.46	40.8	1	897	HI, HS, PZ, CV, Psa
77	7.8	5.6	66.4	0.71	1381	23.7	33.7	686.1	95.5	923	5.94	1.34	38.1	0	839	PZ
78	7.9	6.17	74.1	0.63	1243	24.4	31	685.3	-70	819	3.01	1.73	45	0.3	854	HS
79	7.8	4.09	49.7	0.56	1134	24.9	29.6	686.2	-97.4	734.5	19.75	1.07	47.5	0	841	II, PZ, HC
80	7.4	5.29	63.3	0.53	1063	24.3	27.1	684	-58.2	702	9.56	1.4	48.1	0.4	874	HS, IB
81	7.5	6.42	76.1	0.31	625	23.6	25	678.6	-50.4	416	5.75	2.98	49	0.4	949	_
82	7.2	6.04	66.5	0.41	763	20.2	23.1	676.3	-41.8	546	4.6	2.21	59	0	951	HI
83	7.9	7.63	82.2	0.39	673	17.5	18.1	679.8	-10	513.5	6.16	3	70.4	0.6	936	II, PZ, CO
84	7.4	7.9	83	0.32	561	17.8	21	678.9	-1.9	422.5	1.18	3.67	71	3.2	943	HI, HS, IB, HIn
85	7.3	5.11	51.8	0.34	661	15.3	25.3	664.7	-4.1	448.5	1.02	1.41	59.4	0.6	1111	HS, IB, PZ, PV

Appendix 1 (Continued)

Site	pH	DO	%DO	Salinity	EC	Tw	Ta	Atmp	ORP	TDS	Turbidity	BOD ₅	Moisture	Wind	Elevation	Species
86	7.8	5.42	60	0.25	475.5	20.3	25	657.7	-10.4	339.95	28.11	1.47	57.2	0	1210	IB, PZ, NN
87	7.7	4.76	57	0.15	306.2	24.3	27	656.8	-40	201.5	2.74	0.71	52.8	0.8	1209	CV, LI
88	7.3	8.2	75.9	0.28	434	11.8	28.6	651	-37.8	378.3	1.31	3.77	48.6	0.3	1285	PO, IB, PZ
89	6.6	5.97	62.9	0.35	608	17.7	27.3	673.1	-32.5	461.5	10.27	1.95	46.5	1.2	997	PFa, NN, PKr
90	7.7	9.12	90.8	0.35	581	15.1	26.1	648.4	-29.1	468	2.29	4.51	48.9	2.3	1310	PO, PZ, PV, PS
91	8.1	4.91	62.5	0.17	376.9	27.8	27	661.6	-36.1	232.7	9.2	0.88	50.1	0.3	1134	—
92	8	5.07	62.5	0.28	588	25.8	29.4	667.4	-36.1	377	13.69	1.05	47	0.3	1058	IB, PZ, LI
93	8.4	5.27	67	0.35	749	27.6	24.2	669.8	-60.1	461.5	448.56	5.08	60	1.2	1035	HS, IG, PZ, LI, CP, TC
94	7.4	7.7	72.4	0.31	469.8	11.9	29.4	652.5	-36.7	406.9	0.98	3.42	49	0	1256	—
95	6.6	3.42	32.5	0.33	506	12.1	24.7	643.6	-34.2	435.5	1.05	0	47.2	0.3	1373	PO
96	7.6	4.43	51.8	0.2	403.6	23.1	21.4	660.1	-32.9	272.35	145.1	1.71	60.9	0.6	1155	HI, IG, PZ, HC, CP
97	7.4	6.6	73	0.39	714	20.1	20	663.6	-17.8	513.5	1.83	2.54	58	3.8	1100	HI, HS, PO, NN, EUc
98	7.2	5.73	61.8	0.4	710	18.8	25.5	672.4	-10.7	520	1.03	1.54	51.2	0	1005	HS, IB, PZ
99	7.5	4.43	67.2	0.33	575	17.4	20.9	669.2	-8.9	435.5	0.85	0.33	55.8	0.3	1041	HS, IB, PA
100	7.1	4	44.1	0.3	553	20	19.1	666.3	-7.8	396.5	2.05	0.15	55.7	0.3	1081	HI, HS, PV
101	7.7	4.25	42.4	0.41	660	15.1	24.6	690.7	-9.4	533	6.61	0.85	55.2	0.6	764	IB, PZ, PSa
102	7.3	4.3	48.7	0.4	764	21.4	25	688.8	-7.9	533	4.6	-0.06	49	1.7	799	HI, HS, HH

Appendix 1 (Continued)

Site	pH	DO	%DO	Salinity	EC	Tw	Ta	Atmp	ORP	TDS	Turbidity	BOD ₅	Moisture	Wind	Elevation	Species
103	7.2	4.68	45.6	0.5	800	14	25.4	677.6	-22.3	656.5	1	0.48	50.7	0.5	950	HI, HS
104	7.1	4.73	51.3	0.37	668	19	24.8	672.8	-20	494	19.48	1.89	50.5	0	1006	IB, PV
105	7.1	7.78	88.4	0.7	1297	21.5	25	659.9	-15.7	903.5	2.73	2.98	42	0.3	1171	HI, HS
106	7.1	5.45	59.1	0.4	727	19.1	25.3	666.5	511.6	533	106.6	1.19	40.6	0.8	1081	HS, PV
107	7.7	6.04	79	0.34	755	29.2	27.3	681.2	56	455	10.61	1.49	56	0.3	900	—
108	7.7	6.15	63.8	0.11	189.3	17.2	27	670.9	-9.8	144.95	11.81	1.57	60.4	0.4	1030	PO, IB, NN
109	7.5	7.56	87.5	0.43	824	22.4	28	670.7	14.2	565.5	5	2.2	47.1	0.4	1043	PO, IB, PZ
110	6.9	6.15	70.9	0.18	349	22.4	26	685.1	58.6	238.55	3.87	1.37	43.5	0	845	HS, PF, IB, CV, HIn
111	8.4	12.6	150	0.34	695	24.1	28	681.9	-0.6	461.5	6.38	6.72	43	0	895	IB, PZ
112	8.5	5.43	66.5	0.39	809	25.5	27.8	680.9	-16.7	520	5.52	1.14	41.3	0	909	LI
113	7.6	6.7	65	0.4	639	13.9	29.3	687.6	-21.9	526.5	3.53	2.4	46.6	0	815	IB, PZ, NN
114	8.1	9.61	118.8	0.23	483	26.1	31.4	687.7	-19.6	307.45	1.22	4	44.3	0	806	HS, PO, IB
115	7.3	6.86	81.2	0.35	708	23.7	28.1	670.7	-0.5	474.5	1.03	2.1	47.7	0	1026	HS, IB, CV, HB
116	8.4	5.52	63.4	0.52	988	22.1	25.8	675.4	-70.1	682.5	7.43	1.42	46.1	0	988	HS, IG
117	7.2	4.85	49.1	0.44	740	15.9	23.6	678.5	-13.2	585	5.43	0.7	55.5	0.6	938	HI
118	7.5	5.83	59	0.36	603	15.8	20.4	673.3	-0.7	474.5	1.26	0	57	0	995	PF

Appendix 2 Water Ion Concentrations Values in Eskişehir. Abbreviations: Site, Sampling Site; NO₂-N, Nitrite Nitrogen; NO₃-N, Nitrate Nitrogen; Tot N, Total Nitrogen; Kj N, Kjendahl Nitrogen; PO₄-P, Phosphorus phosphate; Tot P, Total Phosphorus; Ca⁺², Calcium; Mg⁺², Magnesium; Tot Hrd, Total Hardness; NO₂, Nitrite; NO₃, Nitrate; PO₄, Phosphate. Units: mg L⁻¹. CW, *Candona weltneri*; CO, *Cypria ophtalmica*; CV, *Cypridopsis vidua*; CP, *Cypris pubera*; DS, *Darwinula stevensoni*; EUc, *Eucypris dorlionensis*; FF, *Fabaeformiscandona fabaeformis*; HB, *Herpetocypris brevicaudata*; HC, *H. chevreuxi*; HH, *H. helenae*; HIn, *H. intermedia*; HI, *Heterocypris incongruens*; HS, *H. salina*; IB, *Ilyocypris bradyi*; ID, *I. decipiens*; IG, *I. gibba*; II, *I. inermis*; IM, *I. monstifica*; IBe, *Isocypris beauchampi*; LI, *Limnocythere inopinata*; NN, *Neglecandona neglecta*; PKr, *Physocypris kraepelini*; PCn, *Plesiocypridopsis newtoni*; PA, *Potamocypris arcuata*; PFa, *P. fallax*; PP, *P. pallida*; PS, *P. similis*; PU, *P. unicaudata*; PVa, *P. variegata*; PV, *P. villosa*; PZ, *Prionocypris zenkeri*; PSa, *Pseudocandona albicans*; PF, *Psychrodromus fontinalis*; PO, *P. olivaceus*; TC, *Trajancypris clavata*; TYr, *Tyrrhenocythere amnicola*.

