BOLU ABANT IZZET BAYSAL UNIVERSITY
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

RESEARCH ON THE RELATIONSHIP BETWEEN WATER CHEMISTRY, SEDIMENT CHEMISTRY AND CARAPACE STRUCTURE OF NON-MARINE OSTRACODA (CRUSTACEA) FROM GIRESUN (TURKEY)

MASTER OF SCIENCE

ÇAĞATAY ÇAPRAZ

BOLU, JULY 2018

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APPROVAL OF THE THESIS

RESEARCH ON THE RELATIONSHIP BETWEEN WATER CHEMISTRY, SEDIMENT CHEMISTRY AND CARAPACE STRUCTURE OF NON-MARINE OSTRACODA (CRUSTACEA) FROM GIRESUN (TURKEY) submitted by **ÇAĞATAY ÇAPRAZ** in partial fulfillment of the requirements for the degree of **Master of Science** in **Department of Biology, The Graduate School of Natural and Applied Sciences of ABANT IZZET BAYSAL UNIVERSITY in 02/07/2018** by

Examining Committee Members	**Signature**
Supervisor Prof. Dr. Okan KÜLKÖYLÜOĞLU Abant İzzet Baysal University	....
Member Prof. Dr. Cemal TUNOĞLU Hacettepe University	....
Member Assist. Prof. Dr. Erhan BUDAK Abant İzzet Baysal Üniversitesi	....

Graduation Date :

Doç. Dr. Ömer ÖZYURT ....

Director of Graduate School of Natural and Applied Sciences

To my family

Sabit ÇAPRAZ, Gülay ÇAPRAZ
Hasan ÇAPRAZ and Çiğdem ÇAPRAZ

DECLARATION

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Çağatay ÇAPRAZ

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ABSTRACT

RESEARCH ON THE RELATIONSHIP BETWEEN WATER CHEMISTRY, SEDIMENT CHEMISTRY AND CARAPACE STRUCTURE OF NON- MARINE OSTRACODA (CRUSTACEA) FROM GIRESUN (TURKEY)
MSC THESIS
ÇAĞATAY ÇAPRAZ
ABANT IZZET BAYSAL UNIVERSITY GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
DEPARTMENT OF BIOLOGY
(SUPERVISOR: PROF. DR. OKAN KÜLKÖYLÜOĞLU)

BOLU, JULY 2018

This study includes 105 different freshwater habitats were sampled from Giresun during 3-8 October 2015. Nine genera and 16 species were recorded from 69 of 105 sampling sites in Giresun. All species were new record for this province. Water and sediment samples from different aquatic habitat types were collected and analyzed to show possible relationship between abundance and effects on carapace structure of Ostracoda. Selected 17 carapace sample prepared for Energy Dispersive X-ray Analysis (EDX) and the percentages of the elements forming the carapace were determined. First two axes of Canonical Correspondence Analysis (CCA) revealed 69.5% of relationship between nine species and four environmental variables. Among variables, while water temperature ($P<0.05$) was the most effective variable, electrical conductivity, magnesium and nitrate were less effective variables. According to C2 analysis, *Heterocypris salina* has maximum optimum value for water temperature. *Potamocypris fallax* has minimum tolerance and optimum values for electrical conductivity. Sodium in the carapace structure of *H. salina* was found higher than other edx samples. There was no clear evidence of relationship between calcium concentrations at water and carapace. This finding suggets that major source of calcium in carapace was sediment through water.

KEYWORDS: Ostracoda, Ecology, Distribution, Carapace, Giresun

ÖZET

GİRESUN (TÜRKİYE) İLİNDE SUCUL HABİTATLARDAN TOPLANAN ÖRNEKLERİN, OSTRAKODA (CRUSTACEA) KABUĞU, SU KİMYASI VE SEDİMENT KİMYASI BAKIMINDAN ARALARINDAKİ İLİŞKİNİN ARAŞTIRILMASI
YÜKSEK LISANS TEZI
ÇAĞATAY ÇAPRAZ
ABANT İZZET BAYSAL ÜNİVERSİTESİ FEN BİLİMLERİ ENSTİTÜSÜ BIYOLOJI ANABILIM DALI
(TEZ DANIŞMANI: PROF. DR. OKAN KÜLKÖYLÜOĞLU)

BOLU, TEMMUZ - 2018

Bu çalışma, 3-8 Ekim 2015 tarihleri arasında Giresun il sınırları kapsamından toplanan 105 farklı noktadaki tatlısu habitatını kapsamaktadır. Giresun'daki 105 örnekleme alanından 69'unda, dokuz cinse ait 16 ostrakod türü kaydedilmiştir. Bütün türler bu bölge için yeni kayıttır. Farklı sucul habitat türlerinden su ve sediman örnekleri toplanarak, ostrakod çeşitliliği ve kabuk yapısı üzerindeki etkileri arasındaki ilişkiyi göstermesi için analiz edilmiştir. Enerji Dağılımlı X-ışını Analizi (EDX) için hazırlanmış 17 kabuk örneğinin ve kabukları oluşturan elementlerin yüzdeleri belirlenmiştir. Kanonik İlişki Analizi (CCA)'nin ilk iki ekseni, dokuz tür ve dört çevresel değişken arasındaki ilişkinin % 69.5'ini ortaya çıkarmıştır. Değişkenler arasında, su sıcaklığı ($P < 0.05$) en etkili değişken iken, elektriksel iletkenlik, magnezyum ve nitrat daha az etkili değişkenlerdir. C2 analizine göre *Heterocypris salina* su sıcaklığı için maksimum optimum değere sahiptir. *Potamocypris fallax*, elektriksel iletkenlik için minimum tolerans ve optimum değerlerine sahiptir. *H. salina*'nın kabuk yapısındaki sodyum, diğer EDX örneklerinden daha yüksek bulunmuştur. Sudaki ve kabuktaki kalsiyum konsantrasyonları arasında açık bir ilişki kanıtı yoktur. Bu bulgu, kabuğun en önemli kalsiyum kaynağının su yoluyla sedimandan olduğunu göstermektedir.

ANAHTAR KELİMELER: Ostrakod, Ekoloji, Dağılım, Kabuk, Giresun

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LIST OF ABBREVIATIONS AND SYMBOLS

DO	**:** Dissolved Oxygen
%DO	**:** Percentage of Dissolved Oxygen
EC	**:** Electrical Conductivity
Spe.EC	**:** Specific Eletrical Conductivity
TDS	**:** Total Dissolved Solid
ORP	**:** Oxidation Reduction Potential
Atm.p	**:** Atmospheric Pressure
W.S	**:** Wind Speed
Elev	**:** Elevation
Sal	**:** Salinity
Nit	**:** Nitrate concentration of water
St. Ty	**:** Station Type
St. No	**:** Station Number
EDX	**:** Energy Dispersive X-ray
DCA	**:** Detrended Correspondance Analysis
CCA	**:** Canonical Correspondance Analysis

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1. INTRODUCTION

1.1 Ostracoda

Ostracods are small bivalved crustaceans named as “seed shrimps or mussel-shrimps” (Meisch, 2000; Karanovic, 2012) and are found in marine, brackish and freshwater bodies (Martens et al., 2008). Although freshwater ostracods are usually found between 0.3 mm and 5 mm length, some radical species such as *Gigantocypris* Müller, 1895 is about 30 mm in length (Meisch, 2000). They compose with two calcareous valves and soft body parts (Figure 1.1).

Ostracods were first described in the 18th century, and related works started with simple collections and taxonomic studies. Afterwards, they continued with ecological, paleoecological and geochemical studies (Holmes and Chivas, 2002). The ostracods, which have wide global distribution in freshwater and marine environments, have quite old fossil records known from Cambrian period. For many years, they have been used as indicator in determining the environment changes in the old periods (Ruiz et al., 2004). Heretofore, scientists have been reported the state and balance of the aquatic environment, depth, water temperature, salinity, the amount of dissolved oxygen, presence of macrophytes, competition and hunting factors determine the distribution of ostracods (Horne and Boomer, 2000).

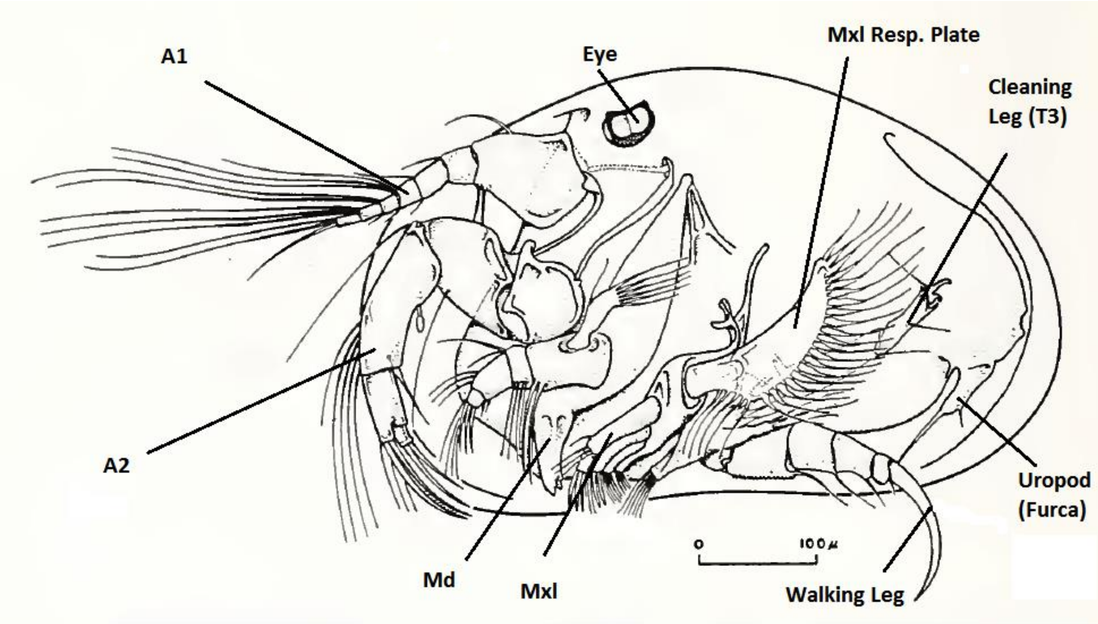

Figure 1.1. The arrangement of limbs on the right side of *Cypridopsis vidua* modified from Kesling (1951).

Living ostracods are subdivided into three lineages classified as orders. These are Platicopida and Myocopida, both of which have only marine species. On the other hand, the last order Podocopida has marine, brackish and freshwater species. So, all freshwater ostracods belong to the Podocopida (Meisch, 2000). Under the Podocopida, there are three superfamily (Darwinuloidea, Cypridoidea and Cytheroidea). In the lower step, there are 13 families. 75% of about 2,000 known species are included in the Cyprididae and Candoninae classes. The other 11 families contain only 25% of the species (Martens et al., 2008).

1.1.1 Morphology

If we examine the morphology of Ostracoda, we can look at two sub-title as carapace and soft body parts.

1.1.1.1 Carapace

All ostracods have one pair of calcium carbonated valves and they are linked each other at medio-dorsal part called “hinge” (Figure 1.2.).

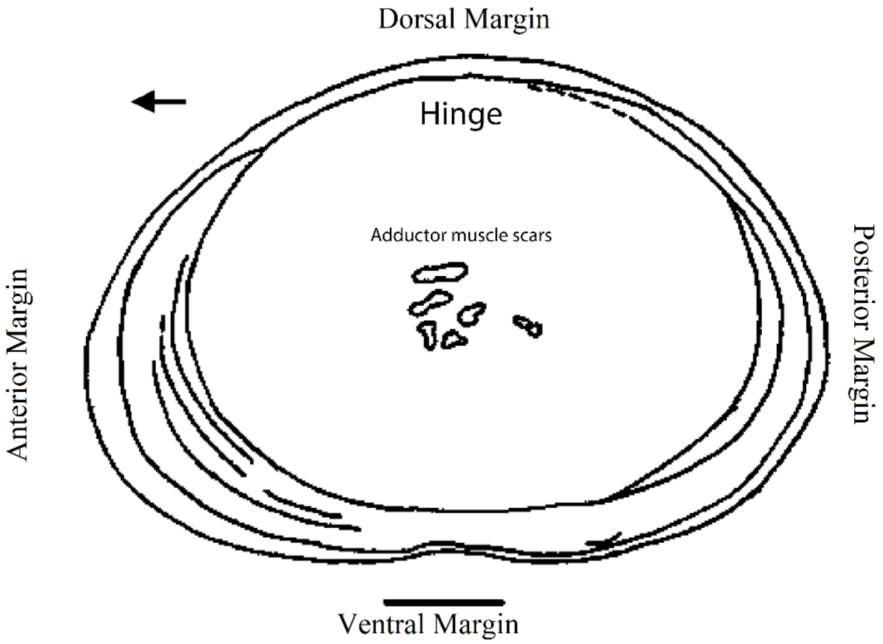

Figure 1.2. The internal view of right valve of *Cyclocypris vinyardi*. Modified from Külköylüoğlu (2008).

This bivalved carapace structure surround soft body parts of ostracods and this carapace structure has vital role for all crustaceans. The structures seen on the carapace such as pores, spines, nodes or tubercles’ abundance play important role for activities of ostracods (Martens, 1998). On the other hand, adductor muscles have vital effect for carapace’s movement. Additionally, these muscles leave scar on carapace’s inner surface insomuch that these scars can be observed from outer side of carapace. Adductor muscle scars are important for species identification such as rosette shape on superfamily Darwinuloidea (Meisch, 2000). Ornamentation of the carapace plays an important role in the species identification because soft tissue cannot be obtained in fossil forms (Delorme, 1991; Meisch, 2000; Karanovic, 2012).

As a subphylum Crustacea has very important role in paleontological studies because calcareous shells can preserve themself in sediment as a fossil form for a long time. Although ostracod’s soft body parts can be decayed, its carapace can preserve its structure until today.

When we look at the chemical structure of carapace, the trace elements that are basically based on are magnesium, calcium and strontium (Chivas et al., 1986). In scientific studies on this subject, generally their rates are used between each other (Ca/Mg, Ca/Sr, Mg/Sr etc.) (Gouramanis and De Decker, 2010; Külköylüoğlu et al., 2015; Turpen and Angel, 1971; Wansard et al., 1999; Xia et al., 1997).

1.1.1.2 Appendages

There is no any discernable segmentation like other arthropod's cephalon, thorax or abdomen of Ostracoda. However, eight pair appendages are found in podocopid ostracods. Their names are antennule (A1), antenna (A2), mandible (Md), maxillula (Mx1), first thoracopod (T1), second thoracopod (T2), third thoracopod (T3) and uropod (furca) (Figure 1.3). Although carapace is an important identification factor at first sight, appendages for recent forms have vital importance during species identification. Even so, the number or length of a setae on any appendage is important for a character of ostracod species.

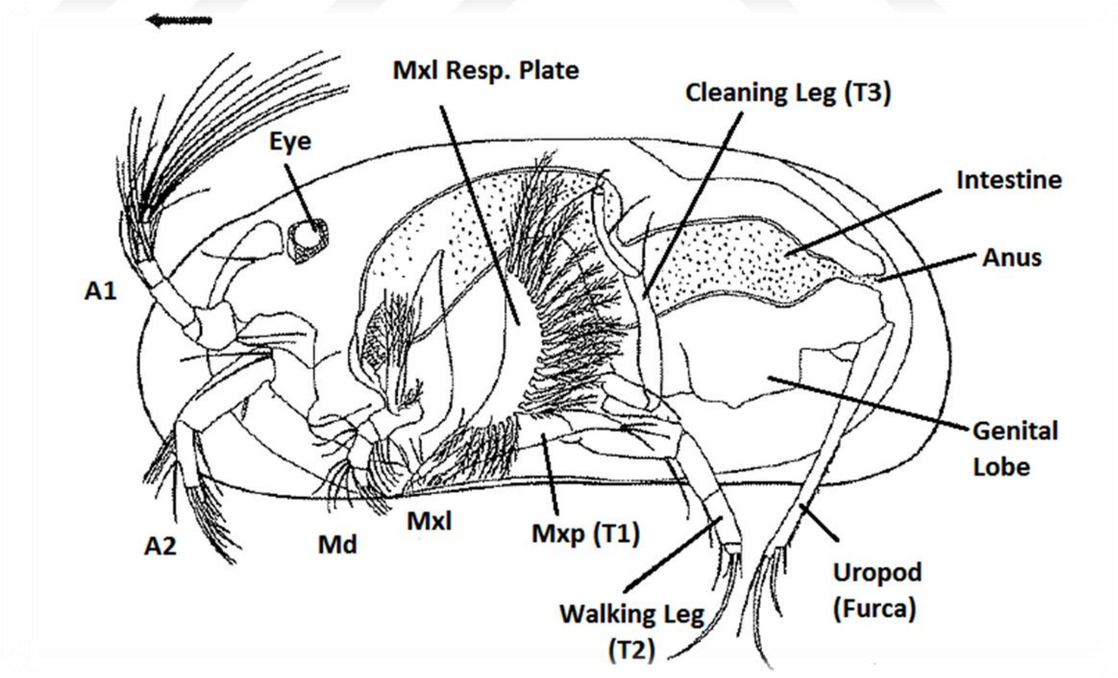

Figure 1.3. Modified internal view of *Herpetocypris reptans* from Meisch (2000).