Appendix 2 (Continued)

Site	NO ₂ -N	NO ₃ -N	Tot N	Kj N	PO ₄ -P	Tot P	Ca ⁺²	Mg ⁺²	Tot Hrd	NO ₂	NO ₃	PO ₄	Species
1	0.001	1.433	12.1900	4.4087	0.031	0.1012	156.31	24.3	430.1	0.0044	6.3426	0.0939	HI, PO, PP
2	0.080	1.659	13.3406	3.9934	0.563	1.1602	192.38	114.3	668.4	0.2631	7.3448	1.7276	_
3	0.037	0.955	8.1687	2.8311	0.454	0.9737	300.60	17.0	778.1	0.1208	4.2255	1.3906	_
4	0.009	0.335	6.7306	4.8746	0.057	0.2145	156.31	45.0	464.1	0.0284	1.4837	0.1756	_
5	0.008	0.400	6.0017	3.8010	0.041	0.2011	136.27	58.4	436.2	0.0248	1.7688	0.1246	HI, HS, IB, PZ
6	0.002	3.348	22.5824	4.4026	0.650	1.4599	156.31	85.1	530.3	0.0081	14.8211	1.9930	_
7	0.007	0.575	7.1990	4.0486	0.027	0.1146	150.30	85.1	515.3	0.0229	2.5455	0.0837	HI
8	0.010	0.981	9.9072	4.5393	0.151	0.3810	196.39	14.6	514.0	0.0340	4.3425	0.4615	PO
9	0.007	0.415	7.4642	5.1821	0.024	0.1345	98.20	45.0	319.1	0.0229	1.8371	0.0735	PZ, CV, CP
10	0.008	3.056	21.6199	5.0014	0.027	0.0613	104.21	28.0	306.1	0.0266	13.5278	0.0837	PO
11	0.009	1.191	10.5370	4.0370	0.031	0.0613	159.92	13.6	421.4	0.0303	5.2700	0.0939	HS
12	0.007	0.385	5.9915	3.8710	0.011	0.0213	83.77	47.7	287.6	0.0229	1.7054	0.0327	HI
13	0.045	0.801	9.7392	5.1987	0.254	0.5475	120.24	57.2	394.2	0.1485	3.5457	0.7780	HI
14	0.009	1.150	10.7599	4.4821	0.017	0.0413	96.19	186.0	546.6	0.0303	5.0888	0.0531	HS, IG
15	0.017	0.815	10.2571	5.7647	0.427	1.0003	114.23	80.3	417.3	0.0543	3.6068	1.3089	CV, CP, PCn, IBe
16	0.033	0.798	13.8380	9.3648	0.337	0.8072	94.19	75.4	359.2	0.1097	3.5321	1.0333	_
17	0.009	0.350	5.8040	3.8678	0.800	1.7862	108.22	141.1	502.5	0.0303	1.5471	2.4525	IG, FF, PSa

Appendix 2 (Continued)

Site	NO ₂ -N	NO ₃ -N	Tot N	Kj N	PO ₄ -P	Tot P	Ca ⁺²	Mg ⁺²	Tot Hrd	NO ₂	NO ₃	PO ₄	Species
18	0.055	1.324	25.9335	18.5162	0.640	1.5398	144.29	116.7	552.4	0.1799	5.8590	1.9624	_
19	0.012	1.549	12.5909	4.1353	0.061	0.2877	144.29	38.9	424.1	0.0395	6.8554	0.1858	_
20	0.015	2.442	17.1999	3.8813	0.047	0.1479	72.14	77.8	308.3	0.0506	10.8104	0.1450	HI, PO, HC
21	0.006	2.046	17.0677	5.9401	0.021	0.0679	90.18	66.9	335.2	0.0211	9.0547	0.0633	_
22	0.009	1.756	16.1268	6.5572	0.180	0.4542	106.21	79.0	395.3	0.0303	7.7738	0.5534	HS, PO, PF, IB
23	0.008	6.562	41.0686	5.4267	0.087	0.2078	52.10	102.1	298.3	0.0248	29.0476	0.2675	HI, HS, PZ
24	0.014	0.338	7.1435	5.2528	0.054	0.2078	46.09	18.2	145.1	0.0451	1.4943	0.1654	IG
25	0.009	0.309	6.5963	4.8822	0.024	0.0746	92.18	24.3	270.1	0.0303	1.3659	0.0735	IG, PZ
26	0.014	1.160	11.3717	5.0182	0.107	0.2744	150.30	42.6	445.1	0.0451	5.1348	0.3288	PO, II
27	0.010	0.553	6.5250	3.4794	0.054	0.1279	34.07	193.3	403.6	0.0340	2.4482	0.1654	PO, PF, II
28	0.010	0.486	7.3489	4.6669	0.087	0.1945	22.04	195.8	377.6	0.0340	2.1517	0.2675	PO
29	0.009	0.812	12.8434	8.4025	0.427	1.3067	158.32	249.3	805.8	0.0284	3.5922	1.3089	_
30	0.009	0.495	7.8981	5.1737	0.044	0.1079	128.26	133.8	540.4	0.0284	2.1921	0.1348	_
31	0.022	0.459	6.5899	4.0021	0.054	0.1345	84.17	4.9	218.0	0.0728	2.0335	0.1654	PO, PF, CW, NN
32	0.011	0.411	6.2651	3.9882	0.084	0.1945	130.26	57.2	419.2	0.0377	1.8172	0.2573	PO, IB, PZ, PP
33	0.008	0.441	20.4917	18.0689	0.041	0.2344	36.07	60.8	190.2	0.0248	1.9500	0.1246	_
34	0.008	1.601	14.7566	6.0339	0.031	0.0679	126.25	125.2	521.4	0.0266	7.0870	0.0939	HS, PO, IB, HH

Appendix 2 (Continued)

Site	NO ₂ -N	NO ₃ -N	Tot N	Kj N	PO ₄ -P	Tot P	Ca ⁺²	Mg ⁺²	Tot Hrd	NO ₂	NO ₃	PO ₄	Species
35	0.012	2.025	18.3547	7.3142	0.064	0.1678	104.21	141.1	492.5	0.0395	8.9639	0.1960	HS, PF, IB, CV
36	0.010	2.117	19.6894	8.1617	0.324	1.1335	136.27	133.8	560.4	0.0321	9.3692	0.9924	_
37	0.009	3.066	27.7447	11.0709	0.024	0.0480	126.25	76.6	441.3	0.0284	13.5709	0.0735	HS, IB
38	0.008	4.070	28.9003	6.7795	0.017	0.0213	250.50	173.9	911.6	0.0248	18.0181	0.0531	_
39	0.008	0.154	9.5447	8.6751	0.037	0.0813	50.10	103.4	295.3	0.0248	0.6830	0.1144	IB
40	0.010	0.058	3.7823	3.4236	0.034	0.1146	28.06	133.8	290.4	0.0321	0.2583	0.1041	LI
41	0.011	1.030	12.3511	6.7115	0.310	1.3933	138.28	86.3	487.3	0.0377	4.5603	0.9516	HI, PU, PKr, PCn
42	0.011	0.128	3.8954	3.1500	0.054	0.1678	186.37	93.6	619.3	0.0377	0.5680	0.1654	HS
43	0.011	0.136	3.7449	2.9589	0.021	0.0879	148.30	73.0	490.2	0.0358	0.6030	0.0633	HI, PO
44	0.036	3.777	34.9521	14.2994	0.054	0.1945	270.54	28.0	721.1	0.1190	16.7203	0.1654	HS
45	0.015	1.122	11.4109	5.2568	0.051	0.1412	178.36	232.3	827.8	0.0488	4.9681	0.1552	HS, PO, II, CV, LI, DS
46	0.056	0.201	4.8603	3.5283	0.041	0.0946	46.09	10.9	133.0	0.1855	0.8892	0.1246	HH, PU
47	0.029	1.823	14.6863	4.6708	0.194	0.5741	120.24	111.9	484.4	0.0950	8.0688	0.5942	_
48	0.018	0.793	8.1786	3.8020	0.084	0.2145	44.09	138.6	338.5	0.0580	3.5084	0.2573	_
49	0.014	0.168	5.2364	4.2649	0.061	0.1345	22.04	302.8	554.0	0.0469	0.7425	0.1858	LI
50	0.024	2.279	17.0223	4.5496	0.047	0.0613	144.29	17.0	388.1	0.0802	10.0889	0.1450	PF, PV
51	0.036	1.658	14.4930	5.3431	0.031	0.0413	38.08	76.6	221.3	0.1190	7.3372	0.0939	HI

Appendix 2 (Continued)

Site	NO ₂ -N	NO ₃ -N	Tot N	Kj N	PO ₄ -P	Tot P	Ca ⁺²	Mg ⁺²	Tot Hrd	NO ₂	NO ₃	PO ₄	Species
52	0.016	1.768	14.2717	4.6102	0.017	0.0213	106.21	30.4	315.1	0.0525	7.8252	0.0531	LI
53	0.014	0.094	6.2337	5.6609	0.121	0.2544	80.16	29.2	248.1	0.0469	0.4173	0.3696	ID, PVa, LI
54	0.014	15.491	85.1507	1.0286	0.031	0.0413	152.30	51.1	464.2	0.0451	68.5724	0.0939	HS, PA
55	0.001	1.182	10.9498	4.5313	0.074	0.2211	166.33	71.7	533.2	0.0044	5.2310	0.2267	HS, IB, HIn, PA
56	0.008	1.445	14.3598	6.4840	0.224	0.5741	881.76	3064.3	7250.1	0.0248	6.3982	0.6861	HS
57	0.002	1.194	9.8849	3.3981	0.087	0.1479	136.27	184.8	644.6	0.0063	5.2848	0.2675	IG, PZ
58	0.008	1.280	9.9544	2.9756	0.057	0.1545	274.55	441.4	1412.5	0.0248	5.6664	0.1756	—
59	0.017	1.345	11.2429	3.8757	0.024	0.0413	156.31	24.3	430.1	0.0543	5.9518	0.0735	—
60	0.014	1.209	10.3242	3.7010	0.737	1.9394	302.60	439.0	1478.4	0.0469	5.3528	2.2585	HS
61	0.003	1.547	10.1863	1.7760	0.014	0.0413	222.44	142.3	789.5	0.0100	6.8499	0.0429	IB, PZ, TYr
62	0.014	2.404	15.1324	2.0295	0.031	0.0346	222.44	81.5	689.3	0.0451	10.6404	0.0939	IB, PZ
63	0.005	8.115	48.8004	4.7390	0.007	0.0813	24.05	362.4	657.2	0.0174	35.9234	0.0225	IB, PZ
64	0.006	20.568	114.3415	2.7001	0.074	0.1412	252.50	165.4	902.5	0.0211	91.0462	0.2267	—
65	0.002	1.964	13.2926	2.6283	0.024	0.0413	108.22	31.6	322.1	0.0063	8.6924	0.0735	HI, HS, PA
66	0.001	4.402	27.5001	3.6073	0.024	0.0280	72.14	136.2	404.4	0.0026	19.4872	0.0735	HS, PO, IB, PZ
67	0.013	0.234	11.2913	9.9680	0.567	3.5511	70.14	113.1	361.4	0.0414	1.0354	1.7378	—
68	0.001	5.024	30.7334	3.4622	0.021	0.1412	150.30	71.7	493.2	0.0044	22.2411	0.0633	HI, HS

Appendix 2 (Continued)

Site	NO ₂ -N	NO ₃ -N	Tot N	Kj N	PO ₄ -P	Tot P	Ca ⁺²	Mg ⁺²	Tot Hrd	NO ₂	NO ₃	PO ₄	Species
69	0.021	0.431	14.7639	12.3339	1.160	5.4359	160.32	73.0	520.2	0.0691	1.9087	3.5552	HS, IM, PZ, TC
70	0.003	0.170	9.3422	8.4067	0.513	1.3134	188.38	153.2	722.5	0.0100	0.7525	1.5744	IB, PZ, PKr
71	0.002	1.776	13.0518	3.4033	0.047	0.1279	94.59	64.2	341.8	0.0063	7.8639	0.1450	—
72	0.002	2.904	67.1050	51.3368	0.007	0.1612	238.48	30.4	645.1	0.0081	12.8538	0.0225	PO
73	0.005	0.161	7.8383	6.9446	0.021	0.0413	154.31	66.9	495.2	0.0155	0.7125	0.0633	IG, LI
74	0.006	2.155	19.5878	7.8704	0.044	0.0679	140.28	121.6	550.4	0.0192	9.5377	0.1348	IB
75	0.032	3.374	23.7846	5.3393	0.051	0.0813	146.29	59.6	463.2	0.1060	14.9335	0.1552	HS, IB, PZ
76	0.004	2.527	20.1117	6.3789	0.041	0.1678	108.22	87.6	414.3	0.0137	11.1876	0.1246	HI, HS, PZ, CV, Psa
77	0.001	1.767	14.7861	5.1960	0.017	0.0280	168.34	214.0	772.7	0.0026	7.8201	0.0531	PZ
78	0.001	1.194	22.4803	16.0002	0.024	0.1279	242.48	103.4	775.3	0.0026	5.2832	0.0735	HS
79	0.004	1.895	21.7965	11.4926	0.330	0.6807	328.66	94.8	976.3	0.0137	8.3906	1.0128	II, PZ, HC
80	0.004	1.183	16.1810	9.7439	0.047	0.1212	218.44	83.9	683.3	0.0118	5.2383	0.1450	HS, IB
81	0.001	1.498	13.6540	5.5193	0.031	0.1345	160.32	24.3	440.1	0.0026	6.6330	0.0939	—
82	0.001	28.820	161.7842	5.3819	0.037	0.1279	180.36	48.6	530.2	0.0044	127.5764	0.1144	HI
83	0.004	2.105	17.2136	5.7727	0.107	0.2078	90.18	98.5	387.3	0.0118	9.3200	0.3288	II, PZ, CO
84	0.001	8.786	53.7050	6.0189	0.027	0.0413	118.24	45.0	369.1	0.0044	38.8940	0.0837	HI, HS, IB, HIn
85	0.005	4.506	32.9349	8.4582	0.054	0.0946	142.28	25.5	397.1	0.0174	19.9478	0.1654	HS, IB, PZ, PV

Appendix 2 (Continued)

Site	NO ₂ -N	NO ₃ -N	Tot N	Kj N	PO ₄ -P	Tot P	Ca ⁺²	Mg ⁺²	Tot Hrd	NO ₂	NO ₃	PO ₄	Species
86	0.035	0.836	9.4204	4.7331	0.064	0.2744	140.28	38.9	414.1	0.1134	3.7028	0.1960	IB, PZ, NN
87	0.005	0.337	7.4066	5.5560	0.027	0.0280	118.24	1.2	297.0	0.0155	1.4931	0.0837	CV, LI
88	0.002	0.961	27.0201	21.797	0.061	0.1012	140.28	34.0	406.1	0.0063	4.2538	0.1858	PO, IB, PZ
89	0.010	3.128	40.5689	23.553	0.067	0.1479	132.26	68.1	442.2	0.0321	13.8459	0.2062	PFa, NN, PKr
90	0.004	7.359	42.5620	2.6134	0.024	0.0280	160.32	46.2	476.2	0.0118	32.5745	0.0735	PO, PZ, PV, PS
91	0.007	0.173	17.8747	16.904	0.071	0.1678	92.18	19.5	262.1	0.0229	0.7676	0.2165	—
92	0.006	0.527	23.5693	20.684	0.067	0.2011	116.23	36.5	350.1	0.0211	2.3312	0.2062	IB, PZ, LI
93	0.057	0.109	6.5663	5.7323	1.609	4.4369	110.22	288.2	749.9	0.1873	0.4809	4.9335	HS, IG, PZ, LI, CP, TC
94	0.005	4.260	29.9167	6.7757	0.044	0.1479	188.38	12.2	490.0	0.0174	18.8582	0.1348	—
95	0.026	6.363	39.4760	4.8360	0.151	0.2145	106.21	74.2	387.2	0.0857	28.1655	0.4615	PO
96	0.055	0.448	15.6136	12.944	0.147	0.5741	110.22	37.7	337.1	0.1818	1.9845	0.4513	HI, IG, PZ, HC, CP
97	0.015	2.869	22.2117	6.5773	0.064	0.0813	182.36	76.6	581.3	0.0488	12.7015	0.1960	HI, HS, PO, NN, EUc
98	0.006	5.343	36.7883	7.7675	0.037	0.0679	142.28	62.0	457.2	0.0211	23.6505	0.1144	HS, IB, PZ
99	0.015	7.692	46.6303	4.8213	0.067	0.1279	138.28	47.4	423.2	0.0506	34.0508	0.2062	HS, IB, PA
100	0.004	3.751	27.3827	7.0108	0.067	0.1678	128.26	41.3	388.1	0.0118	16.6053	0.2062	HI, HS, PV
101	0.005	1.759	17.9981	8.4325	0.240	0.5208	88.18	92.4	372.3	0.0155	7.7864	0.7372	IB, PZ, PSa
102	0.003	1.066	11.6386	5.8389	0.037	0.1146	140.28	68.1	462.2	0.0100	4.7204	0.1144	HI, HS, HH

Appendix 2 (Continued)

Site	NO ₂ -N	NO ₃ -N	Tot N	Kj N	PO ₄ -P	Tot P	Ca ⁺²	Mg ⁺²	Tot Hrd	NO ₂	NO ₃	PO ₄	Species
103	0.003	11.059	75.4330	15.4087	0.141	0.3210	240.48	26.8	644.1	0.0100	48.9526	0.4309	HI, HS
104	0.009	11.097	68.8989	8.6419	0.217	0.5275	150.30	88.8	521.3	0.0284	49.1229	0.6657	IB, PV
105	0.019	11.263	72.4599	11.2575	0.317	0.6740	234.47	127.7	795.4	0.0617	49.8586	0.9720	HI, HS
106	0.005	2.600	16.7069	2.5767	0.077	0.1612	218.44	30.4	595.1	0.0174	11.5079	0.2369	HS, PV
107	0.006	0.383	7.4508	5.3429	0.114	0.3410	118.24	57.2	389.2	0.0211	1.6970	0.3492	_
108	0.008	0.198	4.4683	3.3592	0.057	0.1612	40.08	7.3	112.0	0.0266	0.8764	0.1756	PO, IB, NN
109	0.005	0.296	5.1882	3.5575	0.047	0.1079	200.40	65.7	608.2	0.0174	1.3117	0.1450	PO, IB, PZ
110	0.009	1.788	14.5398	4.7992	0.074	0.1545	50.10	40.1	191.1	0.0284	7.9153	0.2267	HS, PF, IB, CV, HIn
111	0.008	0.217	4.3298	3.1204	0.054	0.1412	106.21	71.7	383.2	0.0248	0.9602	0.1654	IB, PZ
112	0.008	0.393	8.3242	6.1585	0.037	0.1146	40.08	148.4	344.5	0.0266	1.7383	0.1144	LI
113	0.006	0.777	10.2200	5.9785	0.284	0.6007	92.18	102.1	398.3	0.0192	3.4395	0.8699	IB, PZ, NN
114	0.004	1.793	13.7557	4.0094	0.051	0.1545	64.13	58.4	256.2	0.0118	7.9377	0.1552	HS, PO, IB
115	0.009	0.363	6.0627	4.0572	0.041	0.2145	220.44	29.2	598.1	0.0284	1.6057	0.1246	HS, IB, CV, HB
116	0.009	0.362	6.8152	4.8103	0.061	0.1279	38.08	220.1	457.7	0.0303	1.6032	0.1858	HS, IG
117	0.007	6.768	38.1929	1.4379	0.227	0.5275	76.15	133.8	410.4	0.0229	29.9576	0.6963	HI
118	0.005	6.109	33.9459	0.7766	0.024	0.0746	50.10	142.3	359.5	0.0155	27.0404	0.0735	PF

Appendix 3 Sampled sites habitat type and Coordinates in Eskişehir Province. Abbreviations: Site, Sampling site; Ht type, Habitat Type; CW, *Candona weltneri*; CO, *Cypria ophtalmica*; CV, *Cypridopsis vidua*; CP, *Cypris pubera*; DS, *Darwinula stevensoni*; EUc, *Eucypris dorlionensis*; FF, *Fabaeformiscandona fabaeformis*; HB, *Herpetocypris brevicaudata*; HC, *H. chevreuxi*; HH, *H. helenae*; HIn, *H. intermedia*; HI, *Heterocypris incongruens*; HS, *H. salina*; IB, *Ilyocypris bradyi*; ID, *I. decipiens*; IG, *I. gibba*; II, *I. inermis*; IM, *I. monstifica*; IBe, *Isocypris beauchampi*; LI, *Limnocythere inopinata*; NN, *Neglecandona neglecta*; PKr, *Physocypria kraepelini*; PCn, *Plesiocypridopsis newtoni*; PA, *Potamocypris arcuata*; PFa, *P. fallax*; PP, *P. pallida*; PS, *P. similis*; PU, *P. unicaudata*; PVa, *P. variegata*; PV, *P. villosa*; PZ, *Prionocypris zenkeri*; PSa, *Pseudocandona albicans*; PF, *Psychrodromus fontinalis*; PO, *P. olivaceus*; TC, *Trajancypris clavata*; TYr, *Tyrrhenocythere amnicola*.