1.1.2 Reproduction System

Like another appendages, reproductive organs in Ostracoda are paired too. They are located between Third thoracopods and Uropodal rami. The genital lobe, referring to gender, is easy to observe during carapace dissection on lateral view. There are four different reproductive modes among freshwater ostracods (Meisch, 2000).

First of them is known as fully sexual (or bisexual) reproduction. The ratio between male and female of this populations generally very close to 1. Parthenogenetic reproduction is not seen in this populations.

Second reproduction type is found in mixed populations. We can separate three different populations under this reproduction type. They are bisexual populations with fully sexual reproduction, bisexual populations with mixed reproduction and lastly fully parthenogenetic populations.

Third type of reproduction includes populations that are breeding fully parthenogenesis in recent asexual spin-offs. Many species are found as populations of only female individuals.

The last reproduction type is parthenogenesis in ancient asexual. Only the Darwinuloidea and bellelloid rotifers are classified within this group in all animal kingdom. The reason that Darwinuloidea entered this group is that marine forms, believed to be ancestral form, still show sexual reproduction.

1.1.3 Ecology and Distribution

Ostracods are the most diverse class in Crustacea (Meisch, 2000). Although we know that stagnant aquatic habitats more convenient, they are found in almost all aquatic habitat such as ocean, lagoons, caves, throughs, underground waters. In terms of depth, from shallow littoral zone to abyssal depths, they spread all over the World. They maintain their lives as predator, herbivores, omnivores or detritivores. Even cannibalism, commensals or ectoparasites are also seen for some species (Hobbs, 1971).

The physico-chemical factors of water such as pH, dissolved oxygen, elevation, salinity, temperature etc. affect their distribution and abundance (Külköylüoğlu, 2005a, Mezquita et al., 2001; Pérez et al., 2010). Hence, freshwater ostracods are considered bioindicators because they have a certain level of tolerance to some environmental factors (Benson, 1990; Delorme, 1991; Külköylüoğlu, 1999). Ostracods can be distributed over long distances. This distribution can be passive or active transportion (Danielopol et al., 1994). In passive mode, adults or eggs can be carried by different factors like wind, some plants, insects, amphibians, fishes, birds and humans (Horne and Martens, 1998; Külköylüoğlu, 1999; Meisch, 2000, Rossi et al., 2003). Active transport is provided by swimming that species have long swimming setae (Delorme, 1991).

Some Ostracoda species show wide tolerance range despite many environmental difficulties such as pollution and because of this reason we can use cosmopolitan definition for them (Külköylüoğlu, 2004). They can adapt to different environmental conditions easily (Külköylüoğlu, 2005a). Furthermore, increasing the numbers of cosmopolitan species may indicate the effect of disturbance and pollution causing degradation of the numbers of native species (Külköylüoğlu, 2005b). This situation is called by "Pseudorichness" (Külköylüoğlu, 2004). On the other hand, some ostracod species have wide tolerance and distribution. This phenomenon is named as "cosmoecious" (Külköylüoğlu, 2013a).

1.1.4 The History of Freshwater Ostracods in Turkey

The adventure of Ostracoda studies in Turkey have been started with German scientist H.W. Schäfer at 1952 and he reported the species *Ilyocypris brehmi*, *Cypris pubera*, *Eucypris pagasti*, *Heterocypris barbara*, *Stenocypris fischeri*, *Potamocypris arcuata* and *Zonocypris inconspicua* as the first records for Turkey. After that, another German scientist G. Hartman followed with a study in 1964.

In the ongoing process, according to records, D. Gülen was the first Turkish scientist to work on ostracods in 1965. From 1965 to 1999, Gülen and his colleagues continued to studies (Gülen, 1975; 1977; 1985; Gülen et al,, 1994; Gülen and Altınsaçlı, 1999). Altınsaçlı, a student of Gülen, has been working with ostracods since 1988 .

During the similar period, Okan Külköylüoğlu started to his studies on freshwater ostracods in early 1987. He published many studies about Ostracoda. Also, he is reputed scientist with his studies about the ecology and taxonomy of ostracods (Külköylüoğlu, 1998, 1999, 2003a, 2003b, 2003c, 2004, 2005a, 2005b, 2005c, 2007, 2008, 2013; Külköylüoğlu and Yılmaz, 2006; Külköylüoğlu and Vinyard, 2000; Külköylüoğlu et al., 1993, 2007, 2010, 2012a-c, 2017) Additionally, since 1995, O. Özuluğ has contributed to ostracod studies in Turkey (e.g., Özuluğ, 2005; Özuluğ and Yaltalıer, 2008; Özuluğ, 2012). In 1996 Cem Aygen reputed some ostracods from İzmir and environments (Aygen and Balık, 1998, Aygen et al., 2004, 2012). In 1997, Mustafa Kılıç defended his Phd thesis about the ostracods of coasts of Black Sea along and this study included Giresun (Kılıç, 2001).

On the last decade, there are new scientists (Derya Akdemir, since 2004; Necmettin Sarı, since 2007; Mehmet Yavuzatmaca, since 2009 etc.) and they have been studying on freshwater ostracods and they have publications at different parts of Turkey (Akdemir, 2008; Sarı and Külköylüoğlu, 2010; Yavuzatmaca et al., 2012).

Besides, paleontologic studies (Nazik and Gross-Uffenorde, 2016; Tuncer and Tunoğlu, 2015; Tunoğlu and Ertekin, 2008) on ostracod from different region of Turkey have been continued since the last 30 years.

2. AIM AND SCOPE OF THE STUDY

Since first description of freshwater Ostracoda, there are a lot of studies about their ecology and distribution (e.g., Delorme, 1991; Mezquita et al., 2001; Külköylüoğlu, 2003a), carapace structure and its chemistry (e.g., Gouramanis and De Decker, 2010; Xia et al., 1997; De Deckker et al., 1999, Frenzel et al., 2012) in literature. However, the effects of environmental variables of ostracods' distribution and their carapace chemistry have important role for ecological basis. Hence, the main aim of this work is to determine relationship among carapace structure, water and sediment chemistry. On the other hand, this study is thought to have a high-potential for contribution of Ostracoda fauna due to the lack of extensive study in the literature for Giresun province.

Therefore, the main purpose of this study is to shed on the following issues as:

i. To contribute knowledge into the Ostracoda fauna of Giresun province of Turkey,

ii. To detect the most effective environmental variable(s) on species,

iii. To estimate ecological optimum and tolerance levels of species for different variables,

iv. To observe distributional patterns of among aquatic habitats.

3. MATERIAL AND METHODS

3.1 Site Description

3.1.1 Giresun

The area where the study work was done is named Giresun located in the Eastern Black Sea region. The coordinates of this region, (6934 km^2 surface area), are between 40°07'-41°08' North latitude and 37°50'-39°12' East longitude. The north part of Giresun is bordered by 105 km length of Black Sea shore while the south side is bounded by Giresun Mountains. As the surface shape, this field is fairly rough and the average height of the Giresun Mountains, which is 50 to 60 kilometers from the shore and runs parallel to the shore, is 2000 meters. The eastern Black Sea region, is known with relatively high rain period. Two different climates are seen in this area under the influence of Giresun Mountains. Two main climatic characteristics are seen on the north side of the Giresun Mountains and a part of the area that is included in the Kelkit Basin. In part of close to the Black Sea, is observed warm and rainy climate. However, the continental climate is seen around the Kelkit Basin. As annually, February has the lowest average temperature (6.7 °C) and August has the highest average temperature (23.0 °C) between 1975 and 2008 (Giresun Valiliği, 2008).

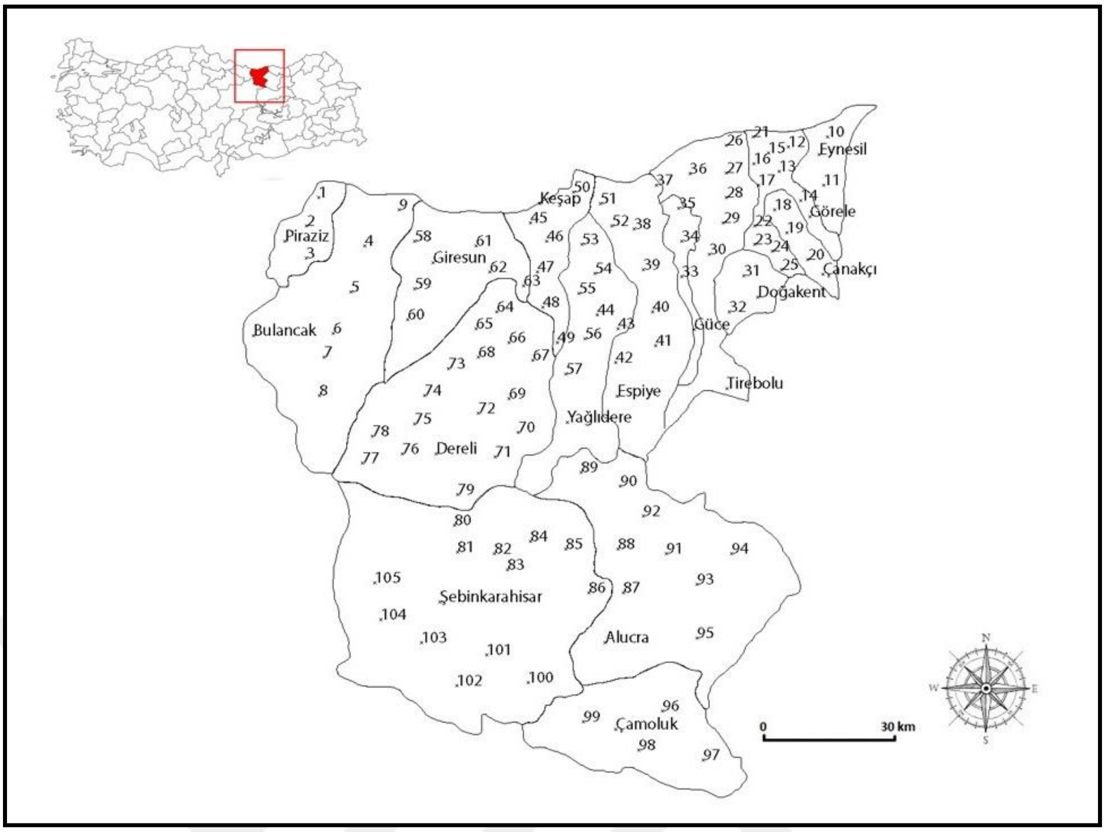

Figure 3.1. 105 Randomly selected sampling sites from 16 counties (Merkez, Alucra, Bulancak, Çamoluk, Çanakçı, Dereli, Doğakent, Espiye, Eynesil, Görele, Güce, Keşap, Piraziz, Şebinkarahisar, Tirebolu, Yağlıdere) of Giresun, Turkey.

3.2 Sampling and Measurements

All along this field study, all 105 samples were randomly collected from different aquatic bodies during 3 - 8 October 2015 (Figure 3.1). Sampling is made from nine different aquatic habitats (lake, creek, trough, water body, stream, waterfall, river, pond, pool) and there are approximately 5 – 10 kilometers between them. Each sampling site has some environmental data records before ostracods sampling to prevent possible results of “Pseudoreplication” (Hurlbert, 1984). YSI-Professional Plus was used to measure dissolved oxygen concentration (DO, mg/L), percent oxygen saturation (% sat.), water temperature (Tw, ºC), electrical conductivity (EC, µS/cm), total dissolved solids (TDS, mg/L), salinity (Sal, ppt), pH, atmospheric pressure (mmHg). On the other hand, Testo 410-2 anemometer were used for the measuring atmospheric data of each sampling sites (wind speed (km/h), air moisture (%), the air temperature (Ta, °C), elevation, and coordinates) and Garmin e-trex Vista H GPS were used for detect coordinates in each site.

The ostracod samples were collected by hand net with 200 µm mesh size from sediment and were preserved in 250ml. plastic bottles. Thenafter 70% alcohol solution were added to fixed the sample. Additionally, water samples were collected in plastic bottles with 100 ml. for chemical analysis and kept in 4°C of container and only sediment samples were collected in eppendorfs for chemical analysis. After the field study, each ostracod sample was filtered with three layer sieves (2mm, 1mm and 0.250mm aperture) in laboratory. They were separated from sediment under a stereomicroscope (Olympus ACH 1X) and dissected in lactophenol solution for taxonomic identification. Micropaleontological slides were used to keep carapace and valves for Scanning Electron Microscope (SEM) Photographs, EDX Analysis and further studies. The taxonomic keys of Meisch (2000) and Karanovic (2012) were used for identification of species. This process was finished under the light microscope (Olympus BX-51). On the other hand, pre-determined species' single valves were covered with gold with 4mA with COXEM KIC-IA model ION-COATER. After that, they were photographed under the JEOL JSM-6390LV model Scanning Electron Microscope (SEM). Additionally, their EDX Analysis were recorded with JEOL SEM control user interface program Version 8.25. All of the ostracod samples stocked in Limnology Laboratory of İzzet Baysal University, Bolu/Turkey and they are available upon request.

Furthermore, water samples were prepared to analyze by filtering from syringe-type membrane filter (1.45µm). Later, standard method no: 4110 Ion Chromatography (Dionex 1100) was applied cation and anion analyses to the water samples in the Department of Environmental Engineering, Abant Izzet Baysal University. Under the light of this analysis, sodium (Na^{+}), potassium (K^{2+}), magnesium (Mg^{2+}), calcium (Ca^{2+}), fluoride (F^{-}), chloride (Cl^{-}), nitrite (NO_2^{-}), nitrate (NO_3^{-}) and sulphate (SO_4^{-2}) values of the water samples were calculated.

If we look at the sediment analysis, this process can be examined three main steps. First of them NaOH-P and HCl-P. 200 mg sediment was placed in the centrifuge tube and 20 ml 1M NaOH were added. The tubes were shaken for 16 hours in a closed manner. Then they were centrifuged at 2000 rpm for 15 minutes. In the remaining process of the first step, the top-most layer and the folded bottom layer are separated again for NaOH-P and HCl-P analyzes, respectively. 10 ml of the top-most layer was put into another tube, 4 ml of 3.5M HCl was added. It was stirred for 20 seconds and allowed to stand over 16 hours in closed tubes. When a brown pellet was formed, it was centrifuged at 2000 rpm for 15 minutes. 0.1 ml of 12M NaOH was added to 2 ml of supernatant and it was completed to 10 ml with pure water. Thus, NaOH-P analyzes were completed by adding 2 ml mixed reagent. Mixed reagent includes (for 100 ml) 50 ml of 2.5 M sulfuric acid, 15 ml of ammonium hepta molybdate, 30 ml ascorbic acid and 5 ml antimon potassium tartarate. At the second process of the first step, centrifuge pellet was shaken with 12 ml 1M NaCl for 5 minutes for the analysis of HCL-P. It was centrifuged at 2000 rpm for 15 minutes and the upper water was poured. These two steps were repeated one more time. After adding 20 mL of 1 M HCL, the tube was shaken for 16 hours. It was centrifuged at 2000 rpm for 15 minutes. 0.1 ml of 12 M NaOH was added to 2 ml of supernatant and it was completed to 10 ml with pure water. Thus, HCl-P analyzes were completed by adding 2 ml mixed reagent. At the second step, 200mg dried sediment was taken to porcelain tube for the analysis of concentrate HCl-P. It was burned for 3 hours at 450 ºC in an ash furnace. After the resulting mass cooled down, 20 ml of 3.5M HCl was added and placed in the falcon tube. After 16 hours of shaking, it was centrifuged at 2000 rpm for 15 minutes. 0.56 ml of 12 M NaOH was added to 2 ml of supernatant and it was completed to 10 ml with pure water. At the last step, we calculated inorganic and organic phosphate. 200 mg dry sediment was placed in a falcon tube and 20 ml 1 M HCl was added. The tubes were shaken for 16 hours were centrifuged at 2000 rpm for 15 minutes. In the remaining process of the first step, the supernatant layer and the pellet layer was separated again for inorganic phosphate and organic phosphate analyzes, respectively. Firstly, 0.16 ml 12 M NaOH was added to 2ml of supernatant and it was completed to 10 ml with pure water. Thereupon, inorganic phosphate analyzes were completed by adding 2 ml mixed reagent. For the analysis of organic phosphate, the pellet was washed by adding 12 ml of distilled water by shaking 5 minutes. It was centrifuged at 2000 rpm for 15 minutes and the top-most layer was poured. These two steps were repeated one more time. The residue was dried at 80 °C. The tubes were placed in an ultrasonic bath and the contents were transferred to a porcelain tube. It was burned in an ash furnace at 450 °C for 3 hours. The cooled mass was placed in the falcon tube with the addition of 20 ml of 1 M HCL. The tube was shaken for 16 hours. It was centrifuged at 2000 rpm for 15 minutes. 0.16 ml 12 M NaOH was added to 2 ml of supernatant and it was completed to 10 ml with pure water. Finally, organic phosphate analyzes were completed too by adding 2 ml mixed reagent.