Appendix 3 (Continued)

Site	Ht type	County name/Village name	Coordinate	Date/Time	Species
1	trough	Sarıcakaya/ Beyyayla village	N 40° 06' 57.9" E 030° 39' 37.7 "	11.07.2020/9:48	HI, PO, PP
2	river	Sarıcakaya/ İğdir village/Sakarya river	N 40° 02' 02.8" E 030° 37' 02.7"	11.07.2020/10:31	—
3	river	Sarıcakaya/ Kapıkaya village /Sakarya river	N 40° 03' 28.9" E 030° 44' 30.9"	11.07.2020/11:12	—
4	stream	Sarıcakaya/ Örencik village/ Çatak stream	N 40° 06' 28.1" E 030° 47' 19"	11.07.2020/11:41	—
5	stream	Sarıcakaya/ Düzköy village/ Sakarya river Çatak stream connection	N 40° 04' 43.2" E 030° 48' 42.8"	11.07.2020/12:12	HI, HS, IB, PZ
6	river	Mihalgazi/ Alpagut village/ Sakarya nehri	N 40° 01' 20.7" E 030° 30' 12.4"	11.07.2020/14:00	—
7	trough	Tepebaşı/ Avlamış road	N 40° 00' 00.6" E 030° 28' 59.7"	11.07.2020/14:29	HI
8	stream	Tepebaşı/ Karaçobanpınar village	N 39° 56' 00.5" E 030° 26' 21.5"	11.07.2020/15:04	PO
9	dam	Tepebaşı/ Keskin dam	N 39° 52' 31.8" E 030° 23' 35.8"	11.07.2020/15:54	PZ, CV, CP
10	trough	Tepebaşı/ Uludere village	N 39° 55' 01" E 030° 20' 04.4"	11.07.2020/16:31	PO

Appendix 3 (Continued)

Site	Ht type	County name/Village name	Coordinate	Date/Time	Species
11	trough	Tepebaşı/ Tekeçiler village	N 39° 57' 38.9" E 030° 29' 55.1"	11.07.2020/17:30	HS
12	trough	Tepebaşı/Muttalıp area	N 39° 54' 35.5" E 030° 33' 41.5"	11.07.2020/18:01	HI
13	canal	Tepebaşı/ Karadere canal	N 39° 50' 08.7" E 030° 35' 09"	11.07.2020/18:42	HI
14	trough	Tepebaşı/ Y.Danişment village	N 39° 51' 51.5" E 030° 43' 07.2"	11.07.2020/19:34	HS, IG
15	stream	Alpu/ Bahçecik village	N 39° 49' 08.8" E 030° 52' 24"	11.07.2020/20:35	CV, CP, PCn, IBe
16	canal	Tepebaşı/ Çavlum village	N 39° 47' 35.4" E 030° 42' 52.6"	12.07.2020/8:52	_
17	stream	Alpu	N 39° 46' 42.6" E 030° 00' 28.1"	12.07.2020/9:47	IG, FF, PSa
18	stream	Alpu/ Yeşilden village	N 39° 43' 32.6" E 031° 01' 54.6"	12.07.2020/10:16	_
19	dam	Beylikova/ Beylikahır dam	N 39° 40' 24.3" E 031° 04' 54.4"	12.07.2020/10:42	_
20	trough	Beylikova/ Emircik village	N 39° 42' 09.6" E 031° 15' 19.8"	12.07.2020/11:15	HI, PO, HC
21	trough	Beylikova/ Gökçeayva village	N 39° 48' 26.7" E 031° 20' 55.1"	12.07.2020/11:45	_
22	trough	Mihalıççık/ Korucu village	N 39° 50' 44.3" E 031° 23' 05.3"	12.07.2020/12:15	HS, PO, PF, IB

Appendix 3 (Continued)

Site	Ht type	County name/Village name	Coordinate	Date/Time	Species
23	trough	Beylikova/ Alpu/ Dođanođlu village	N 39° 49' 22.3" E 031° 13' 04.2"	12.07.2020/12:32	HI, HS, PZ
24	dam	Alpu/ Bůđdůz dam	N 39° 54' 10.1" E 031° 05' 57.1"	12.07.2020/13:24	IG
25	dam	Alpu/ Őzdenk dam	N 39° 55' 15.6" E 031° 01' 23.6"	12.07.2020/14:10	IG, PZ
26	stream	Alpu/ Őzdenk stream	N 39° 56' 40.2" E 030° 59' 20.8"	12.07.2020/14:35	PO, II
27	stream	Tepebaşı/ Taycılar village	N 39° 58' 29.4" E 030° 54' 47.7"	12.07.2020/14:56	PO, PF, II
28	trough	Alpu/ Alapınar village	N 40° 01' 30.4" E 030° 50' 46.4"	12.07.2020/15:21	PO
29	dam	Alpu/ Sakarıkarakacaören village/ Gökçekaya dam	N 40° 02' 01.3" E 030° 55' 52.4"	12.07.2020/16:17	—
30	trough	Alpu/ Belkese village	N 39° 59' 32.4" E 030° 57' 23.6"	12.07.2020/16:47	—
31	trough	Alpu/ Çeşnir village	N 39° 58' 54.1" E 031° 04' 53.9"	12.07.2020/17:16	PO, PF, CW, NN
32	stream	Mihaliççık/ Otluk village	N 40° 00' 18" E 031° 07' 37.6"	12.07.2020/17:56	PO, IB, PZ, PP
33	trough	Mihaliççık/ Yeşilyurt village	N 40° 00' 32.5" E 031° 11' 01.8"	12.07.2020/18:20	—
34	trough	Mihaliççık/ Çalkaya village	N 40° 02' 57.5" E 031° 15' 19.8"	12.07.2020/19:02	HS, PO, IB, HH

Appendix 3 (Continued)

Site	Ht type	County name/Village name	Coordinate	Date/Time	Species
35	stream	Sivrihisar/ Karadat village	N 39° 40' 12.3" E 031° 39' 29.3"	13.07.2020/8:27	HS, PF, IB, CV
36	stream	Sivrihisar/ Biçer village	N 39° 40' 17.1" E 031° 42' 19.2"	13.07.2020/8:54	_
37	trough	Mihaliççık/ Ahurözü village	N 39° 47' 10.7" E 031° 42' 52.9"	13.07.2020/9:39	HS, IB
38	stream	Mihaliççık/ Sarayköy village	N 39° 49' 32.9" E 031° 47' 51.4"	13.07.2020/10:07	_
39	trough	Mihaliççık/ Hamidiye village	N 39° 50' 09.8" E 031° 40' 15.8"	13.07.2020/11:10	IB
40	dam	Mihaliççık/ Bahtiyar dam	N 39° 56' 47.4" E 031° 39' 35.7"	13.07.2020/13:16	LI
41	dam	Mihaliççık/ Sarıyar dam	N 40° 00' 05" E 031° 38' 59.4"	13.07.2020/13:31	HI, PU, PKr, PCn
42	trough	Mihaliççık/ Çukurören village	N 39° 56' 00.9" E 031° 32' 31.7"	13.07.2020/14:33	HS
43	trough	Mihaliççık/ Obruk village	N 39° 56' 31.4" E 031° 27' 14.9"	13.07.2020/15:09	HI, PO
44	trough	Mihaliççık/ Dinek village	N 39° 58' 37.2" E 031° 22' 12.9"	13.07.2020/15:34	HS
45	stream	Mihaliççık/ Gürleyik waterfall	N 39° 59' 17.2" E 031° 20' 26.9"	13.07.2020/15:52	HS, PO, II, CV, LI, DS
46	pool	Alpu/ Ağaçhisar village	N 39° 55' 21.4" E 031° 08' 00.1"	13.07.2020/17:05	HH, PU
47	stream	Mihaliççık/ Kayı stream	N 39° 50' 44.5" E 031° 25' 04.1"	13.07.2020/17:49	_
48	dam	Mihaliççık/ Diközü dam	N 39° 48' 56.1" E 031° 30' 23.3"	13.07.2020/18:28	_
49	dam	Mihaliççık/ Ahırköyü dam	N 39° 46' 39.5" E 031° 32' 27.5"	13.07.2020/18:47	LI

Appendix 3 (Continued)

Site	Ht type	County name/Village name	Coordinate	Date/Time	Species
50	trough	Sivrihisar/ Dümrek village	N 39° 35' 11.7" E 031° 32' 32.4"	13.07.2020/20:10	PF, PV
51	trough	Sivrihisar/ Memik village	N 39° 33' 04.4" E 031° 33' 02.8"	13.07.2020/20:29	HI
52	dam	Sivrihisar/ Nasrettin hoca dam	N 39° 30' 33.7" E 031° 39' 52.2"	14.07.2020/08:09	LI
53	dam	Sivrihisar/ Koçaş dam	N 39° 26' 22.7" E 031° 41' 05.1"	14.07.2020/09:00	ID, PVa, LI
54	trough	Günyüzü/ Dutlu village	N 39° 23' 38.9" E 031° 42' 57.4"	14.07.2020/09:28	HS, PA
55	stream	Günyüzü/ Çardaközü stream	N 39° 26' 07" E 031° 46' 39.1"	14.07.2020/09:52	HS, IB, HIn, PA
56	dam	Günyüzü/ Kavuncu dam	N 39° 24' 43" E 031° 57' 17.2"	14.07.2020/10:26	HS
57	dam	Günyüzü/ Mercan dam	N 39° 22' 36.5" E 031° 52' 54.4"	14.07.2020/10:57	IG, PZ
58	pond	Günyüzü/ Gümüşyaka village	N 39° 20' 21.7" E 032° 00' 48.6"	14.07.2020/11:27	_
59	trough	Günyüzü/ Çotaya village	N 39° 17' 06.1" E 031° 50' 08.7"	14.07.2020/13:32	_
60	pond	Günyüzü/Taşlık village	N 39° 13' 28" E 031° 55' 20.4"	14.07.2020/13:24	HS
61	river	Sivrihisar/ İlyaspaşa village/ Sakarya river	N 39° 09' 50.7" E 031° 43' 31.3"	14.07.2020/14:06	IB, PZ, TYr
62	river	Sivrihisar/ Ahiler village/ Sakarya river	N 39° 11' 42.2" E 031° 37' 17.3"	14.07.2020/14:56	IB, PZ
63	river	Sivrihisar/ Sığircık village/ Sakarya river	N 39° 10' 03.6" E 031° 28' 21.7"	14.07.2020/15:30	IB, PZ

Appendix 3 (Continued)

Site	Ht type	County name/Village name	Coordinate	Date/Time	Species
64	trough	Sivrihisar/ Muttalip village	N 39° 19' 29.5" E 031° 28' 02.1"	14.07.2020/16:20	—
65	trough	Sivrihisar/ Karacaören village	N 39° 17' 48.7" E 031° 41' 54.3"	14.07.2020/17:01	HI, HS, PA
66	trough	Odunpazarı/ Türkmentokat village	N 39° 40' 53.5" E 030° 46' 55.3"	15.07.2020/10:42	HS, PO, IB, PZ
67	pond	Alpu/ Sarıkavak village	N 39° 39' 57.6" E 030° 55' 09"	15.07.2020/11:10	—
68	trough	Mahmudiye/ Tokathan village	N 39° 36' 44.9" E 030° 50' 42.5"	15.07.2020/11:35	HI, HS
69	pond	Mahmudiye/ Fahriye village	N 39° 36' 53.1" E 030° 56' 28.5"	15.07.2020/11:57	HS, IM, PZ, TC
70	stream	Mahmudiye/ Mesudiye village/ Seydi stream	N 30° 32' 30.1" E 030° 56' 59.4"	15.07.2020/12:23	IB, PZ, PKr
71	trough	Mahmudiye/ Kaymazyayla village	N 39° 29' 18" E 031° 06' 54.8"	15.07.2020/13:43	—
72	trough	Mahmudiye/ Balçıkhisar village	N 39° 35' 03.8" E 031° 06' 21.1"	15.07.2020/14:20	PO
73	dam	Beylikova/ Kaymaz dam	N 39° 32' 39.4" E 031° 13' 01"	15.07.2020/15:00	IG, LI
74	stream	Beylikova/ Okçu stream	N 39° 36' 31.3" E 031° 18' 03.2"	15.07.2020/15:41	IB
75	trough	Sivrihisar/ Karaburhan village	N 39° 33' 27.8" E 031° 22' 50.8"	15.07.2020/16:11	HS, IB, PZ
76	dam	Sivrihisar/ Bahçecik dam	N 39° 25' 16.2" E 031° 25' 16.2"	15.07.2020/16:58	HI, HS, PZ, CV, Psa
77	river	Sivrihisar/ Aktaş village	N 39° 19' 11.9" E 031° 20' 11.7"	15.07.2020/17:41	PZ

Appendix 3 (Continued)

Site	Ht type	County name/Village name	Coordinate	Date/Time	Species
78	river	Çifteler/ Körhasan village/ Sakarya river	N 39° 23' 23.6" E 031° 11' 52.6"	15.07.2020/18:08	HS
79	river	Çifteler/ Ortaköy village	N 39° 16' 07.4" E 031° 15' 50.6"	15.07.2020/18:41	II, PZ, HC
80	river	Çifteler/ Sadıroğlu village	N 39° 17' 29.2" E 031° 09' 43.5"	15.07.2020/19:13	HS, IB
81	trough	Çifteler/ Dikilikaya village	N 39° 12' 10" E 031° 05' 05.5"	15.07.2020/19:36	_
82	trough	Çifteler/ Çatmapınar village	N 39° 13' 25" E 030° 57' 58.5"	15.07.2020/20:20	HI
83	stream	Seyitgazi/ Yazıdere village/ Seydi stream	N 39° 29' 37.1" E 030° 44' 05.9"	16.07.2020/08:14	II, PZ, CO
84	trough	Seyitgazi/ Gümüşbel village	N 39° 26' 24.7" E 030° 48' 37.3"	16.07.2020/09:25	HI, HS, IB, HIn
85	trough	Han/ Gökçekuyu village	N 39° 14' 43.6" E 030° 49' 48.6"	16.07.2020/10:41	HS, IB, PZ, PV
86	stream	Han/ Kayı village	N 39° 12' 48.5" E 030° 45' 37.9"	16.07.2020/11:14	IB, PZ, NN
87	dam	Han/ Üççam dam	N 39° 08' 43.9" E 030° 51' 53.6"	16.07.2020/12:12	CV, LI
88	trough	Han/ Akhisar village	N 39° 05' 42.6" E 030° 42' 43.4"	16.07.2020/12:48	PO, IB, PZ
89	stream	Seyitgazi/ Bardakçı stream	N 39° 21' 17.3" E 030° 47' 07.7"	16.07.2020/13:50	PFa, NN, PKr
90	trough	Seyitgazi/ Şükranlı village	N 39° 16' 32.1" E 030° 40' 35.5"	16.07.2020/14:43	PO, PZ, PV, PS
91	dam	Seyitgazi/ Yapıldak dam	N 39° 09' 14.3" E 030° 38' 32.4"	16.07.2020/15:20	_

Appendix 3 (Continued)

Site	Ht type	County name/Village name	Coordinate	Date/Time	Species
92	stream	Seyitgazi/ Kümbet village	N 39° 12' 53.2" E 030° 36' 08.8"	16.07.2020/16:00	IB, PZ, LI
93	dam	Seyitgazi/ Çatören dam	N 39° 17' 33.3" E 030° 34' 15"	16.07.2020/16:40	HS, IG, PZ, LI, CP, TC
94	trough	Seyitgazi/ İkizoluk village	N 39° 18' 15.8" E 030° 24' 55.1"	16.07.2020/17:21	—
95	trough	Seyitgazi/ İdrisyayla village	N 39° 23' 13.3" E 030° 25' 06.3"	16.07.2020/17:53	PO
96	pool	Seyitgazi/ Göknebi village	N 39° 23' 31.6" E 030° 28' 55.2"	16.07.2020/18:30	HI, IG, PZ, HC, CP
97	trough	Seyitgazi/ Yukarısöğüt village	N 39° 27' 16" E 030° 35' 35.4"	16.07.2020/19:12	HI, HS, PO, NN, EUc
98	trough	Seyitgazi/ Sancar village	N 39° 23' 58.1" E 030° 38' 43"	16.07.2020/19:45	HS, IB, PZ
99	trough	Seyitgazi/ Ayvalı village	N 39° 28' 39" E 030° 37' 22.7"	16.07.2020/20:08	HS, IB, PA
100	trough	Seyitgazi/ Sarayönü village	N 39° 33' 18.9" E 030° 36' 35.2"	16.07.2020/20:25	HI, HS, PV
101	stream	Tepebaşı/ Muttalip village	N 39° 49' 44" E 030° 32' 48.5"	17.07.2020/09:13	IB, PZ, PSa
102	trough	Tepebaşı/ Gökdere village	N 39° 49' 33.1" E 030° 41' 07.6"	17.07.2020/09:56	HI, HS, HH
103	trough	Odunpazarı/ Yukarıçağlan village	N 39° 40' 06.5" E 030° 30' 00.5"	17.07.2020/11:12	HI, HS
104	pond	Odunpazarı/ Kıravdan village	N 39° 38' 32.6" E 030° 39' 10.8"	17.07.2020/11:43	IB, PV

Appendix 3 (Continued)

Site	Ht type	County name/Village name	Coordinate	Date/Time	Species
105	trough	Odunşpazarı/ Kuyucak village	N 39° 31' 46.3" E 030° 33' 14.1"	17.07.2020/12:14	HI, HS
106	trough	Odunpazarı/ Ayvacıklı village	N 39° 32' 02.3" E 030° 28' 59.4"	17.07.2020/12:40	HS, PV
107	dam	Odunpazarı/ Ilıca dam	N 39° 34' 22.9" E 030° 27' 07"	17.07.2020/13:14	—
108	stream	Odunpazarı/ Yukarı kalabak stream	N 39° 31' 14.7" E 030° 24' 21.2"	17.07.2020/14:20	PO, IB, NN
109	trough	Odunpazarı/ Demirli village	N 39° 33' 44.4" E 030° 18' 20.1"	17.07.2020/15:16	PO, IB, PZ
110	trough	Odunpazarı/ Yenisofça village	N 39° 38' 02.1" E 030° 21' 48.2"	17.07.2020/15:33	HS, PF, IB, CV, HIn
111	stream	Odunpazarı/ E. İncesu village/ Porsuk stream	N 39° 36' 25.2" E 030° 15' 51.1"	17.07.2020/16:01	IB, PZ
112	dam	Odunpazarı/ Musaözü dam	N 39° 41' 54.2" E 030° 19' 26.6"	17.07.2020/16:43	LI
113	river	Odunpazarı/ Kızılınler village/ Porsuk river	N 39° 42' 34.7" E 030° 24' 25.8"	17.07.2020/17:06	IB, PZ, NN
114	trough	Tepebaşı/ Satılmışoğlu village	N 39° 48' 31.2" E 030° 20' 38.8"	17.07.2020/17:40	HS, PO, IB
115	trough	İnönü/ Yörükayla village	N 39° 48' 00.4" E 030° 05' 47.7"	17.07.2020/18:21	HS, IB, CV, HB
116	dam	İnönü/ Aşağıkuzfındık dam	N 39° 41' 30.6" E 030° 03' 13.4"	17.07.2020/19:05	HS, IG
117	trough	İnönü/ Kümbet Akpınar village	N 39° 42' 52.9" E 030° 07' 10.5"	17.07.2020/19:28	HI
118	trough	Tepebaşı/ Nemli village	N 39° 43' 41.9" E 030° 13' 25.4"	17.07.2020/19:51	PF