3.3 Statistical Analyses

Firstly, during the statistical analyses period, Microsoft Office (2016) was used to list and organize the data. In the ongoing process, different statistical analyses and software products were used for the relationship between ostracod diversity, distributions and environmental variables of different sampling sites (such as C2 program, Canonical Correspondence Analysis (CCA)).

Optimum (uk) and tolerance (tk) levels of each ostracod species were calculated by C2 program. However, the species that were found at least three different sampling sites should be used for the accurate results. Transfer function of weighted averaging regression is included by C2 software (Juggins, 2003).

Besides, as a multivariate statistical method, Canonical Correspondence Analysis (CCA) with 499 Monte Carlo Permutation test, was used to detect possible relationships among ostracods and ecological variables (Tw, DO, EC, pH, Ta, Atmp., ORP, Moist., W.S, Elev.,W.S., St. Ty, TDS, Sal.). The compatibility of data for CCA was applied to log-transformation and then tested with DCA (Detrended Correspondence Analysis). If the result value of DCA is higher than to three, data is convenient to use for CCA usage (Ter Braak, 1987; Birks et al., 1990). During to prepare data for CCA, rarely found species are eliminated like C2 Analysis.

4. RESULTS

4.1 Taxonomic Results

In Giresun province, 16 species (*Candona neglecta, Cypridopsis vidua, Herpetocypris reptans, Herpetocypris intermedia*, *Heterocypris incongruens, Heterocypris salina*, *Ilyocypris bradyi*, *Ilyocypris brehmi*, *Ilyocypris inermis, Potamocypris fallax*, *Potamocypris fulva*, *Potamocypris villosa, Pseudocandona albicans, Psychrodromus fontinalis, Psychrodromus olivaceus, Scottia pseudobrowniana*) were reported from 69 of 105 sampling sites and all species are new records for Giresun province.

4.2 Taxonomic Description

PHYLUM:	ARTHROPODA
SUBPHYLUM:	CRUSTACEA Pennat, 1777
CLASS:	OSTRACODA Latreille, 1802
SUBCLASS:	PODOCOPA Müller, 1894
ORDER:	PODOCOPIDA Sars, 1866
SUBORDER:	Podocopina Sars, 1866
INFRAORDER:	Cypridocopina Sohn, 1988
SUPERFAMILY:	Cypridoidea s. str. Braid, 1845
Family:	Candonidae Kaufmann, 1900
Subfamily:	Candoninae Kaufmann, 1900
Genus:	Candona s. str. Braid, 1845

Candona neglecta Sars, 1887

Genus: Pseudocandona Kaufmann, 1900

Pseudocandona albicans Bradyi, 1864

Family: Cyprididae Braid, 1845

Subfamily: Cypridopsinae Kaufmann, 1900

Genus: Cypridopsis Brady, 1867

Cypridopsis vidua O.F. Müller, 1776

Subfamily: Herpetocypridinae Kaufmann, 1900

Genus: Herpetocypris Brady and Norman, 1889

Herpetocypris reptans Baird, 1835

Herpetocypris intermedia Kaufmann, 1900

Genus: Psychrodromus Danielopol and McKenzie, 1977

Psychrodromus fontinalis Wolf, 1920

Psychrodromus olivaceus Brady and Norman, 1889

Subfamily: Cyprinotinae Bronshtein, 1947

Genus: Heterocypris Claus, 1892

Heterocypris incongruens (Ramdohr, 1808)

Heterocypris salina (Brady, 1868)

Family: Ilyocyprididae Kaufmann, 1900

Subfamily: Ilyocypridinae Kaufmann, 1900

Genus: Ilyocypris Brady and Norman, 1889

Ilyocypris bradyi Sars, 1890

Ilyocypris brehmi Schafer, 1952

Ilyocypris inermis Kaufmann, 1900

Subfamily: Cypridopsinae Kaufmann, 1900

Genus: Potamocypris Brady, 1870

Potamocypris fulva Brady, 1868

Potamocypris fallax Fox, 1967

Potamocypris villosa Jurine, 1820

Genus: Scottia Brady and Norman, 1889

Scottia pseudobrowniana Kempf, 1971

4.3 Ecological Results

The first two axes of Canonical Correspondence Analysis (CCA) explained 69.5% of relationship between 9 species and 4 ecological variables (Table 4.1).

Table 4.1. CCA summary table with four variables (EC, Magnesium, Nitrate and water temperature) and nine species with three or more times occurrences from Giresun (*DCA results).

Axes	**1**	**2**	**3**	**4**	**Total internia**
Eigenvalues	0.393	0.261	0.104	0.073	4.266
Length of gradients*	4.072	4.057	3.790	3.273	
Species-environment correlations	0.773	0.627	0.422	0.333	
Cumulative percentage variance:					
of species data	9.2	15.3	17.8	19.5	
of species-environment relation	41.7	69.5	80.5	88.3	
Sum of all eigen values					4.266
Sum of all canonical eigenvalues					0.941

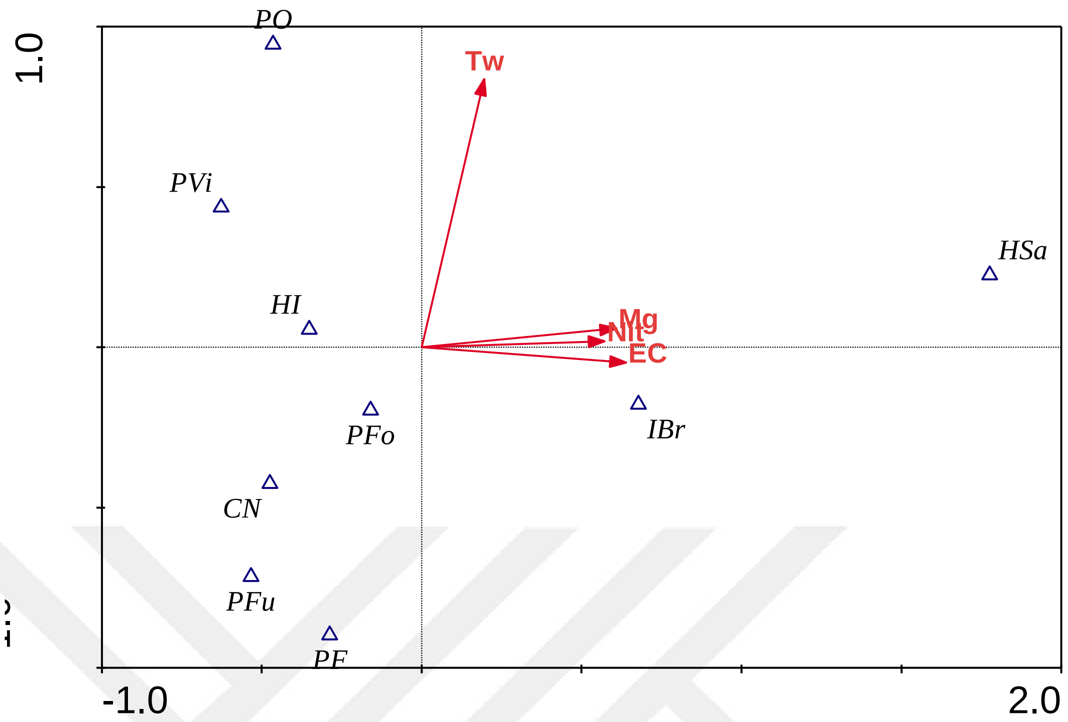

Figure 4.1. The diagram of CCA indicate the relationship between four ecological variables (water temperature (Tw), magnesium content of water (Mg), nitrate content of water (Nit), electrical conductivity (EC)) and nine species (*Candona neglecta* (CN), *H. inongruens* (HI), *H. salina* (HSa), *I. bradyi* (IBr), *P. fallax* (PF), *P. fontinalis* (PFo), *P. fulva* (PFu), *P. olivaceus* (PO), *P. villosa* (PVi)) from 64 different sampling sites in Giresun.

CCA diagram (Figure 4.1) shows that four environmental variables (Tw (F = 3.044, P = 0.006), EC (F = 3.995, P = 0.008), Mg (F = 3.672, P = 0.012), Nit (F = 3.196, P = 0.018)) are the most effective on species. Although three variables (Ca (F = 2.137, P = 0.074), DO (F = 1.095, P = 0.278), pH (F = 0.943, P = 0.426)) are found on fourth, fifth and sixth effective environmental variables, they are not significant. Except three species *(H. incongruens*, *I. bradyi* and *P. fontinalis*) all of species are far away from the center of the diagram. *H. salina* and *I. bradyi* located very close to Mg, Nit and EC.

While the distribution of *P. olivaceus* was limited to the northern part, the distribution of *H. salina* was only found in the western part of the field (Figure 4.2). On the other hand, *C. neglecta*, *P. fontinalis, P. fallax P. villosa* and *I. bradyi* were distributed all over the region, when *P. fulva and I. inermis* were found with limited distribution within the borders of Dereli region. The remaining species were not found in sufficient numbers to observe clear distribution. While a large majority of the empty station is located in the Yağlıdere region and its east side, the number of empty stations in the southeast direction is very low. In fact, the richest stations are in the central regions and in the south. The two most common species that were found together are *H. incongruens* and *P. villosa* with seven stations. The most diverse sampling site is the number 102, which is a trough with 6 species. Sampling site 71 has 5 different species although the number of species are not much.

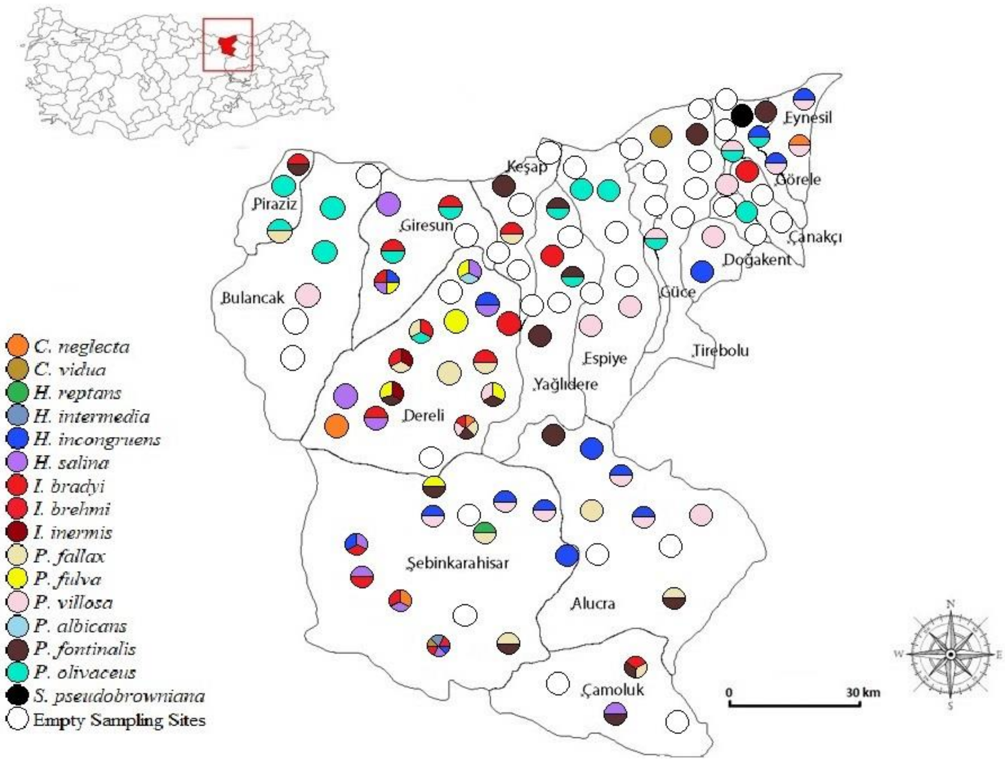

Figure 4.2. Distribution of ostracod species in Giresun province.

Throughout the field study, it was observed that the probability of finding station without any ostracod is somewhat less than 50%. However, it is seen that this ratio is 10% in the troughs (Table 4.2).

Table 4.2. Comparison of the habitat types with the ostracod observed sampling sites in the field study.

St.Ty	Total Sampling Site	Sites with Ostracod	Number of Species	Ratio of sampling sites with ostracod (%)	Number of species per Sites with ostracod
Lake	1	1	1	100.0	1
Creek	11	7	8	63.64	1.143
Trough	30	27	13	90.0	0.481
Stream	25	13	9	52.0	0.692
Pond	2	1	1	50.0	1
River	19	10	8	52.64	0.8
Waterbody	7	4	4	57.14	1
Pool	4	2	2	50.0	1
Waterfall	6	4	5	66.67	1.25

The detailed table of C2 software analysis results are available in Appendix C.

If we look at the optimum and tolerance values for pH, *P. olivaceus* is found at maximum point of optimum value and *Candona neglecta* is found at minimum. At the point of tolerance, *P. fulva* has a maximum level, *P. villosa* has minimum level.

For DO, *P. villosa* has the maximum value for both optimum and tolerance. On the other hand, *P. fulva* has the minimum optimum value and *P. fallax* has minimum tolerance level.

At the point of EC of water, *H. salina* has the maximum value for both optimum and tolerance. *C. neglecta* has minimum optimum and *P. villosa* has minimum tolerance.

The results of the Tw show that *P. fallax* has the minimum value for both tolerance and optimum. *P. olivaceus* has the maximum optimum value and *P. fontinalis* has the maximum tolerance level.

When we look at ORP, at the optimum point, *C. neglecta* has the maximum and *P. villosa* has the minimum value. For the tolerance level, *I. bradyi* has the maximum and *H. salina* has the minimum level.

For the elevation, *C. neglecta* has the maximum point of optimum and maximum level of tolerance. *P. olivaceus* has the minimum optimum value and *P. fallax* has the minimum tolerance level.

For the Na^{+}, *H. incongruens* has the maximum value of optimum and minimum level of tolerance. *I. bradyi* has the minimum optimum and *H. salina* has the maximum tolerance level.

For the K^{2+}, *I. bradyi* has the maximum of both optimum value and tolerance level. *P. fulva* has the minimum point of both optimum value and tolerance level.

For the Mg^{2+}, *I. bradyi* has the minimum of both optimum value and tolerance level. On the other hand, *P. olivaceus* has the maximum value for optimum and *C. neglecta* has the maximum level of tolerance.

For the Ca^{2+}, at the optimum point, *I. bradyi* has the maximum point and *C. neglecta* has the minimum point. At the tolerance level, *H. salina* has the maximum level and *P. fulva* has the minimum level.

For the F^{-}, *P. villosa* has the maximum of both optimum value and tolerance level. *P. fontinalis* has the minimum value of optimum and *P. fulva* has the minimum level of tolerance.