Appendix 4 The Notes Taken from the Sampling Area During Field Study. Abbreviations: Site, Sampling Site; Ht type, Habitat Type; CW, *Candona weltneri*; CO, *Cypria ophtalmica*; CV, *Cypridopsis vidua*; CP, *Cypris pubera*; DS, *Darwinula stevensoni*; EUc, *Eucypris dorlionensis*; FF, *Fabaeformiscandona fabaeformis*; HB, *Herpetocypris brevicaudata*; HC, *H. chevreuxi*; HH, *H. helenae*; HIn, *H. intermedia*; HI, *Heterocypris incongruens*; HS, *H. salina*; IB, *Ilyocypris bradyi*; ID, *I. decipiens*; IG, *I. gibba*; II, *I. inermis*; IM, *I. monstifica*; IBe, *Isocypris beauchampi*; LI, *Limnocythere inopinata*; NN, *Neglecandona neglecta*; PKr, *Physocypria kraepelini*; PCn, *Plesiocypridopsis newtoni*; PA, *Potamocypris arcuata*; PFa, *P. fallax*; PP, *P. pallida*; PS, *P. similis*; PU, *P. unicaudata*; PVa, *P. variegata*; PV, *P. villosa*; PZ, *Prionocypris zenkeri*; PSa, *Pseudocandona albicans*; PF, *Psychrodromus fontinalis*; PO, *P. olivaceus*; TC, *Trajancypris clavata*; TYr, *Tyrrhenocythere amnicola*.

Appendix 4 (Continued)

Site	Ht type	Notes from Sampling Area	Species
1	trough	Farming present. Agriculture present. No garbage. Close to village. Manure present.	HI, PO, PP
2	river	Rocky sediment. Close to town. Plenty of garbage. Close to park and picnic area.	—
3	river	Rocky sediment. Far from town. Close to agricultural areas. Herons present. Far from the road.	—
4	stream	Village is not close, on the SW. Agriculture present. Watering pipes present. Manure present. Arid and sandy field.	—
5	stream	Rocky sediment. Village is on SW. A canal comes from the village is mixing the stream. Close to the road. Agricultural activity is intense. Plenty of garbage. Water is turbid and dirty.	HI, HS, IB, PZ
6	river	Rocky sediment. Plenty of agriculture area and greenhouse. Organic and inorganic pollution present. Garbage present. Far from the town.	—
7	trough	Far from the town. No garbage, no manure. Arid/rocky field.	HI
8	stream	Not too close to the town. Farming activity is intense. Agriculture present. Watering pipes present. Close to dirt road.	PO
9	dam	Not too close to town. Herons on the lake. Macrophytes are intense. Garbages are intense. Built in 1998.	PZ, CV, CP
10	trough	Close to town. Manures are intense. Garbages are intense.	PO
11	trough	Far from the town. Picnic area. Garbages are intense. Manure present.	HS
12	trough	Close to the town. Villagers are using the source actively. Manure present.	HI

Appendix 4 (Continued)

Site	Ht type	Notes from Sampling Area	Species
13	canal	DSI watering canal. Passing through to the town. Close to road. Agricultural activity is intense. Farming traces are intense. Small amount of garbage.	HI
14	trough	Far from the town. Far from the road. Farming traces are present. No garbage.	HS, IG
15	stream	Watering canal. Water is turbid. Organic pollution present. Agricultural activity is intense. Watering pipes present. Small amount of garbage. Close to the road.	CV, CP, PCn, IBe
16	canal	Watering canal. Agricultural activity is intense. Waterin pipes present. Few garbage. Close to the road.	—
17	stream	Watering canal. Water is turbid. Organic pollution is intense. Macrophyts are intense. Agricultural activity is intense. Watering pipes present.	IG, FF, PSa
18	stream	Far from town. Agricultural activity is intense. Watering pipes present. Macrophyts are intense. Near to dirt road. Few garbage.	—
19	dam	Not so close to the town. Fishing present. Agricultural activity present. Garbages are intense. Built in 2002.	—
20	trough	Enter on the town. Agricultural and farming activities present. Lots of garbage.	HI, PO, HC
21	trough	Enter on the town. Gooses are present. Farming activity present. No garbage.	—
22	trough	Far from the town. Close to the road. Close to the picnic area. Lots of garbage. Farming traces present.	HS, PO, PF, IB
23	trough	Far from the town. Close to the road. Farming activity present.	HI, HS, PZ

Appendix 4 (Continued)

Site	Ht type	Notes from Sampling Area	Species
24	dam	Far from the town. Between the hills, and area is arid. Farming activity traces are present. Few garbage. Built in 2017.	IG
25	dam	Far from the town. Between the hills, and area is arid. Fisheries activity present. Lots of garbage. Built in 2004.	IG, PZ
26	stream	Far from the town. Close to the road, and between 2 villages. Farming activity traces present. Dirt road. Between the hills. Far from agricultural areas.	PO, II
27	stream	In the forest. Road on the upper side. Manure and garbage present.	PO, PF, II
28	trough	Close to the town. Farming activity traces present. No garbage.	PO
29	dam	Close to the town. Garbage present. Macrophytes are intense. Farming present. Built in 1973.	—
30	trough	Close to the road. Far from the town.	—
31	trough	Far from the town. No garbage.	PO, PF, CW, NN
32	stream	On the mountain road. Far from the town. Farming traces present.	PO, IB, PZ, PP
33	trough	Close to the town. Farming traces present. No garbage.	—
34	trough	Close to the town. Farming traces present. No garbage. No agricultural activity.	HS, PO, IB, HH
35	stream	Between the hills. Close to road. Farming traces present. Far from the town. No garbage. Arid/rocky field.	HS, PF, IB, CV
36	stream	Branch of Porsuk stream. Lots of fish. Agricultural activity is intense. Watering pipes present. Farming activity present. Temporary workers accomodate in tents, nearby.	—

Appendix 4 (Continued)

Site	Ht type	Notes from Sampling Area	Species
37	trough	Farming present. Far from the town. Arid area. Between the hills. No agriculture. No garbage.	HS, IB
38	stream	Water is weak and shallow. Agricultural activity intense. Waterin pipes present. Farming present. No garbage.	—
39	trough	Close to the road. Far from the town. Farming traces present. No agricultural activity. No garbage. Near the road goes to the forest.	IB
40	dam	Arid area. Between the hills. Far from the town. No garbage. Wild animals treces present. Built in 2016.	LI
41	dam	Far from the town. Herons present. Storks present. Farming traces present. Macrophyte present. No garbage. Built in 1956.	HI, PU, PKr, PCn
42	trough	Forest area. Not too close to the town. Agricultural activity present. Garbage present.	HS
43	trough	Not too close to the town. Agriculture present. Water is weak and shallow. No animal traces. Garbage present.	HI, PO
44	trough	Close to the town. Phytoplankton present. Close to the road. Water is weak. No human and animal effect.	HS
45	stream	Picnic area. Human effect is intense. Garbage present.	HS, PO, II, CV, LI, DS
46	pool	Pool for firefighters usage. Inside the forest. Far from the town. Garbage present.	HH, PU
47	stream	Not too close to the town. Gardens are close. No farming activity.	—

Appendix 4 (Continued)

Site	Ht type	Notes from Sampling Area	Species
48	dam	Not too close to the town. Between the hills. Garbage present. Agricultural machines present on the nearby village. Built in 2015.	—
49	dam	Not too close to the town. Herons present. Fisheries present. Macrophyte and phytoplankton present. Garbage present. Built in 1981.	LI
50	trough	Close to the town. Sheeps/goats present. Far from the road. No garbage.	PF, PV
51	trough	Far from the town. Close to dirt road. Farming effect present. No agricultural areas. No garbage.	HI
52	dam	Close to the town. Fisheries present. Plenty of fishes. Human effect intense. Garbage intense. Built in 2016.	LI
53	dam	Close to the town. Fisheries present. No agriculture. Garbage present. Built in 1990.	ID, PVa, LI
54	trough	Close to the town. Farming present. No garbage.	HS, PA
55	stream	Not too close to the town. Close to the agricultural area. Farming present. Storks present.	HS, IB, HIn, PA
56	dam	Migratory birds are everywhere. Storks, flamingo, herons present. Farming and agriculture present. Organic pollution intense. Close to the road. Far from the town. Built in 2013.	HS
57	dam	Far from the town. Herons present. Farming present. Macrophytes present. Garbage present. Close to the road. Built in 1981.	IG, PZ
58	pond	Between the agricultural areas. Close to the Sakarya river. Farming present. Macrophyte present. Close to dirt road.	—

Appendix 4 (Continued)