For the Cl^{-}, at the optimum point, *P. fontinalis* has the maximum value and *P. villosa* has the minimum value. At the tolerance level, *P. olivaceus* has the maximum level and *P. fallax* has the minimum level.

For the NO_2^-, at the optimum point, *P. olivaceus* has the maximum value and *P. fontinalis* has the minimum value. At the tolerance level, *I. bradyi* has the maximum and *P. fallax*.

For the NO_3^-, at the optimum point, *H. incongruens* has the maximum value and *P. olivaceus* has the minimum value. At the tolerance level, *P. fallax* has the maximum and *P. fulva* has the minimum level.

For the SO_4^{2-}, *P. olivaceus* has the minimum point of both tolerance point and optimum level. On the other hand, *C. neglecta* has the maximum point of optimum and *P. olivaceus* has the maximum level of tolerance.

For the inorganic phosphate ($InO.PO_4^{3-}$) amount of sediment, *P. fulva* has the both of maximum value of optimum and minimum level of tolerance. *P. fallax* has the minimum value of optimum and *C. neglecta* has the maximum level of tolerance.

For the organic phosphate ($O.PO_4^{3-}$) amount of sediment, *I. bradyi* has the maximum value of optimum and *P. fallax* has the minimum value of optimum. *P. villosa* has the maximum and *H. salina* has the minimum level of tolerance.

For the total phosphate ($T.PO_4^{3-}$) amount of sediment, *P. fulva* has the both of maximum value of optimum and minimum level of tolerance. *C. neglecta* has the minimum point of optimum and *P. fulva* has the minimum level of tolerance.

4.4 Carapace EDX (Energy Dispersive X-ray) Spectroscopy Analysis

According to the Table 4.3, the three basic elements that compose about 98 percent of the carapace are oxygen, carbon, and calcium. On the other hand, some carapace samples also contain elements that some of them are heavy metals, such as copper, silver, aluminum, silicon, sulfur, rubidium and argon. Interestingly, in EDX analysis of *Pseudocandona albicans*'s carapace in sampling area 64, technetium -an artificially obtained radioactive element- was encountered in very small quantities. A detailed version of these EDX analyses is available in the appendix (Appendix D).

Table 4.3. Elemental atomic percentages (%) from the carapace of 17 ostracod species according to EDX Analyses. Numbers written in parentheses indicate the sampling sites.

Species	C	O	Na	Mg	P	Ca	Sr
H. reptans (83)	36.046	48.884	0.301	0.198	0.493	14.049	0.029
H. incongruens (14)	29.069	54.520	0.316	0.222	0.285	15.264	0.004
P. fallax (72)	29.905	53.562	0.319	0.198	0.205	15.801	0.010
P. fulva (60)	27.502	53.715	0.302	0.251	0.261	17.957	0.012
P. olivaceus (13)	31.114	52.382	0.328	0.408	0.297	15.401	0.000
I. brehmi (102)	23.699	57.375	0.336	0.315	0.279	17.858	0.132
I. bradyi (71)	28.426	55.915	0.191	0.616	0.193	10.766	0.000
P. albicans (64)	26.771	54.821	0.267	0.170	0.245	17.543	0.040
P. villosa (6)	30.574	52.974	0.281	0.193	0.352	15.620	0.007
H. salina (60)	23.651	57.834	0.419	0.186	0.397	17.504	0.008
I. inermis (74)	31.049	54.246	0.241	0.122	0.268	13.777	0.017
P. fontinalis (98)	27.585	52.062	0.302	0.359	0.262	19.380	0.051
C. vidua (102)	33.279	49.880	0.366	0.277	0.377	15.633	0.000
*P. olivaceus (*24)	30.190	51.757	0.209	0.162	0.337	17.297	0.025
H. intermedia (102)	28.122	54.018	0.401	0.309	0.338	16.749	0.064
H. incongruens (92)	24.151	59.124	0.245	0.075	0.185	16.193	0.010
S. pseudobrowniana (15)	42.552	47.583	0.329	0.310	0.255	8.951	0.020
Mean	29.629	53.568	0.303	0.257	0.279	15.632	0.025
Minimum	23.651	47.583	0.191	0.075	0.185	19.380	0.000
Maximum	42.552	59.124	0.419	0.616	0.493	8.951	0.132

5. DISCUSSION AND CONCLUSION

Throughout this study, 16 species of freshwater Ostracoda were reported from Giresun province. All species are new record for Giresun. Previously, there is only one study about recent ostracod species of Giresun in the literature. Kılıç (2001) reputed from the area almost all of them brackish and marine forms (*Potamocypris steueri, Xestoleberis aurantia aurantia, Loxoconcha rhomboidea, Paradoxostoma guttatum, Callistocythere mediterranea, Pontocythere baceseoi, Eucytherura bulgarica)*. Moreover, there are previously no paleologic studies about Ostracoda in this area.

5.1 Evaluation of Data

Although having 6934 km^2 surface area, Giresun province has 16 different Ostracoda species in 105 sampling sites (Appendix A). The most common species among these 105 stations are *I. bradyi* and *P. villosa* with 18 stations. Subsequently, *P. fontinalis* in 16 stations, *P. olivaceus* and *H. incongruens* in 15 stations and *P. fallax* in 12 stations were found. *I. bradyi, P. villosa, P. olivaceus* and *H. incongruens,* already known to be cosmopolitan (Külköylüoğlu, 2007), have been observed in many studies in all over the world especially Anatolia and Black Sea regions (Kılıç, 2011; Yavuzatmaca et al., 2017; Külköylüoğlu et al., 2012c; 2007; Külköylüoğlu, 2004; Rossi et al., 2011). All of these 16 species are first record for Giresun province.

Candona neglecta, was found from four sampling sites which are three of them trough and one of them pond. The species, which has the minimum optimum in terms of pH, electrical conductivity and the amount of calcium in the water, has maximum optimum value for ORP and sulfate amount of water. On the other hand, this species has maximum tolerance level for magnesium amount of water and inorganic phosphate of sediment. Lastly for this species, elevation is an important variable because *C. neclecta* has maximum tolerance level and optimum point. These results are supported to previous findings for electrical conductivity (Pieri et al., 2009, Rasouli et al., 2014), elevation (Külköylüoğlu 2012b; 2013). On the other hand, the values of water temperature in the range of 8.70 °C and 14.60 °C confirm that this species prefers relatively cold waters (Meisch, 2000; Külköylüoğlu, 2005a; Külköylüoğlu, et al., 2012b).

Cypridopsis vidua was found in two sampling sites and both of them are trough. This species has very large geographical distribution all over the world (Martens and Savatenalinton, 2011) and it is an example of cosmocious species (Külköylüoğlu, 2013). Because it was found in only two stations, we could not reaches any general consensus.

Heterocypris incongruens was found in fifteen sampling sites and nearly all of them are trough (except one creek and one water body). The statement that the stagnant and shallow habitat types are more suitable for this species (Külköylüoğlu, 2012b) was supported by this study. This species, known as the "horse trough" ostracod (Fryer, 1997), is widely distributed around the world (Martens et al., 2013). We can say that it is a good example as a cosmocious species (Külköylüoğlu, 2013). According to CCA results of this study, this species reversely related with electrical conductivity, nitrate and magnesium of water (Figure 4.1). This species has the minimum optimum value in terms of oxidation reduction potential and has the maximum optimum value and the minimum tolerance level depending on the sodium amount in the water.

Heterocypris salina was found in eleven sampling sites and nearly all of them are trough (except one stream, one river and one lake). The distribution of this species is Nearctic, Neotropical and Palearctic regions (Martens et al., 2013). According to CCA results, this species has maximum tolerance level and optimum estimates for electrical conductivity. This finding supports one of the previous study (Malmqvist et al., 1997). It is also supported that the amount of calcium in the water has the maximum level of tolerance (Van der Meeren et al., 2010). This species has minimum tolerance level for ORP and air temperature and has maximum optimum point for water temperature. This situation about water temperature is supported by previous studies (Uçak et al., 2014; Mezquita et al., 2001; Meisch, 2000). Additionally, it has been found that *H. salina* has a maximum level of tolerance in terms of sodium and sulphate. Lastly, finally, it has once again proven that it is a cosmopolitan species with such high tolerance and optimum value.

Ilyocypris bradyi was found in 18 sampling sites and their distribution as habitat types are eight trough, four river, three stream, two creek and one waterfall. As a cosmoecious species (Külköylüoğlu, 2013), *I. bradyi* is found nearly all aquatic habitats (Meisch, 2000; Pieri et al., 2009; Li et al., 2010) and all over the world (Meisch, 2010; Martens and Savatenalinton, 2011; Külköylüoğlu et al., 2012b). According to C2 analysis, this species has maximum tolerance level for ORP and nitrate. According to a previous study (Bunbury and Gajewski, 2005), *I. bradyi*, which appears to have a high tolerance for the amount of sodium in the water, has the lowest optimum value in this study. This finding also suggests that there is an inverse relationship between tolerance and optimum values. On the other hand, for potassium content of water, it has maximum optimum and tolerance level, while minimum optimum tolerance and optimum level for magnesium content of water.

Potamocypris fallax was found in twelve sampling site and their distribution as habitat types are three through, two creek, stream and river, a pool and a waterfall. This species is found in Palearctic region (Martens et al., 2013) and can be found in both stagnant and mobile habitat types (Meisch, 2000; Külköylüoğlu et al., 2012a,c). As in a previous study (Külköylüoğlu, 2013), this study showed negatively significant correlation with water temperature (Figure 4.1). Also, this species has minimum tolerance and optimum value in terms of water temperature. Despite previous work (Akdemir and Külköylüoğlu, 2014), this species has a minimum level of tolerance to the amount of dissolved oxygen in the water in this study. *P. fallax* has maximum tolerance and optimum value for nitrate amount of water.

Potamocypris fulva was found in six sampling site and their distribution as habitat types are two stream, two river, a trough and a creek. This species is found in Palearctic region like *P. fallax* (Martens et al., 2013). It has been found that this species has a minimum tolerance and optimum value to the phosphate amount in the water. Additionally, this species has the maximum optimum value for the total amount of phosphate in sediment, while it has the minimum tolerance value for both inorganic and organic as well as total phosphate.

Potamocypris villosa was found in eighteen sampling site and their distribution as habitat types are ten trough, three water body, two creek, a river and a stream. This species also known as one of the cosmopolitan species. In a previous study (Külköylüoğlu and Yılmaz, 2006), it was observed that this species was positively related to the electrical conductivity, although it was negatively corelated with all of electrical conductivity, nitrate and magnesium in this study. Furthermore, this species has maximum tolerance level and optimum point for dissolved oxygen and fluoride of water and maximum tolerance level for pH of water and organic phosphate of sediment.

Psychrodromus fontinalis was found in sixteen sampling sites and their distribution as habitat types are six stream, five trough, two creek, a waterfall, a river and a water body. This species is shown distribution in Palearctic region (Martens et al., 2013) and are observed in many habitat types. Like previous studies (Meisch, 2000; Pieri et al., 2009; Külköylüoğlu et al., 2013), in this study, this species has the wide range tolerance for water temperature. Also, it has maximum tolerance range for total phosphate amount of sediment.

Psychrodromus olivaceus was found in fifteen sampling sites and their distribution as habitat types are five stream, four river, two creek, a trough, a waterfall, a water body and a pool. From this perspective, *P. olivaceus*, is the only species observed in seven different habitat types in this study. Therefore, it is well known cosmoecious species (Külköylüoğlu, 2013) that is found in Palearctic region (Martens et al., 2013). Although this species did not show any relationships with most effective variables, it has the maximum optimum values for pH, air temperature, magnesium and nitrite of water and inorganic phosphate of sediment.

Ilyocypris brehmi was found in only one sampling site and this through is sampling site 102 that has the most species richness.

Ilyocypris inermis was found from two stream sites with one individual each.

Scottia pseudobrowniana was found from a stream site and this is a very rare species for Turkey. Previously, Külköylüoğlu (2003a) reported first record for Turkey and this study is the second record on 15^{th} sampling site with two individuals.

Pseudocandona albicans was found from a river site with two individuals.

Herpetocypris reptans and *Herpetocypris intermedia* were found in only one sampling site and they were throughs.

According to Figure 4.2, *P. olivaceus* seems to be not able to migrate to the southern region while it has wide distribution in the northern regions. The Giresun Mountains, which extend along the western and eastern regions of the Giresun region, range in height from 1700 to 2000 meters. According to previous findings about *P. olivaceus*, (Külköylüoğlu, 2013; Meisch, 2000), the maximum range in terms of elevation is 1300- 1700 meters. These findings suggest that the distribution of *P. olivaceus* is restricted in the northern region by the Giresun Mountains.

On the other hand, according to a previous study (Ganning, 1971), *H. incongruens and H. salina* never occur together but recent study showed us four sampling sites have these two species.

Although, it is known that the species diversity in the troughs are generally less than the other habitat types (Külköylüoğlu et al., 2013b), they are considered to be the richest habitat type in this study. However, the fact that the number of samples was predominantly trough is thought to be the cause of this result. On the other hand, nearly all habitat types had around fifty percent of non-empty sampling site ratio, while troughs are around ninety percent. We can attribute this to the fact that the number of cosmopolitan species were high. Because there is a direct proportion between the number of troughs and the number of cosmopolitan species.

CCA results (Figure 4.1) show that water temperature along with other three variables (EC, Nit, Mg) was the most effective variables on species.

For EDX Analysis results (Apendix C), the sample with the highest percentage of calcium is *P. fontinalis*, taken from sampling point 62 and the sample with the highest percentage of magnesium *I. bradyi*, taken from sampling point 71.

According to Turpen and Angel (1971), Ca^{+2} of the carapace is formed from marginal sides to the center of the carapace during molting stage. Based on this information, one may claim know that the later-acquired calcium participates in the carapace chemistry through water, not directly from the sediment. Although there is still controvertial issues on the movement of Ca^{2+} trough carapace, studies show that water is probably the main source of Ca^{2+} in carapace. However, due to lack of Ca^{2+} in sediment that we were not able to measure, a clear relationship between sediment and carapace cannot be made in the present study. In addition to this, since there was no significant relationship between the levels of pollutants and any environmental factors in those aquatic sites sampled, a general conclusion cannot be provided to show such relationship.

When the relation among sediment, water and carapace is considered, some other factors (e.g., ORP, DO, and phosphate as well) might be critical to explain such associations. This is probably why these two variables might give us the most positive information about eutrophication levels. If so, a range beyond the tolerance levels of the species would not be observed. Unfortunately, the values of ORP and DO ranges are too small to make general approach displaying their importance on the issue discussed herein.

Percent values of Mg^{2+} and Ca^{2+} (Mg/Ca) showed an increasing trend close to each other. However, this (although not comparatively correct) is just a simple linear relationship and is not valued as significant (Figure 5.1).

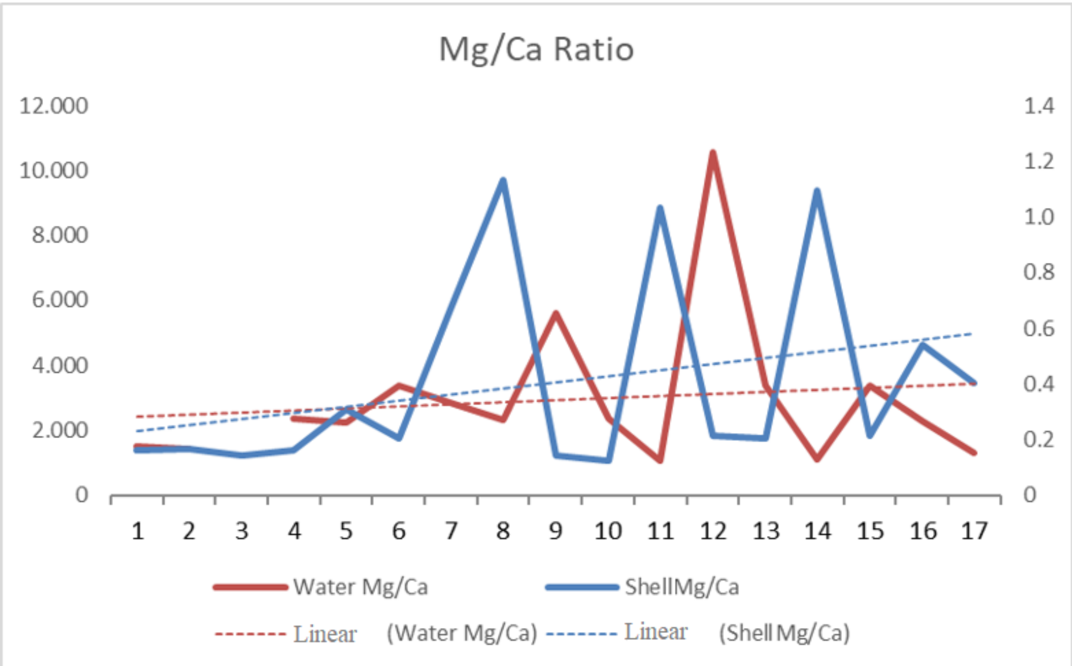

Figure 5.1. The relationship between carapace and water's Mg/Ca ratio.