Site	Ht type	Notes from Sampling Area	Species
59	trough	Far from the town. Between the agricultural areas. Made from a truck wheel.	—
60	pond	Between the agricultural areas. Watering pipes present. Macrophyte present. Branch of Sakarya river. No garbage.	HS
61	river	Close to the town. Farming present. Gooses present. Herons present. Macrophyte and phytoplankton present. Watering pipes present. No garbage.	IB, PZ, TYr
62	river	Close to the town. Macrophyte present. Farming and agriculture present.	IB, PZ
63	river	Close to the town. Agriculture present. Watering pipes present. Farming present. Macrophytes present.	IB, PZ
64	trough	Inside the village. Farming present. Chickens present. No garbage.	—
65	trough	Inside the village. Farming intense. All villagers are using this source.	HI, HS, PA
66	trough	Inside the village. Gardens present. No farming. No garbage.	HS, PO, IB, PZ
67	pond	Close to the town. Farming present. Close to a wide swamp area. Between agricultural areas. Close to the road. Macrophytes present.	—
68	trough	Close to the town. Farming present. Nearby a dry swamp area. No garbage.	HI, HS
69	pond	Close to the town. Farming present. Close to a through. Water mixing with through is possible.	HS, IM, PZ, TC
70	stream	Far from the town. Farming present. Agriculture present. Watering pipes present. Macrophytes present. Fish kills present.	IB, PZ, PKr

Appendix 4 (Continued)

Site	Ht type	Notes from Sampling Area	Species
71	trough	Close to the town. Farming present. Inside the park. Garbage present. Nearby a swampy area.	—
72	trough	Close to the town. Farming present. Garbage present.	PO
73	dam	Farming present. Fisheries present. Picnic area. Garbage present. Built in 1978.	IG, LI
74	stream	Not too close to the town. Water is coming here from the village. Agriculture present. Close to a trout farm.	IB
75	trough	Inside the village. Farming present. No garbage.	HS, IB, PZ
76	dam	Far from the town. Farming present. Macrophyte and phytoplankton present. Garbage present. Temporary workers accommodate here in tents. Built in 1988.	HI, HS, PZ, CV, Psa
77	river	Entrance at the village. Farming present. Agriculture present.	PZ
78	river	Close to the town. Farming present. Agriculture present. Watering pipes present. Garbage present.	HS
79	river	Not too close to the town. Farming present. Agriculture present. Watering pipes present. Macrophytes intense. Garbage present.	II, PZ, HC
80	river	Close to the town. Farming present. Agriculture present. Watering pipes present. Garbage present.	HS, IB
81	trough	Inside the village. Farming present. Agriculture present.	—
82	trough	Not too close to the town. Farming present. Through has a water pump.	HI

Appendix 4 (Continued)

Site	Ht type	Notes from Sampling Area	Species
83	stream	Far from the town. Farming present. Close to the road. Agricultural areas present. Garbage present.	II, PZ, CO
84	trough	Close to the town. Farming present. No garbage. No agriculture.	HI, HS, IB, HIn
85	trough	Inside the village. Farming present. Garbage present.	HS, IB, PZ, PV
86	stream	Far from the town. Gardens present. Farming present. No garbage.	IB, PZ, NN
87	dam	Far from the town. Macrophytes are intense. Human activity present. Garbages has picked. Built in 2006.	CV, LI
88	trough	Near the forest road. Not too close to the town. No human activity. No garbage.	PO, IB, PZ
89	stream	Far from the town. Close to the road. Fishes present. Gardens present. Garbage present.	PFa, NN, PKr
90	trough	Inside the village. Farming present. No garbage.	PO, PZ, PV, PS
91	dam	Far from the town. Fishing activity present. Humah effect present. Garbage present. Farming present. Water was drown. Built in 1993.	—
92	stream	Close to the town. Gardens are close to the area. Farming present. Garbage present.	IB, PZ, LI
93	dam	Not too close to the town. Agricultural activitiy close to the lake. Human effects are intense. Garbage present. Farming present. Built in 1987.	HS, IG, PZ, LI, CP, TC
94	trough	Close to the town. Farming present. No garbage. Close to the road.	—
95	trough	Inside the village. Farming present. Phytoplankton present	PO

Appendix 4 (Continued)

Site	Ht type	Notes from Sampling Area	Species
96	pool	Far from the town. Farming present. No garbage. Close to the road. No human effect.	HI, IG, PZ, HC, CP
97	trough	Far from the town. Farming present. No garbage	HI, HS, PO, NN, EUc
98	trough	Inside the village. Farming present. No garbage.	HS, IB, PZ
99	trough	Inside the village. Farming present. Garbage present.	HS, IB, PA
100	trough	Inside the village. Farming present. Garbage present.	HI, HS, PV
101	stream	Close to the road. Close to the town. Agriculture present. Waterin pipes present. Macrophyte present. No garbage.	IB, PZ, PSa
102	trough	Inside the village. Farming present. Phytoplankton present. No garbage.	HI, HS, HH
103	trough	Close to the town. Farming present. Phytoplankton present. Agricultural activity present. No garbage.	HI, HS
104	pond	Inside the village. Farming present. Water coming from the nearby through. Frogs are everywhere. Macrophyte present. No garbage.	IB, PV
105	trough	Close to the town. Farming present. Water flow is weak. Garbage present.	HI, HS
106	trough	Close to the town. Farming present. No garbage. Bees are everywhere.	HS, PV
107	dam	Close to the town. Fisheries present. Human effect present. Garbage present. Macrophyte present. Built in 2018.	—
108	stream	Far from the town. Inside the forest. Waterway connected with pipes to get drinking water. No garbage.	PO, IB, NN

Appendix 4 (Continued)

Site	Ht type	Notes from Sampling Area	Species
109	trough	Inside the village. Farming present. Chickens present. No garbage.	PO, IB, PZ
110	trough	Inside the village. Farming present. No garbage.	HS, PF, IB, CV, HIn
111	stream	Far from the town. Connected with dam. Phytoplanktons and makrophytes are intense. Garbage present.	IB, PZ
112	dam	Far from the town. Picnic area. Lots of human impact. Garbage present. Fishing present. Built in 1966.	LI
113	river	In the village. Water flow is fast. Deep. Goose present. No garbage.	IB, PZ, NN
114	trough	In the village. Farming present. Phytoplanktons are intense. No garbage. Water is so weak.	HS, PO, IB
115	trough	Far from the town. Close to the road. Garbage present. Macrophyte is intense.	HS, IB, CV, HB
116	dam	Not too close to the town. Fishing activity present. Farming present. Lots of garbage. Built in 2007.	HS, IG
117	trough	In the village. Farming present. No garbage.	HI
118	trough	In the village. Farming present. No garbage. No agriculture.	PF

Appendix 5 t-Test Unequal Variance Analysis (two tailed P= 0.05) Results. Abbreviations: EC, Electrical conductivity; DO, Dissolved oxygen; T water, Water temperature; BOD₅, Biochemical oxygen demand; Mg⁺², Magnesium; NO₂, Nitrite; NO₃, Nitrate; PO₄, Phosphate.

t-Test: Two-Sample Assuming Unequal Variances
Species in Natural and Artificial habitats

	<i>Natural</i>	<i>Artificial</i>
Mean	167.7857143	595.3214
Variance	121830.3228	1075720
Observations	28	28
Hypothesized Mean Difference	0	
df	33	
t Stat	-2.067305001	
P(T<=t) one-tail	0.023310794	
t Critical one-tail	1.692360309	
P(T<=t) two-tail	0.046621587	
t Critical two-tail	2.034515297	

t-Test: Two-Sample Assuming Unequal Variances
Asexual species in Source and Sink habitats

	<i>Source</i>	<i>Sink</i>
Mean	150.6666667	678
Variance	55290.42424	1588759.143
Observations	12	8
Hypothesized Mean Difference	0	
df	7	
t Stat	-1.169824675	
P(T<=t) one-tail	0.14017785	
t Critical one-tail	1.894578605	
P(T<=t) two-tail	0.2803557	
t Critical two-tail	2.364624252	

Appendix 5 (Continued)

pH optimum of species in sink and source habitats

t-Test: Two-Sample Assuming Unequal Variances

	<i>Sink</i>	<i>Source</i>
Mean	7.465451667	7.536345
Variance	0.054727029	0.031228784
Observations	6	6
Hypothesized Mean Difference	0	
df	9	
t Stat	-0.592302268	
P(T<=t) one-tail	0.284114166	
t Critical one-tail	1.833112933	
P(T<=t) two-tail	0.568228332	
t Critical two-tail	2.262157163	

DO optimum of species in sink and source habitats

t-Test: Two-Sample Assuming Unequal Variances

	<i>Sink</i>	<i>Source</i>
Mean	6.273615	6.38332
Variance	0.602552014	0.088004955
Observations	6	6
Hypothesized Mean Difference	0	
df	6	
t Stat	-0.323371909	
P(T<=t) one-tail	0.378693593	
t Critical one-tail	1.943180281	
P(T<=t) two-tail	0.757387185	
t Critical two-tail	2.446911851	

Salinity optimum of species in sink and source habitats

t-Test: Two-Sample Assuming Unequal Variances

	<i>Sink</i>	<i>Source</i>
Mean	0.408899667	0.341499833
Variance	0.014206149	0.007611551
Observations	6	6
Hypothesized Mean Difference	0	
df	9	
t Stat	1.117712125	
P(T<=t) one-tail	0.146318356	
t Critical one-tail	1.833112933	
P(T<=t) two-tail	0.292636712	
t Critical two-tail	2.262157163	

EC optimum of species in sink and source habitats

t-Test: Two-Sample Assuming Unequal Variances

	<i>Sink</i>	<i>Source</i>
Mean	762.8848333	626.1788333
Variance	46742.83758	27731.63284
Observations	6	6
Hypothesized Mean Difference	0	
df	9	
t Stat	1.227042173	
P(T<=t) one-tail	0.125467856	
t Critical one-tail	1.833112933	
P(T<=t) two-tail	0.250935712	
t Critical two-tail	2.262157163	

T water optimum of species in sink and source habitats

t-Test: Two-Sample Assuming Unequal Variances

	<i>Sink</i>	<i>Source</i>
Mean	20.63893333	18.7334
Variance	1.023163723	10.22743712
Observations	6	6
Hypothesized Mean Difference	0	
df	6	
t Stat	1.391567628	
P(T<=t) one-tail	0.106726942	
t Critical one-tail	1.943180281	
P(T<=t) two-tail	0.213453883	
t Critical two-tail	2.446911851	

BOD optimum of species in sink and source habitats

t-Test: Two-Sample Assuming Unequal Variances

	<i>Sink</i>	<i>Source</i>
Mean	2.195532	2.682541667
Variance	0.979985261	0.082127667
Observations	6	6
Hypothesized Mean Difference	0	
df	6	
t Stat	-1.157518283	
P(T<=t) one-tail	0.145526927	
t Critical one-tail	1.943180281	
P(T<=t) two-tail	0.291053854	
t Critical two-tail	2.446911851	

Appendix 5 (Continued)

Elevation optimum of species in sink and source habitats

t-Test: Two-Sample Assuming Unequal Variances

	<i>Sink</i>	<i>Source</i>
Mean	1025.3265	1002.4335
Variance	6137.050202	20442.933
Observations	6	6
Hypothesized Mean Difference	0	
df	8	
t Stat	0.343954489	
P(T<=t) one-tail	0.369873134	
t Critical one-tail	1.859548038	
P(T<=t) two-tail	0.739746268	
t Critical two-tail	2.306004135	

Mg optimum of species in sink and source habitats

t-Test: Two-Sample Assuming Unequal Variances

	<i>Sink</i>	<i>Source</i>
Mean	79.63606667	83.52898333
Variance	714.7799548	1641.359746
Observations	6	6
Hypothesized Mean Difference	0	
df	9	
t Stat	-0.196449177	
P(T<=t) one-tail	0.424311475	
t Critical one-tail	1.833112933	
P(T<=t) two-tail	0.848622949	
t Critical two-tail	2.262157163	

NO₂ optimum of species in sink and source habitats

t-Test: Two-Sample Assuming Unequal Variances

	<i>Sink</i>	<i>Source</i>
Mean	0.037905683	0.0467899
Variance	0.000344985	0.002234784
Observations	6	6
Hypothesized Mean Difference	0	
df	7	
t Stat	-0.428454194	
P(T<=t) one-tail	0.34059785	
t Critical one-tail	1.894578605	
P(T<=t) two-tail	0.6811957	
t Critical two-tail	2.364624252	

NO₃ optimum of species in sink and source habitats

t-Test: Two-Sample Assuming Unequal Variances

	<i>Sink</i>	<i>Source</i>
Mean	11.91181333	11.06410833
Variance	53.75017639	42.88185993
Observations	6	6
Hypothesized Mean Difference	0	
df	10	
t Stat	0.211232045	
P(T<=t) one-tail	0.41847438	
t Critical one-tail	1.812461123	
P(T<=t) two-tail	0.836948761	
t Critical two-tail	2.228138852	

PO₄ optimum of species in sink and source habitats

t-Test: Two-Sample Assuming Unequal Variances

	<i>Sink</i>	<i>Source</i>
Mean	0.188669667	0.263357167
Variance	0.003647487	0.018088176
Observations	6	6
Hypothesized Mean Difference	0	
df	7	
t Stat	-1.240900909	
P(T<=t) one-tail	0.127307007	
t Critical one-tail	1.894578605	
P(T<=t) two-tail	0.254614014	
t Critical two-tail	2.364624252	

Appendix 5 (Continued)

pH tolerance of species in sink and source habitats

t-Test: Two-Sample Assuming Unequal Variances

	<i>Sink</i>	<i>Source</i>
Mean	0.494345	0.430204333
Variance	0.034256607	0.028940881
Observations	6	6
Hypothesized Mean Difference	0	
df	10	
t Stat	0.624970024	
P(T<=t) one-tail	0.27299314	
t Critical one-tail	1.812461123	
P(T<=t) two-tail	0.54598628	
t Critical two-tail	2.228138852	

DO tolerance of species in sink and source habitats

t-Test: Two-Sample Assuming Unequal Variances

	<i>Sink</i>	<i>Source</i>
Mean	1.941385	1.246039333
Variance	0.98545891	1.574993731
Observations	6	6
Hypothesized Mean Difference	0	
df	9	
t Stat	1.0644322	
P(T<=t) one-tail	0.157428069	
t Critical one-tail	1.833112933	
P(T<=t) two-tail	0.314856138	
t Critical two-tail	2.262157163	

Salinity tolerance of species in sink and source habitats

t-Test: Two-Sample Assuming Unequal Variances

	<i>Sink</i>	<i>Source</i>
Mean	0.427734667	0.135819783
Variance	0.467424699	0.009041941
Observations	6	6
Hypothesized Mean Difference	0	
df	5	
t Stat	1.035894707	
P(T<=t) one-tail	0.173864322	
t Critical one-tail	2.015048373	
P(T<=t) two-tail	0.347728644	
t Critical two-tail	2.570581836	

EC tolerance of species in sink and source habitats

t-Test: Two-Sample Assuming Unequal Variances

	<i>Sink</i>	<i>Source</i>
Mean	490.444	288.7581667
Variance	605163.3366	48597.75779
Observations	6	6
Hypothesized Mean Difference	0	
df	6	
t Stat	0.611000384	
P(T<=t) one-tail	0.281807176	
t Critical one-tail	1.943180281	
P(T<=t) two-tail	0.563614352	
t Critical two-tail	2.446911851	

T water tolerance of species in sink and source habitats

t-Test: Two-Sample Assuming Unequal Variances

	<i>Sink</i>	<i>Source</i>
Mean	3.594168333	3.738821667
Variance	2.25127152	1.113552739
Observations	6	6
Hypothesized Mean Difference	0	
df	9	
t Stat	-0.19316253	
P(T<=t) one-tail	0.425560258	
t Critical one-tail	1.833112933	
P(T<=t) two-tail	0.851120516	
t Critical two-tail	2.262157163	

BOD tolerance of species in sink and source habitats

t-Test: Two-Sample Assuming Unequal Variances

	<i>Sink</i>	<i>Source</i>
Mean	1.484678333	1.435307667
Variance	0.335950332	1.990627635
Observations	6	6
Hypothesized Mean Difference	0	
df	7	
t Stat	0.079284047	
P(T<=t) one-tail	0.469512817	
t Critical one-tail	1.894578605	
P(T<=t) two-tail	0.939025635	
t Critical two-tail	2.364624252	

Appendix 5 (Continued)

Elevation tolerance of species in sink and source habitats

t-Test: Two-Sample Assuming Unequal Variances

	<i>Sink</i>	<i>Source</i>
Mean	131.9517833	222.165
Variance	3657.414538	14370.7516
Observations	6	6
Hypothesized Mean Difference	0	
df	7	
t Stat	-1.64577332	
P(T<=t) one-tail	0.07190308	
t Critical one-tail	1.894578605	
P(T<=t) two-tail	0.143806161	
t Critical two-tail	2.364624252	

Mg tolerance of species in sink and source habitats

t-Test: Two-Sample Assuming Unequal Variances

	<i>Sink</i>	<i>Source</i>
Mean	136.5918	54.24406667
Variance	31215.20829	428.8956144
Observations	6	6
Hypothesized Mean Difference	0	
df	5	
t Stat	1.133915975	
P(T<=t) one-tail	0.154125752	
t Critical one-tail	2.015048373	
P(T<=t) two-tail	0.308251503	
t Critical two-tail	2.570581836	

NO₂ tolerance of species in sink and source habitats

t-Test: Two-Sample Assuming Unequal Variances

	<i>Sink</i>	<i>Source</i>
Mean	0.028670633	0.042448367
Variance	0.000143889	0.001066398
Observations	6	6
Hypothesized Mean Difference	0	
df	6	
t Stat	-0.97008386	
P(T<=t) one-tail	0.184734522	
t Critical one-tail	1.943180281	
P(T<=t) two-tail	0.369469045	
t Critical two-tail	2.446911851	

NO₃ tolerance of species in sink and source habitats

t-Test: Two-Sample Assuming Unequal Variances

	<i>Sink</i>	<i>Source</i>
Mean	12.445835	8.947626667
Variance	69.19927652	10.74639773
Observations	6	6
Hypothesized Mean Difference	0	
df	7	
t Stat	0.958349257	
P(T<=t) one-tail	0.184904234	
t Critical one-tail	1.894578605	
P(T<=t) two-tail	0.369808467	
t Critical two-tail	2.364624252	

PO₄ tolerance of species in sink and source habitats

t-Test: Two-Sample Assuming Unequal Variances

	<i>Sink</i>	<i>Source</i>
Mean	0.195654817	0.438553017
Variance	0.024325698	0.264605257
Observations	6	6
Hypothesized Mean Difference	0	
df	6	
t Stat	-1.10688598	
P(T<=t) one-tail	0.15536763	
t Critical one-tail	1.943180281	
P(T<=t) two-tail	0.31073526	
t Critical two-tail	2.446911851	

Appendix 6 ANOVA Test Results (Single factor, P= 0.05).

Anova: Single Factor for Species in
Natural and Artificial habitats

SUMMARY

<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>
1116	27	3582	132.6667	90654.15
3388	27	13281	491.8889	806020.3

ANOVA

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	1742048	1	1742048	3.885575	0.054035	4.026631
Within Groups	23313537	52	448337.2			
Total	25055585	53				

Anova: Single Factor for Asesual
species in Source and Sink
habitats

SUMMARY

<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>
Source	12	1808	150.6667	55290.42
Sink	8	5424	678	1588759

ANOVA

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	1334786	1	1334786	2.048351	0.169505	4.413873
Within Groups	11729509	18	651639.4			
Total	13064295	19				

Appendix 7 Various photos from sampling sites in the field study. 1, Sampling site 1 (11.07.2020); 2, Sampling site 4 (11.07.2020); 3, Sampling site 11 (11.07.2020); 4, Sampling site 14 (11.07.2020); 5, Sampling site 18 (12.07.2020); 6, Sampling site 25 (12.07.2020); 7, Sampling site 29 (12.07.2020); 8, Sampling site 39 (13.07.2020); 9, Sampling site 48 (13.07.2020); 10, Sampling site 54 (14.07.2020); 11, Sampling site 67 (15.07.2020); 12, Sampling site 73 (15.07.2020).