Finally, this comprehensive study has provided new ostracod records and their ecological data for Giresun province. On the other hand, both ecological data of aquatic habitat in the region, as well as a very important findings about the impact on ostracods of these data have been identified. However, due to reasons such as the inadequate number of EDX specimens, the vast majority of species being cosmopolitan species, no clear information on the effect of environmental factors on the shell was obtained.

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APPENDICES

7. APPENDICES

Appendix A Ecological variables and taxa were reported from different aquatic bodies in Giresun. Abbreviations: St. no: site number, St. Ty.: station type, DO (dissolved oxygen concentration, mgL^{-1}), % DO (percent saturation), EC (electrical conductivity, µScm^{-1}), Sp. EC (specific electrical conductivity), Sal (salinity, ppt), Tw (water temperature, ºC), Ta (air temperature, ºC), TDS (total dissolved solid, mgL^{-1}), Atm. (atmospheric pressure, mmHg), Moist. (Moisture, %), Elev. (Elevation, m a.s.l), W. S. (wind speed, kmh^{-1}), CN: *Candona neglecta*, CV: *Cypridopsis vidua*, HR:*Herpetoypris reptans* , HIm: *Herpetocypris intemedia*, HI: *Heterocypris incongruens*, HSa: *Heterocypris salina*, IBr: *Ilyocypris bradyi*, IBe: *Ilyocypris brehmi*, II: *Ilyocypris inermis*, PF: *Potamocypris fallax*, PFu: *Potamocypris fulva*, PVi: *Potamocypris villosa*, PAl: *Pseudocandona albicans*, PFo: *Psychrodromus fontinalis*, PO: *Psychrodromus olivaceus*, SPb: *Scottia pseudobrowniana*. Site types; 1: lake, 2: creek, 3: trough, 4: stream, 5: pond, 6: river, 7: water body, 8: pool and 9: waterfall.

Appendix A (continued)

St. No	St. Ty	pH	DO	%DO	EC	Spe. EC	Tw	Ta	Atmp	ORP	Moist.	W.S	Elev	Sal.	TDS	Species
1	3	7.74	8.96	86.7	851.0	1090.0	13.5	22.8	732.7	301.9	67.9	0.0	388	0.54	723.50	IBr, PFo
2	4	7.88	8.71	91.9	397.5	459.6	17.9	23.5	740.3	308.7	66.3	1.7	308	0.22	299.00	PO
3	9	8.18	8.98	89.6	472.2	582.1	15.1	23.1	711.0	317.2	65.6	1.7	529	0.28	378.30	PF, PO
4	6	8.20	8.46	89.8	436.7	499.8	18.4	23.8	757.5	321.7	67.4	0.0	76	0.24	325.00	PO
5	6	8.01	8.41	87.0	409.1	480.2	17.3	22.2	744.9	324.7	74.5	2.3	225	0.23	312.00	PO
6	3	7.79	9.29	91.2	1687.0	2108.0	14.5	23.4	716.2	337.7	66.2	1.5	587	1.09	1371.50	PVi
7	4	7.95	9.08	90.3	287.7	353.9	15.2	18.4	703.8	328.1	74.6	6.2	755	0.17	230.10	
8	8	7.59	7.53	69.7	413.7	526.9	13.7	19.7	679.5	326.1	72.8	0.0	1056	0.26	342.65	
9	4	7.47	5.70	62.2	578.0	645.0	19.6	22.8	766.0	327.2	74.5	0.0	21	0.31	422.50	
10	7	7.55	7.10	69.5	121.7	154.9	14.5	15.7	708.9	338.9	76.2	4.9	677	0.07	98.80	HI, PVi
11	3	6.51	8.11	80.1	114.7	143.0	14.6	13.2	697.6	368.3	84.2	8.5	821	0.07	92.95	CN, PVi
12	9	8.16	8.12	85.8	614.0	710.0	17.9	23.5	756.4	360.1	69.0	0.0	140	0.35	461.50	PFo
13	3	8.50	8.91	93.2	895.0	1062.0	17.6	24.3	743.1	352.3	63.4	0.0	292	0.52	676.00	HI, PO
14	3	8.35	8.79	87.2	332.8	408.8	15.2	19.9	689.2	335.2	60.6	2.1	932	0.20	265.85	HI, PVi
15	4	8.79	9.31	97.1	199.6	169.6	17.1	21.9	739.2	349.2	68.5	2.1	317	0.09	130.00	SP
16	6	8.81	8.91	89.2	699.0	761.0	20.7	23.6	765.8	332.2	61.3	13.9	29	0.37	494.00	
17	6	9.15	8.98	101.0	674.0	730.0	21.0	24.8	757.8	317.9	45.8	3.6	101	0.36	474.50	PVi, PO
18	2	8.28	6.92	74.0	841.0	960.0	18.6	25.8	747.2	322.4	44.2	1.5	215	0.48	624.00	IBr
19	8	8.53	8.04	85.6	313.1	354.8	18.9	28.1	736.3	323.7	45.2	2.3	337	0.17	230.10	
20	4	8.49	8.70	89.4	593.0	703.0	16.8	24.1	719.0	317.5	52.4	9.7	540	0.34	455.00	

Appendix A (continued)

St. No	St. Ty	pH	DO	%DO	EC	Spe. EC	Tw	Ta	Atmp	ORP	Moist.	W.S	Elev	Sal.	TDS	Species
21	6	9.47	11.11	145.7	15153.0	14577.0	27.1	24.9	766.6	256.6	62.4	6.5	-8	8.40	9444.50	
22	3	9.52	8.31	91.7	438.0	479.5	20.4	25.9	744.6	252.3	57.9	1.8	261	0.23	312.00	PVi
23	4	8.16	9.21	92.7	313.8	381.1	15.7	21.5	725.4	330.5	61.4	2.9	495	0.18	247.65	
24	2	8.03	7.90	77.9	540.0	667.0	14.8	21.2	714.3	330.1	70.9	0.0	610	0.33	435.50	PO
25	6	8.43	8.19	86.6	746.0	862.0	17.9	21.8	745.6	335.2	66.9	6.2	254	0.42	559.00	
26	7	7.62	6.95	69.4	508.0	620.0	15.5	14.3	747.8	351.5	78.0	3.2	186	0.30	403.00	
27	4	7.91	7.06	72.3	579.0	690.0	16.6	16.3	757.1	367.7	70.9	2.1	77	0.34	448.50	PFo
28	6	7.88	7.52	76.3	2724.0	3336.0	15.4	15.5	759.4	363.1	78.3	4.2	52	1.76	2171.00	
29	3	8.43	9.64	85.4	277.2	389.9	10.2	14.6	669.1	314.6	57.3	11.3	1124	0.19	252.20	
30	2	7.98	7.65	72.7	261.5	334.3	13.6	13.5	714.8	353.4	70.6	3.7	566	0.16	217.10	
31	9	7.85	9.72	91.9	345.1	449.9	12.8	17.4	728.9	317.5	63.9	0.0	420	0.22	292.50	PVi
32	3	7.92	8.57	79.7	119.1	157.2	12.4	13.3	694.8	358.6		3.8	817	0.07	102.05	HI
33	4	7.61	7.94	77.9	566.0	709.0	14.5	19.3	735.2	380.1	60.4	4.2	334	0.35	461.50	PVi, PO
34	4	7.90	8.92	91.3	274.4	326.3	16.4	22.0	749.0	363.3	64.2	1.6	225	0.16	213.20	
35	6	8.16	9.46	96.0	449.0	541.7	16.0	27.0	757.7	355.1	50.5	3.8	70	0.26	352.30	
36	3	7.33	7.74	77.9	375.6	456.3	15.8	23.1	739.5	348.4	59.9	9.5	267	0.22	297.05	CV
37	4	7.14	4.25	47.7	572.0	618.0	21.2	24.6	761.3	356.5	56.4	7.2	7	0.30	403.00	
38	8	8.16	8.23	84.4	904.0	1074.0	16.8	24.2	749.7	351.1	57.7	8.1	127	0.53	702.00	PO
39	4	8.33	9.02	91.3	760.0	923.0	15.7	23.1	729.7	354.7	60.6	1.8	365	0.46	598.00	
40	9	8.46	8.45	81.4	674.0	852.0	13.7	22.1	711.1	359.2	60.8	1.6	586	0.43	559.00	

Appendix A (continued)

St. No	St. Ty	pH	DO	%DO	EC	Spe. EC	Tw	Ta	Atmp	ORP	Moist.	W.S	Elev	Sal.	TDS	Species
41	7	9.96	9.54	104.2	312.3	319.9	23.9	20.8	705.2	320.2	63.3	4.9	653	0.15	208.65	PVi
42	7	8.01	9.95	90.3	294.7	400.3	11.2	20.3	679.5	277.2	60.5	1.4	969	0.19	260.65	PVi
43	7	7.84	9.93	90.6	213.4	289.0	11.3	19.6	666.6	309.8	60.6	1.5	1138	0.14	187.20	
44	4	8.04	9.23	89.4	377.3	479.7	13.8	18.8	721.2	347.2	71.8	2.1	469	0.23	313.30	PFo, PO
45	6	8.22	8.88	90.2	832.0	1010.0	16.0	15.8	755.6	373.1	82.2	2.4	35	0.50	656.50	PFo
46	9	8.30	8.85	87.1	543.0	670.0	15.1	14.3	748.8	366.5	76.7	4.2	148	0.33	435.50	
47	6	8.28	8.54	80.0	951.0	1257.0	12.3	12.8	717.9	372.3	68.3	4.4	497	0.63	819.00	Ibr, PF
48	2	8.25	9.48	87.0	213.5	287.1	11.6	16.2	691.7	365.8	67.7	2.7	788	0.14	186.55	
49	2	8.17	8.44	77.6	543.0	730.0	11.7	17.1	474.5	381.6	62.4	2.6	931	0.36	474.50	
50	4	8.21	9.33	96.3	290.7	344.3	16.8	20.7	754.1	362.8	76.7	1.9	49	0.17	224.60	
51	7	7.77	8.02	85.4	389.7	450.2	18.0	24.1	756.3	361.9	57.7	0.0	17	0.22	292.50	
52	4	8.56	8.93	90.4	780.0	939.0	16.2	24.7	751.3	360.9	58.5	2.0	73	0.47	611.00	PO
53	7	8.29	6.06	83.9	980.0	1137.0	17.8	23.6	743.2	339.6	61.8	0.0	200	0.57	741.00	PFo, PO
54	6	8.81	10.24	103.9	1009.0	1216.0	16.1	21.6	736.0	316.9	64.3	4.5	236	0.61	793.00	
55	6	8.67	9.24	92.7	978.0	1193.0	15.6	24.3	722.4	315.8	47.5	0.0	411	0.60	773.50	IBr
56	6	8.98	9.33	92.4	1039.0	1294.0	14.7	24.8	713.0	313.6	38.2	4.3	513	0.65	838.50	
57	4	8.17	5.53	55.4	694.0	863.0	14.8	23.5	702.4	344.3	49.3	2.3	639	0.43	559.00	PFo
58	4	8.62	7.69	83.8	1323.0	1472.0	19.7	24.1	750.3	330.5	58.5	6.7	49	0.74	995.50	HSa
59	6	8.51	8.65	92.1	1580.0	1802.0	18.6	24.0	741.3	329.1	59.7	4.8	157	0.92	1170.00	IBr, PO
60	3	8.16	7.43	73.1	872.0	1090.0	14.4	24.9	714.2	340.0	58.5	1.5	477	0.54	708.50	HI, HSa, IBr, PFu

Appendix A (continued)

St. No	St. Ty	pH	DO	%DO	EC	Spe.EC	Tw	Ta	Atmp.	ORP	Moist.	W.S	Elev.	Sal.	TDS	Species
61	4	8.54	9.16	95.7	882.0	1032.0	17.4	25.3	748.7	342.4	58.6	0.0	64	0.51	669.50	IBr, PO
62	4	8.62	8.72	91.2	638.0	738.0	17.9	23.0	745.0	342.0	65.9	4.6	105	0.36	481.00	
63	6	8.66	7.76	80.5	1269.0	1489.0	17.2	22.4	742.9	342.0	65.9	5.2	134	0.75	968.50	
64	6	8.45	9.17	92.9	1457.0	1768.0	16.0	22.1	738.3	344.7	69.4	3.6	185	0.90	1144.00	HSa, PFu, PAl
65	6	8.17	9.16	91.2	1350.0	1670.0	15.0	22.7	727.8	351.4	67.1	1.5	306	0.85	1085.50	
66	3	8.50	7.31	79.2	1475.0	1663.0	19.1	20.9	712.3	342.3	67.9	3.6	497	0.84	1079.00	HI, HSa
67	9	8.69	8.60	84.7	972.0	1215.0	14.6	19.0	701.7	342.5	67.9	1.5	620	0.61	793.00	IBr
68	6	8.45	9.98	95.4	1451.0	1884.0	13.1	18.0	712.3	370.0	70.1	1.5	507	0.96	1228.50	PFu
69	6	7.48	8.78	79.5	970.0	1337.0	10.8	16.7	665.2	341.5	64.8	1.6	1069	0.67	864.50	IBr, PF
70	2	8.01	15.20	136.2	221.7	382.3	4.2	9.5	615.8	361.7	68.4	5.2	1715	0.18	235.25	PFu, PVi, Pfo
71	3	7.72	8.97	85.1	581.0	751.0	13.1	14.7	636.4	373.3	59.2	3.2	1430	0.37	487.50	CN, IBr, PF, PVi, Pfo
72	8	8.18	7.58	69.2	3862.0	5326.0	10.6	14.6	666.2	353.5	73.0	2.0	1079	2.89	3464.50	PF
73	2	8.61	9.01	77.5	347.3	502.3	8.9	17.9	630.4	304.4	60.4	0.0	1529	0.24	327.60	HSa, PF, PO
74	4	8.53	9.34	84.3	820.0	1129.0	10.7	17.2	654.4	333.2	69.3	0.0	1213	0.56	734.50	IBr, II, PF
75	4	8.23	8.76	78.3	304.3	422.1	10.4	18.8	643.7	340.3	61.3	0.0	1354	0.20	274.30	II, PFu, Pfo
76	3	7.79	9.56	87.3	148.3	213.5	9.0	17.8	611.1	369.1	55.8	0.0	1768	0.10	139.75	HSa, Ibr
77	5	7.75	6.47	55.5	71.9	103.9	8.7	12.8	570.4	368.4	62.7	4.2	2335	0.05	67.80	CN
78	1	9.02	7.73	65.7	128.5	185.9	9.1	3.0	541.9	366.9	86.9	15.4	2752	0.09	120.25	Hsa
79	4	8.13	9.00	82.4	357.7	484.4	11.3	17.2	639.6	366.8	58.2	1.5	1393	0.24	314.60	
80	4	8.36	8.98	81.0	184.9	253.7	10.9	12.9	603.3	361.1	54.2	10.5	1869	0.12	165.10	PFu, PFo

Appendix A (continued)

St. No	St. Ty	pH	DO	%DO	EC	Spe. EC	Tw	Ta	Atmp	ORP	Moist.	W.S	Elev	Sal.	TDS	Species
81	3	8.20	8.15	75.5	211.5	280.3	12.1	16.3	598.2	356.5	51.9	0.0	1943	0.13	182.00	HI, PVi
82	4	7.96	8.74	81.6	327.8	433.5	12.2	20.4	633.5	339.6	52.4	0.0	1477	0.21	282.10	
83	3	8.37	9.18	83.1	1051.0	1441.0	10.9	18.0	655.1	349.1	58.1	6.0	1195	0.73	936.00	HR, PF
84	3	8.12	8.04	72.3	983.0	1224.0	12.8	15.4	652.1	342.7	72.5	6.1	1240	0.61	793.00	HI, PVi
85	3	9.26	15.82	156.0	604.0	752.0	14.7	10.2	636.9	326.5	85.1	12.3	1433	0.37	487.50	HI, PVi
86	3	8.03	6.77	64.7	954.0	1227.0	13.4	12.1	645.8	348.2	81.2	7.3	1311	0.62	799.50	HI
87	5	7.33	2.76	25.8	439.9	576.9	12.6	12.8	625.3	327.6	70.9	5.7	1581	0.28	373.75	
88	2	7.59	7.80	71.1	958.0	1273.0	11.2	14.7	636.6	349.6	70.6	2.4	1435	0.64	864.00	PF
89	3	8.17	8.55	78.9	809.0	1132.0	11.1	15.1	609.0	345.9	60.6	0.0	1811	0.58	721.50	PFo
90	3	8.02	8.90	81.4	305.9	406.8	11.9	16.8	630.2	346.1	72.5	0.0	1532	0.20	267.15	HI
91	3	8.05	6.95	66.8	684.0	826.0	13.5	12.0	637.1	283.3	78.7	2.4	1480	0.42	552.50	HI, PF
92	2	8.23	8.02	70.9	854.0	1199.0	9.7	14.9	626.1	292.9	59.9	0.0	1627	0.61	799.50	HI, PF
93	4	8.16	8.78	79.1	284.7	390.1	10.7	15.1	624.8	301.6	54.2	4.1	1655	0.19	254.80	
94	3	7.05	7.97	73.5	387.5	518.0	11.8	15.8	615.7	333.4	48.9	2.4	1781	0.25	336.05	PF
95	2	8.34	8.33	75.3	849.0	1165.0	10.8	16.5	629.1	350.8	53.9	3.6	1609	0.58	760.50	PF, PFo
96	4	8.32	9.20	86.3	1428.0	1885.0	12.3	18.4	657.0	367.0	54.3	7.6	1250	0.96	1228.50	IBr, PF, PFo
97	2	8.54	8.83	81.5	1014.0	1390.0	11.9	20.0	668.5	384.4	61.4	0.0	1103	0.70	903.50	
98	3	7.80	7.44	78.1	5118.0	6479.0	16.9	16.7	672.4	392.4	58.9	17.4	1072	3.31	3926.00	HSa, PFo
99	3	8.16	7.06	71.6	1010.0	1220.0	16.0	20.8	664.6	377.9	57.6	5.4	1156	0.61	793.00	
100	3	8.47	9.65	87.1	794.0	1116.0	9.1	24.1	621.5	377.2	40.5	3.0	1705	0.57	741.00	PF, PFo

Appendix A (continued)

St. No	St. Ty	pH	DO	%DO	EC	Spe. EC	Tw	Ta	Atmp	ORP	Moist.	W.S	Elev	Sal.	TDS	Species
101	3	8.65	8.81	85.4	1831.0	2305.0	14.2	22.5	664.9	382.5	47.6	0.0	1150	1.19	1501.50	
102	3	8.20	9.67	94.2	1649.0	2092.0	13.9	19.2	652.5	385.3	49.0	1.7	1296	1.08	1358.50	CV, HIm, HI, HSa, IBr, IBe
103	3	7.94	7.45	70.2	2140.0	2824.0	12.3	19.1	647.5	386.6	54.1	2.6	1361	1.47	1839.00	CN, HSa, IBr
104	3	7.80	7.78	83.4	7673.0	9054.0	17.0	23.1	678.9	378.6	44.4	2.8	963	5.09	5889.00	HSa, IBr
105	3	7.54	6.29	60.7	1949.0	2497.0	13.6	21.6	650.2	207.2	42.3	2.2	1335	1.30	1625.00	HI, Hsa, IBr

Appendix B Chemical variables on water and sediment were reported from different aquatic bodies in Giresun. Abbreviations: Na^{+}: sodium ion concentration of the water (ppm), K^{2+}: potassium ion concentration of water (ppm), Mg^{2+}: Magnesium ion concentration of water (ppm), Ca^{2+}: calcium ion concentration of water (ppm), F^{-}: flouride ion concentration of water (ppm), Cl^{-}: chloride ion concentration of water (ppm), NO_2^{-}: nitrite ion concentration of water (ppm), NO_3^{-}: nitrate ion concentration of water (ppm), SO_4^{2-}: sulphate ion concentration of water (ppm), $T.PO_4^{3}$: total phosphate ion concentration of sediment, $InO.PO_4^{3-}$: inorganic phosphate ion concentration of sediment, $O.PO_4^{3-}$: organic phosphate ion concentration of sediment.

Appendix B (continued)

St. No	Na^+	K^{2+}	Mg^{2+}	Ca^{2+}	F^-	Cl^-	NO_2^-	NO_3^-	SO_4^{2-}	T. PO_4^{3-}	InO.PO_4^{3-}	O.PO_4^{3-}	Coordinate	Date
1	3.11	1.93	8.01	40.07		3.54	0.28	12.44	3.47	0.79	0.72	0.272	N 40° 53' 38.8" E 38° 06' 07.5"	03.10.2015
2	2.32	1.03	3.15	23.61		2.00	0.13	4.75	10.91	0.59	0.75	0.91	N 40° 51' 39.6" E 38° 04' 27.9"	03.10.2015
3	7.72	0.21	2.11	13.49	0.05	1.49	0.22	10.57	2.83	0.585	0.735	0.76	N 40° 50' 12.8" E 38° 05' 18.6"	03.10.2015
4	4.17	1.46	3.85	30.49	0.07	2.94	0.17	1.68	34.49	0.55	0.45	0.112	N 40° 50' 59.4" E 38° 08' 18.9"	03.10.2015
5	3.63	1.33	3.26	29.09	0.10	3.00	0.15		38.72	0.645	0.59	0.139	N 40° 47' 12.8" E 38° 09' 01.9"	03.10.2015
6	5.09	0.50	36.57	55.99	0.28	2.26			353.28	0.46	0.36	0.81	N 40° 44' 23.0" E 38° 07' 53.1"	03.10.2015
7	3.46	1.44	2.27	10.08	0.04	2.08	0.12	0.15	22.32	0.515	0.495	0.8	N 40° 41' 38.7" E 38° 06' 08.9"	03.10.2015
8	5.40	1.48	4.08	12.91	0.11	1.56	0.12	0.13	58.43	0.795	0.78	0.44	N 40° 40' 08.2" E 38° 04' 05.7"	03.10.2015
9	4.57	1.61	5.03	38.84	0.05	2.88	0.23	1.19	33.73	0.76	0.51	0.243	N 40° 54' 14.1" E 38° 10' 22.3"	03.10.2015
10	1.06	2.99	0.61	12.25		1.54	0.08	0.16	12.99	0.955	0.745	0.73	N 41° 00' 15.8" E 39° 08' 29.8"	04.10.2015
11	1.88	1.19	0.98	19.87	0.11	1.28	0.30		2.32	1.26	1	0.248	N 40° 59' 07.9" E 39° 08' 01.0"	04.10.2015

Appendix B (continued)

St. No	Na^{+}	K^{2+}	Mg^{2+}	Ca^{2+}	F^{-}	Cl^{-}	NO_2^{-}	NO_3^{-}	SO_4^{2-}	T. PO_4^{3-}	InO.PO_4^{3-}	O.PO_4^{3-}	Coordinate	Date
12	15.11	2.53	5.54	26.43	0.13	4.50	0.21	2.85	28.33	0.855	0.83	0.34	N 41° 00' 09.1" E 39° 06' 09.9"	04.10.2015
13	15.44	0.22	12.20	46.64	0.11	2.41	0.41	0.12	8.14	0.75	0.8	0.34	N 40° 57' 39.9" E 39° 06' 40.6"	04.10.2015
14	5.33	0.99	5.52	32.74		1.97	0.27	3.63	2.35				N 40° 57' 46.2" E 39° 08' 44.8"	04.10.2015
15	7.79	0.62	5.86	38.45	0.06	6.49	0.17	19.69	5.44	0.735	0.63	0.29	N 40° 57' 43.8" E 39° 05' 19.2"	04.10.2015
16	4.76	0.84	4.33	20.17	0.03	3.33	0.14	1.88	27.53	0.6	0.495	0.183	N 41° 00' 34.9" E 38° 59' 22.9"	04.10.2015
17	5.01	0.90	4.33	22.34	0.09	2.54	0.15	2.25	29.24				N 40° 57' 12.1" E 38° 59' 50.5"	04.10.2015
18	14.87	3.44	6.64	41.49	2.15	17.85	0.24		10.81	0.43	0.17	0.76	N 40° 53' 35.3" E 39° 00' 01.6"	04.10.2015
19	2.57	0.53	2.23	35.82		1.46	0.22	0.76	10.81	0.36	0.585	0.19	N 40° 52' 20.3" E 39° 03' 07.9"	04.10.2015
20	5.51	1.36	4.16	36.77		1.90	0.15	1.68	14.75	0.345	0.34	0.43	N 40° 51' 00.9" E 39° 06' 06.0"	04.10.2015
21	2.52	0.16	2.21	16.09					149.85	0.61	0.6	0.54	N 41° 02' 16.8" E 38° 59' 34.2"	04.10.2015
22	11.36	6.41	1.33	36.49	3.83	12.09	0.17	1.02	4.37				N 40° 55' 05.5" E 38° 56' 59.8"	04.10.2015

Appendix B (continued)

St. No	Na^{+}	K^{2+}	Mg^{2+}	Ca^{2+}	F^{-}	Cl^{-}	NO_2^{-}	NO_3^{-}	SO_4^{2-}	T. PO_4^{2-}	InO.PO_4^{3-}	O.PO_4^{3-}	Coordinate	Date
23	2.15	0.27	2.30	9.66		1.54	0.11	5.46	9.98	0.53	0.21	0.152	N 40° 51' 24.7" E 38° 57' 36.4"	04.10.2015
24	1.55	0.56	1.23	9.37		0.85	0.10	2.99	8.76	0.68	0.515	0.169	N 40° 50' 02.3" E 38° 57' 20.9"	04.10.2015
25	5.08	1.03	5.97	36.44	0.04	1.79	0.21		34.57				N 40° 47' 15.4" E 38° 55' 50.8"	04.10.2015
26	5.07	1.53	1.85	49.10	0.02	3.53	0.24	31.28	2.68	0.465	0.445	0.17	N 40° 58' 13.6" E 38° 53' 12.4"	05.10.2015
27	7.14	1.51	5.96	19.28		4.75	0.17	6.57	28.84	0.19	0.85	0.44	N 40° 55' 22.9" E 38° 53' 20.5"	05.10.2015
28	18.41	0.90	29.65	106.16	0.04	4.50	0.47	0.98	281.90	0.36	0.245	0.35	N 40° 53' 17.6" E 38° 51' 56.0"	05.10.2015
29	677.32	22.18	49.15	43.79	0.04	0.68	0.29	2.10	6.47				N 40° 48' 30.1" E 38° 52' 58.6"	05.10.2015
30	5.14	0.28	3.25	23.22		1.32	0.14	4.46	24.00	0.36	0.16	0.158	N 40° 49' 44.6" E 38° 50' 59.0"	05.10.2015
31	3.42	0.31	2.67	19.36	0.03	1.10	0.13	3.18	29.91	0.51	0.18	0.171	N 40° 47' 03.7" E 38° 51' 25.9"	05.10.2015
32	2.78	0.56	1.51	36.62		1.60	0.19	4.13	2.13				N 40° 45' 10.0" E 38° 52' 22.3"	05.10.2015
33	6.78	0.50	4.78	23.37	0.02	2.11		6.32	57.70	0.47	0.38	0.126	N 40° 48' 01.2" E 38° 50' 56.7"	05.10.2015

Appendix B (continued)

St. No	Na^+	K^{2+}	Mg^{2+}	Ca^{2+}	F^-	Cl^-	NO_2^-	NO_3^-	SO_4^{2-}	T. PO_4^{3-}	InO.PO_4^{3-}	O.PO_4^{3-}	Coordinate	Date
34	3.94	0.43	3.09	14.32	0.02	2.86		10.25	9.54	0.22	0.11	0.67	N 40° 50' 57.6" E 38° 49' 52.2"	05.10.2015
35	3.95	0.67	3.42	21.04		1.77		1.85	20.74	0.36	0.286	0.4	N 40° 53' 17.9" E 38° 47' 14.2"	05.10.2015
36						2.89	0.17	14.39	3.90	0.673	0.72	0.88	N 40° 55' 03.6" E 38° 47' 24.1"	05.10.2015
37	6.41	5.10	2.98	19.13	0.03	1.96	0.10	3.16	36.56	0.22	0.2	0.19	N 40° 55' 48.6" E 38° 43' 55.9"	05.10.2015
38	4.87	2.70	17.64	33.20	0.03	5.55	0.30	5.06	38.53				N 40° 51' 16.0" E 38° 46' 11.5"	05.10.2015
39	8.53	0.82	7.37	37.42	0.06	2.87	0.18	11.09	71.66	0.455	0.455	0.15	N 40° 48' 19.7" E 38° 46' 13.8"	05.10.2015
40	2.03	0.31	5.12	42.87		0.73	0.24	5.49	14.38	0.21	0.39	0.75	N 40° 46' 39.4" E 38° 45' 34.0"	05.10.2015
41	5.63	0.27	2.04	28.98	0.03	1.69	0.20	0.98	6.96	0.245	0.12	0.57	N 40° 43' 30.3" E 38° 46' 06.3"	05.10.2015
42	6.86	0.19	1.51	14.63		1.86	0.11	8.53	3.73				N 40° 43' 09.5" E 38° 43' 05.4"	05.10.2015
43	3.58	0.45	2.97	53.64	0.06	0.66	0.28	4.68	4.99	0.21	0.155	0.54	N 40° 44' 31.9" E 38° 43' 02.1"	05.10.2015
44	3.71	0.24	3.04	29.74	0.02	0.85	0.29	1.63	10.72	0.215	0.15	0.36	N 40° 45' 23.6" E 38° 41' 03.9"	05.10.2015

Appendix B (continued)

St. No	Na^{+}	K^{2+}	Mg^{2+}	Ca^{2+}	F^{-}	Cl^{-}	NO_2^{-}	NO_3^{-}	SO_4^{2-}	T. PO_4^{3-}	InO.PO_4^{3-}	O.PO_4^{3-}	Coordinate	Date
45	4.76	0.69	4.53	44.48	0.03	2.98	0.29	8.99	20.61	0.385	0.39	0.185	N 40° 53' 48.4" E 38° 31' 53.9"	06.10.2015
46	5.79	0.89	3.54	32.93		3.41	0.22	10.51	3.57	0.225	0.235	0.21	N 40° 52' 12.2" E 38° 32' 25.9"	06.10.2015
47	3.24	0.65	3.62	37.34	0.02	1.88	0.38	5.98	34.15				N 40° 47' 25.9" E 38° 32' 18.9"	06.10.2015
48	3.66	0.46	1.87	28.21	0.03	0.45	0.07	2.10	4.07	0.375	0.285	0.48	N 40° 45' 59.3" E 38° 33' 19.0"	06.10.2015
49	3.51	0.40	3.00	65.51	0.06	0.89	0.32	0.11	10.63	0.47	0.335	0.95	N 40° 45' 51.5" E 38° 34' 15.0"	06.10.2015
50	6.84	1.09	2.34	14.41	0.02	3.42	0.15	4.17	3.72	0.17	0.13	0.11	N 40° 56' 32.3" E 38° 36' 23.3"	06.10.2015
51	9.24	2.37	2.22	27.56		4.30	0.22	18.59	3.42	0.36	0.34	0.25	N 40° 55' 45.0" E 38° 41' 14.3"	06.10.2015
52	10.18	1.16	6.25	42.00	0.07	5.09	0.27	14.65	6.71	0.325	0.39	0.2	N 40° 52' 52.2" E 38° 38' 00.6"	06.10.2015
53	12.59	2.57	6.98	75.95	0.05	18.35	0.26	3.76	15.91	0.35	0.295	0.39	N 40° 50' 12.7" E 38° 37' 21.6"	06.10.2015
54	4.92	0.69	7.30	55.83	0.03	2.10	0.33	1.85	89.25	0.513	0.32	0.17	N 40° 47' 33.3" E 38° 40' 13.9"	06.10.2015
55	5.94	0.97	7.84	59.73	0.05	2.48	0.27	1.95	80.13				N 40° 45' 13.3" E 38° 38' 06.0"	06.10.2015

Appendix B (continued)

St. No	Na^{+}	K^{2+}	Mg^{2+}	Ca^{2+}	F^{-}	Cl^{-}	NO_2^{-}	NO_3^{-}	SO_4^{2-}	T. PO_4^{3-}	InO.PO_4^{3-}	O.PO_4^{3-}	Coordinate	Date
56	6.40	1.00	9.66	42.28	0.03	2.22	0.14	1.14	89.71	0.593	0.473	0.145	N 40° 42' 47.3" E 38° 37' 50.2"	06.10.2015
57	6.58	1.51	5.72	39.21	0.03	2.51	0.25	0.18	33.41	0.64	0.54	0.144	N 40° 40' 42.0" E 38° 36' 41.5"	06.10.2015
58	14.62	1.53	9.76	57.35		52.91		4.01	54.87				N 40° 52' 05.5" E 38° 19' 09.9"	06.10.2015
59	15.65	1.16	9.94	52.96		25.81	0.21	4.93	61.71	0.36	0.35	0.55	N 40° 49' 16.8" E 38° 18' 39.0"	06.10.2015
60	3.10	0.63	12.17	44.09	0.03	2.16	0.28	10.86	34.66	1.43	1.41	0.93	N 40° 44' 54.4" E 38° 18' 06.9"	06.10.2015
61	8.71	0.97	5.52	44.53		4.98	0.25	12.40	12.73	0.19	0.21	0.16	N 40° 51' 41.7" E 38° 25' 41.8"	06.10.2015
62	5.59	0.76	4.55	38.60	0.08	3.02	0.22	7.30	15.24	0.335	0.365	0.4	N 40° 49' 36.6" E 38° 27' 22.3"	06.10.2015
63	18.66	2.01	14.93	46.13	0.02	24.33	0.17	1.42	42.07				N 40° 47' 31.3" E 38° 28' 11.3"	06.10.2015
64	19.72	1.51	16.59	61.40	0.14	20.59	0.17	1.29	30.65				N 40° 46' 15.2" E 38° 26' 23.5"	06.10.2015
65	15.48	1.49	13.96	64.32	0.03	20.91	0.17	1.85	40.05	0.32	0.3	0.17	N 40° 43' 15.7" E 38° 28' 01.7"	06.10.2015
66	14.22	1.74	8.11	70.67	0.02	23.90	0.19	68.94	18.52	0.66	0.48	0.63	N 40° 41' 49.4" E 38° 29' 58.1"	06.10.2015

Appendix B (continued)

St. No	Na^{+}	K^{2+}	Mg^{2+}	Ca^{2+}	F^{-}	Cl^{-}	NO_2^{-}	NO_3^{-}	SO_4^{2-}	T. PO_4^{3-}	InO.PO_4^{3-}	O.PO_4^{3-}	Coordinate	Date
67	6.43	0.86	10.94	52.47		1.55	0.37	6.00	7.14	0.185	0.21	0.66	N 40° 41' 15.2" E 38° 30' 54.9"	06.10.2015
68	20.81	1.66	16.54	64.73		34.06	0.19	0.55	46.51	0.465	0.465	0.63	N 40° 41' 26.1" E 38° 26' 28.6"	07.10.2015
69	13.24	1.12	10.39	52.75	0.02	11.09	0.20	1.12	12.18	0.35	0.265	0.4	N 40° 36' 28.0" E 38° 27' 03.8"	07.10.2015
70	4.59	0.81	1.81	13.20		2.84	0.09	3.76	7.23	0.125	0.16	0.2	N 40° 33' 19.9" E 38° 28' 28.6"	07.10.2015
71	204.14	9.69	15.27	45.77	0.08	0.62	0.34		8.78	0.49	0.57	0.57	N 40° 33' 25.2" E 38° 23' 04.3"	07.10.2015
72				5.95		296.79			68.87	0.165	0.12	0.31	N 40° 37' 08.9" E 38° 21' 12.9"	07.10.2015
73	2.67	0.57	1.12	25.47		1.89	0.10	1.69	4.25				N 40° 41' 38.3" E 38° 21' 10.5"	07.10.2015
74	6.60	0.61	6.15	48.21	0.03	3.16	0.40	0.66	5.59	0.345	0.37	0.51	N 40° 38' 31.8" E 38° 18' 22.5"	07.10.2015
75	3.45	0.98	2.41	29.81	0.03	1.19	0.19	0.14	26.56	0.89	0.755	0.75	N 40° 34' 22.0" E 38° 16' 17.2"	07.10.2015
76	2.74	0.51	1.79	22.95	0.02	0.45	0.14		3.74	1.57	1.54	0.187	N 40° 33' 41.6" E 38° 13' 03.7"	07.10.2015
77	1.13	1.04	0.82	20.52	0.02	0.60	0.15		3.42				N 40° 32' 34.6" E 38° 10' 57.1"	07.10.2015

Appendix B (continued)

St. No	Na^{+}	K^{2+}	Mg^{2+}	Ca^{2+}	F^{-}	Cl^{-}	NO_2^{-}	NO_3^{-}	SO_4^{2-}	T. PO_4^{3-}	InO.PO_4^{3-}	O.PO_4^{3-}	Coordinate	Date
78	1.64	0.07	0.78	14.11		1.49			11.33				N 40° 30' 50.3" E 38° 11' 30.1"	07.10.2015
79	11.46	2.16	2.62	33.82	0.45	5.96	0.24		18.24	0.845	0.79	0.69	N 40° 32' 21.0" E 38° 21' 26.7"	07.10.2015
80	3.57	0.77	1.23	8.50	0.01	1.34			5.51	0.93	0.85	0.82	N 40° 28' 48.1" E 38° 22' 30.4"	07.10.2015
81	4.41	2.16	1.30	22.50	0.03	2.45	0.15	15.24	3.73	0.75	0.75	0.14	N 40° 25' 47.2" E 38° 23' 38.3"	07.10.2015
82	3.02	1.44	2.33	19.46	0.05	0.93	0.09		38.59	0.77	0.85	0.45	N 40° 23' 23.7" E 38° 26' 20.8"	07.10.2015
83	15.65		10.61	60.34		5.82	0.33	17.89	29.96				N 40° 19' 24.5" E 38° 26' 15.9"	07.10.2015
84	9.44	0.77	17.69	45.11	3.38	1.06	0.31		142.03	0.773	0.9	0.58	N 40° 21' 52.7" E 38° 29' 31.7"	07.10.2015
85	5.82	1.58	6.57	25.44	0.12	1.89	0.22		33.58				N 40° 21' 33.0" E 38° 32' 25.6"	07.10.2015
86	8.20	0.12	3.87	63.67	0.06	4.98	0.39		15.89	0.785	0.83	0.28	N 40° 20' 31.6" E 38° 37' 43.1"	07.10.2015
87	12.27	0.23	2.42	11.77	0.10	0.68	0.48		4.91	0.95	0.53	0.317	N 40° 20' 03.4" E 38° 43' 11.3"	07.10.2015
88	15.96	5.54	4.85	29.54	0.08	3.31	0.31	8.82	30.77	1.3	0.895	0.4	N 40° 22' 40.5" E 38° 45' 04.9"	07.10.2015

Appendix B (continued)

St. No	Na^{+}	K^{2+}	Mg^{2+}	Ca^{2+}	F^{-}	Cl^{-}	NO_2^{-}	NO_3^{-}	SO_4^{2-}	T. PO_4^{3-}	InO.PO_4^{3-}	O.PO_4^{-3}	Coordinate	Date
89	5.75	0.21	8.07	50.51	0.03	0.82	0.24	0.36	1.87				N 40° 29' 53.8" E 38° 43' 59.6"	07.10.2015
90	14.02		1.82	27.57	0.02	1.89	0.20	2.45	11.55	0.88	0.645	0.83	N 40° 25' 24.7" E 38° 46' 32.9"	07.10.2015
91	6.22	0.20	2.19	37.32	0.05	7.87	0.24	5.65	27.88				N 40° 22' 30.4" E 38° 42' 01.0"	08.10.2015
92	9.57	0.84	6.77	25.45	0.09	4.33	0.28	0.12	16.28	0.325	0.28	0.34	N 40° 24' 56.2" E 38° 53' 07.7"	08.10.2015
93	3.90	0.71	2.40	28.34	0.23	4.77	0.11	3.16	9.30	0.715	0.655	0.59	N 40° 18' 54.1" E 38° 51' 02.8"	08.10.2015
94	4.88	5.13	5.12	37.53		1.55	0.35		3.11				N 40° 19' 26.0" E 38° 54' 02.5"	08.10.2015
95	2.67	0.34	6.03	41.05	0.05	1.78	0.23	0.21	5.12	0.245	0.165	0.58	N 40° 16' 15.8" E 38° 50' 20.8"	08.10.2015
96	13.13	0.99	13.14	63.53		3.87	0.32	1.68	113.57	0.48	0.435	0.6	N 40° 10' 18.3" E 38° 49' 02.6"	08.10.2015
97	5.14	0.57	12.12	56.12	0.03	1.32	0.40	2.40	8.63	0.47	0.355	0.139	N 40° 06' 44.3" E 38° 52' 18.5"	08.10.2015
98	199.37	1.23	77.03	62.42		39.64		4.80	777.81				N 40° 07' 58.4" E 38° 40' 29.4"	08.10.2015
99	3.86	0.77	15.17	42.05	0.06	1.53	0.39	0.83	17.52	0.18	0.145	0.16	N 40° 08' 28.0" E 38° 37' 20.8"	08.10.2015

Appendix B (continued)

St. No	Na^{+}	K^{2+}	Mg^{2+}	Ca^{2+}	F^{-}	Cl^{-}	NO_2^{-}	NO_3^{-}	SO_4^{2-}	T. PO_4^{3-}	InO.PO_4^{3-}	O.PO_4^{3-}	Coordinate	Date
100	9.01	0.34	4.36	39.16		0.82	0.36	0.27	4.11				N 40° 11' 40.0" E 38° 33' 34.6"	08.10.2015
101	155.11				1.23	7.92	0.19	0.13	14.13				N 40° 13' 38.9" E 38° 28' 31.3"	08.10.2015
102	27.95	1.06	20.41	51.54	0.34	1.89	0.44	6.55	95.47				N 40° 11' 03.7" E 38° 23' 34.1"	08.10.2015
103	27.32	16.88	25.97	71.39	0.06	36.29		52.58	25.44	1.46	1.1	0.364	N 40° 14' 44.6" E 38° 21' 28.3"	08.10.2015
104	47.65	2.98	53.67	509.83		5.91		13.99	7462.20				N 40° 17' 18.2" E 38° 16' 59.7"	08.10.2015
105	14.25		17.56	108.89	0.24	3.12	0.37	10.10	213.53				N 40° 18' 16.8" E 38° 15' 43.2"	08.10.2015

Appendix C Tolerance and optimum values of 9 species and 19 ecologic variables in Giresun. Abbreviations: DO: dissolved oxygen, EC: electrical conductivity, Tw: water temperature, Ta: air temperature, ORP: oxidation reduction potential, Elev: elevation, Na^{+}: sodium ion concentration of the water (ppm), K^{2+}: potassium ion concentration of water (ppm), Mg^{2+}: Magnesium ion concentration of water (ppm), Ca^{2+}: calcium ion concentration of water (ppm), F^{-}: flouride ion concentration of water (ppm), Cl^{-}: chloride ion concentration of water (ppm), NO_2^{-}: nitrite ion concentration of water (ppm), NO_3^{-}: nitrate ion concentration of water (ppm), SO_4^{2-}: sulphate ion concentration of water (ppm), $T.PO_4^{3-}$;total phosphate ion concentration of sediment, $InO.PO_4^{3-}$: inorganic phosphate ion concentration of sediment, $O.PO_4^{3-}$: organic phosphate ion concentration of sediment, CN: *Candona neglecta*, HI: *Heterocypris incongruens*, HSa: *Heterocypris salina*, IBr: *Ilyocypris bradyi* PF: *Potamocypris fallax*, PFu: *Potamocypris fulva*, PVi: *Potamocypris villosa*, PFo: *Psychrodromus fontinalis*, PO: *Psychrodromus olivaceus*, Count: number of station that occurance of species.

Appendix C (continued)

				pH		DO		EC		Tw		Ta	
Name	Count	Max	N2	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol
CN	4	9	2.43	7,32	0,78	7,25	1,14	238,61	561,55	11,25	3,61	13.42	1.94
HI	15	225	4.65	8,14	0,29	8,32	1,82	540,86	510,08	12,91	1,30	15.97	3.17
HSa	11	190	4.27	8,12	0,28	7,68	0,84	2236,42	2152,91	15,54	2,47	21.34	3.76
IBr	18	135	3.37	8,01	0,32	8,09	1,31	1948,21	1265,53	13,10	1,87	19.60	2.22
PF	12	115	4.00	8,20	0,37	8,76	0,67	955,22	395,77	10,93	1,07	17.39	2.76
PFu	6	58	2.56	8,25	0,15	8,90	2,68	491,65	405,13	11,78	3,72	17.75	7.88
PVi	18	370	5.29	8,27	1,00	9,54	3,25	399,02	302,21	14,00	3,84	15.39	3.54
PFo	16	18	6.43	8,12	0,26	8,96	2,55	1208,74	1870,16	12,50	4,28	15.74	4.43
PO	12	49	2.49	8,42	0,25	8,36	1,40	857,31	234,74	17,02	2,48	23.58	2.11

				ORP		Elev		Na^+		K^{2+}		Mg^{2+}	
Name	Count	Max	N2	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol
CN	4	9	2.43	369.724	570.553	1690.12	919.295	148.771	62.201	253.353	536.603	320.588	862.964
HI	15	225	4.65	344.222	316.563	1512.46	384.266	897.353	61.131	0.910418	107.283	394.751	516.496
HSa	11	190	4.27	359.874	31.188	792.004	430.011	49.21	844.991	241.317	500.299	274.438	294.119
IBr	18	135	3.37	361.315	637.801	1250.02	360.282	29.041	374.286	894.011	937.979	21.749	102.793
PF	12	115	4.00	351.259	142.726	1364.8	265.694	201.332	470.874	148.322	307.154	790.537	390.912
PFu	6	58	2.56	351.985	135.379	1250.78	863.191	373.224	275.253	0.73448	0.174892	601.824	698.235
PVi	18	370	5.29	341.441	217.316	1468.89	543.704	645.083	182.358	199.597	166.079	455.258	614.166
PFo	16	18	6.43	361.251	219.588	1249.12	732.834	394.444	805.696	121.491	138.305	156.014	291.318
PO	12	49	2.49	345.557	164.808	335.111	332.087	127.993	569.925	0.742716	116.679	953.704	511.132

Appendix C (continued)

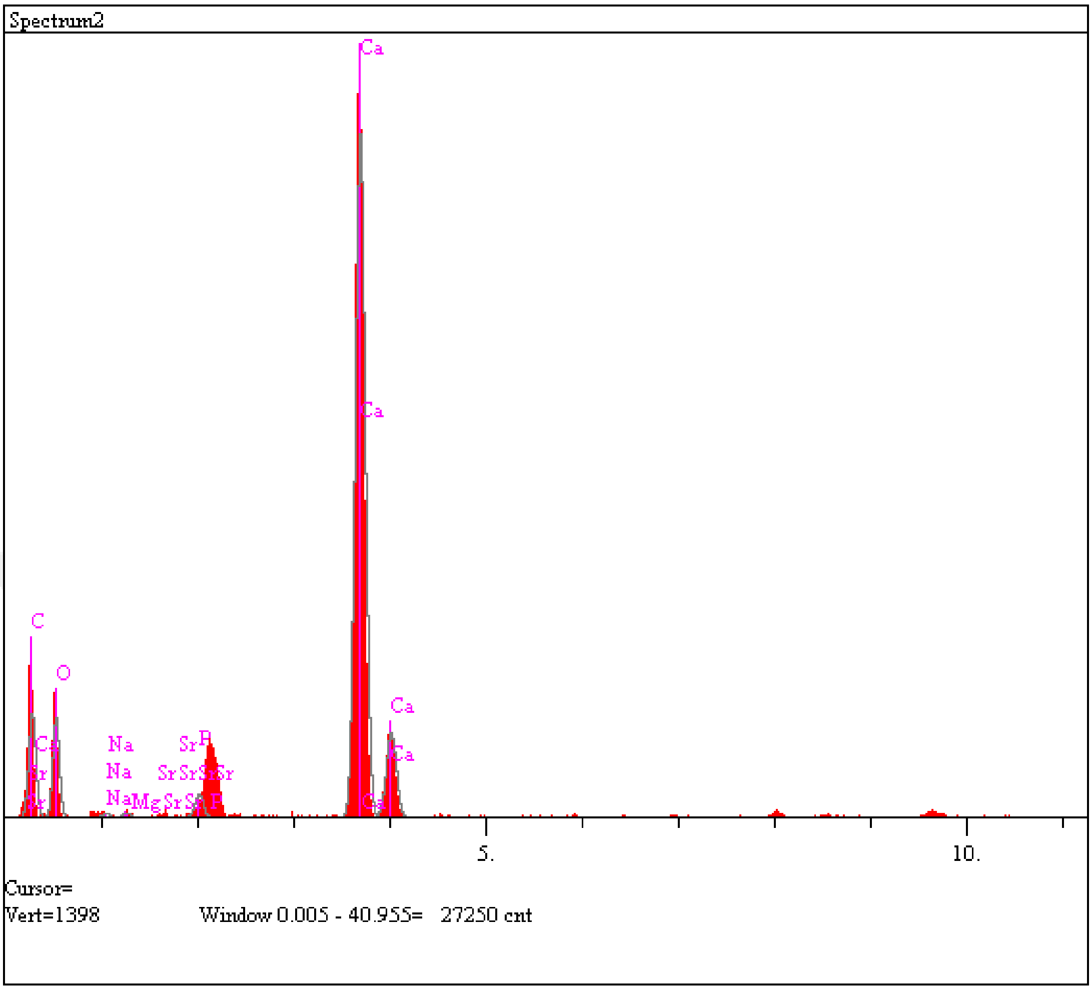
				Ca^{2+}		F^-		Cl^-		NO_2^-		NO_3^-	
Name	Count	Max	N2	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol
CN	4	9	2.43	247.682	170.911	0.0576471	0.0545031	294.059	108.785	0.205294	0.119006	309.294	161.308
HI	15	225	4.65	380.495	235.385	0.0655256	0.251606	283.934	166.486	0.248504	0.113473	633.447	756.646
HSa	11	190	4.27	726.743	979.757	0.0606048	0.117651	162.762	184.164	0.19377	0.168924	227.265	279.618
IBr	18	135	3.37	785.389	911.977	0.136835	0.208687	192.035	200.059	0.176978	0.231154	29.156	273.374
PF	12	115	4.00	464.641	155.905	0.0291166	0.0379649	686.689	34.748	0.294488	0.0741046	901.456	917.577
PFu	6	58	2.56	248.188	225.839	0.01872	0.0199032	221.872	42.914	0.1296	0.168387	477.984	65.963
PVi	18	370	5.29	277.079	951.617	0.33765	104.544	21.584	145.248	0.211528	0.0900573	593.973	784.597
PFo	16	18	6.43	312.411	247.842	0.0150877	0.0257921	897.649	150.161	0.112807	0.131949	288.246	363.484
PO	12	49	2.49	471.651	218.388	0.0795062	0.052994	568.679	888.618	0.331358	0.140862	18.579	374.677

				SO_4^{2-}		$T.PO_4^{3-}$		$InO.PO_4^{3-}$		$O.PO_4^{3-}$	
Name	Count	Max	N2	Opt	Tol	Opt	Tol	Opt	Tol	Opt	Tol
CN	4	9	2.43	464.235	625.036	0.3435	0.3643	0.3305	0.3754	0.0797	0.1046
HI	15	225	4.65	203.539	461.429	0.6301	0.3280	0.5799	0.3269	0.0385	0.0839
HSa	11	190	4.27	451.194	1589.92	0.3946	0.3200	0.3602	0.3309	0.0386	0.0545
IBr	18	135	3.37	272.479	1434.47	0.4111	0.3395	0.3234	0.2809	0.0983	0.1035
PF	12	115	4.00	214.941	187.139	0.2654	0.3599	0.2293	0.3471	0.0252	0.0307
PFu	6	58	2.56	185.889	165.779	0.7593	0.2320	0.6970	0.1983	0.0613	0.0256
PVi	18	370	5.29	250.062	542.546	0.4314	0.3435	0.4183	0.3710	0.0532	0.1514
PFo	16	18	6.43	133.515	304.065	0.4634	0.3811	0.4042	0.3615	0.0590	0.0660
PO	12	49	2.49	119.114	124.704	0.5808	0.2395	0.6007	0.2885	0.0418	0.0385

Appendix D EDX analysis results of 17 selected Ostracoda carapaces. Abbreviations: Elt.: Element name, Conc.: Concentration.

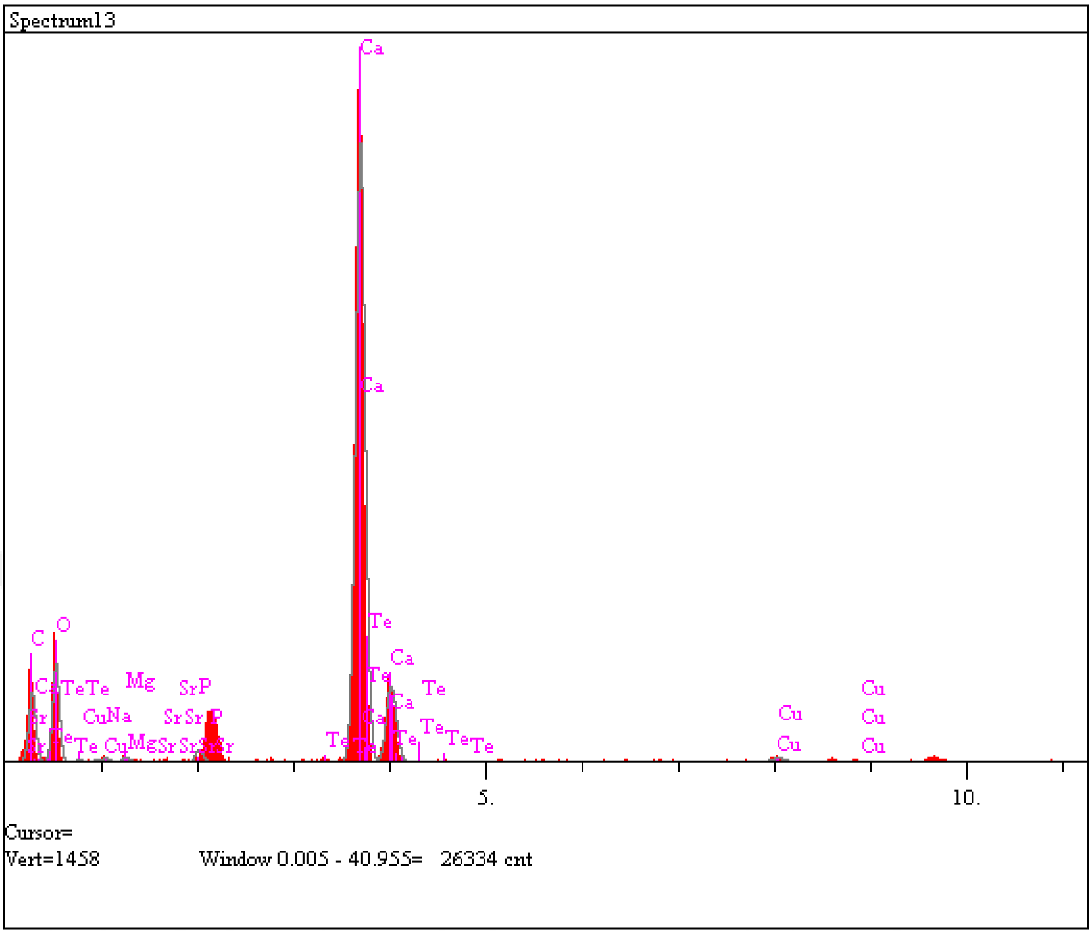
1. *H. reptans* (83)
2. *H. incongruens* (14)
3. *P. fallax* (72)
4. *P.fulva* (60)
5. *P. olivaceus* (13)
6. *I. brehmi* (102)
7. *I. bradyi* (71)
8. *P. albicans* (64)
9. *P. villosa* (6)
10. *H. salina* (60)
11. *I. inermis* (74)
12. *P. fontinalis* (98)
13. *C. vidua* (102)
14. *P. olivaceus* (24)
15. *H. intermedia* (102)
16. *H. incongruens* (92)
17. *S. pseudobrowniana* (15)

Appendix D.1. *Herpetocypris reptans* from sampling site 83



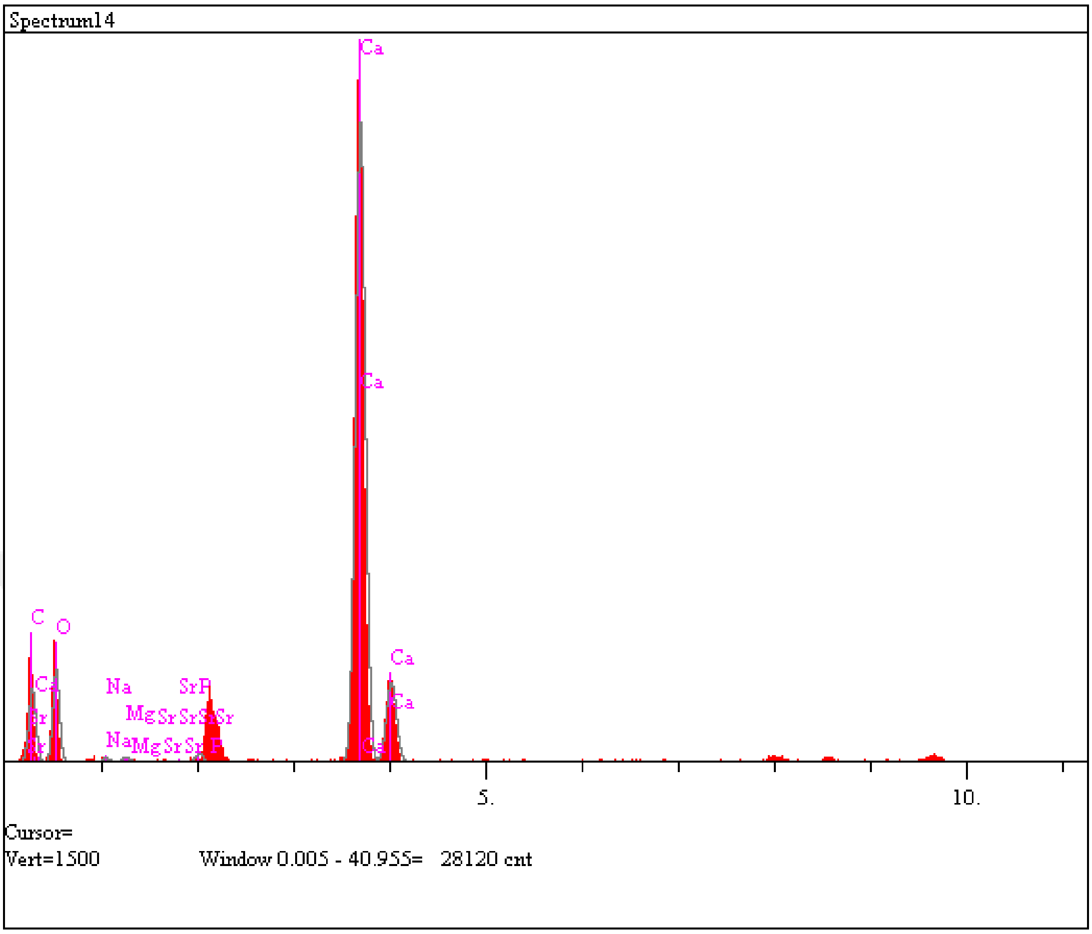
Elt.	**Intensity (c/s)**	**Error 2-sig**	**Atomic %**	**Conc**	
C	43.58	2.087	36.046	23.951	
O	38.65	1.966	48.884	43.268	
Na	2.34	0.483	0.301	0.383	
Mg	2.52	0.502	0.198	0.267	
P	11.80	1.086	0.493	0.844	
Ca	390.31	6.247	14.049	31.149	
Sr	0.73	0.269	0.029	0.139	
			100.000	100.000	Total

Appendix D.2. *Heterocypris incongruens* from sampling site 14



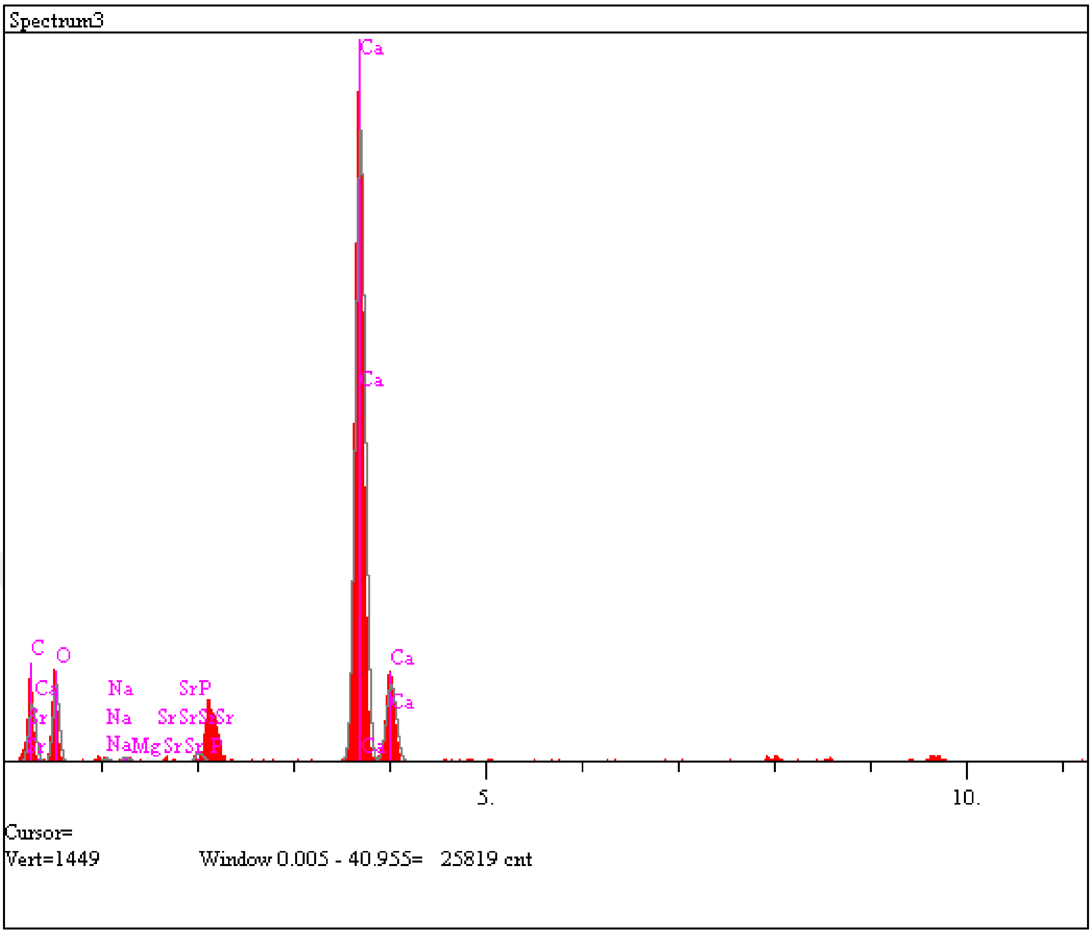
Elt.	Intensity (c/s)	Error 2-sig	Atomic %	Conc	
C	32.09	1.791	29.069	18.617	
O	42.25	2.055	54.520	46.511	
Na	2.21	0.470	0.316	0.387	
Mg	2.54	0.504	0.222	0.288	
P	6.27	0.792	0.285	0.470	
Ca	395.73	6.290	15.264	32.619	
Cu	4.05	0.637	0.321	1.087	
Sr	0.10	0.100	0.004	0.020	
			100.000	100.000	Total

Appendix D.3. *Potamocypris fallax* from sampling site 72



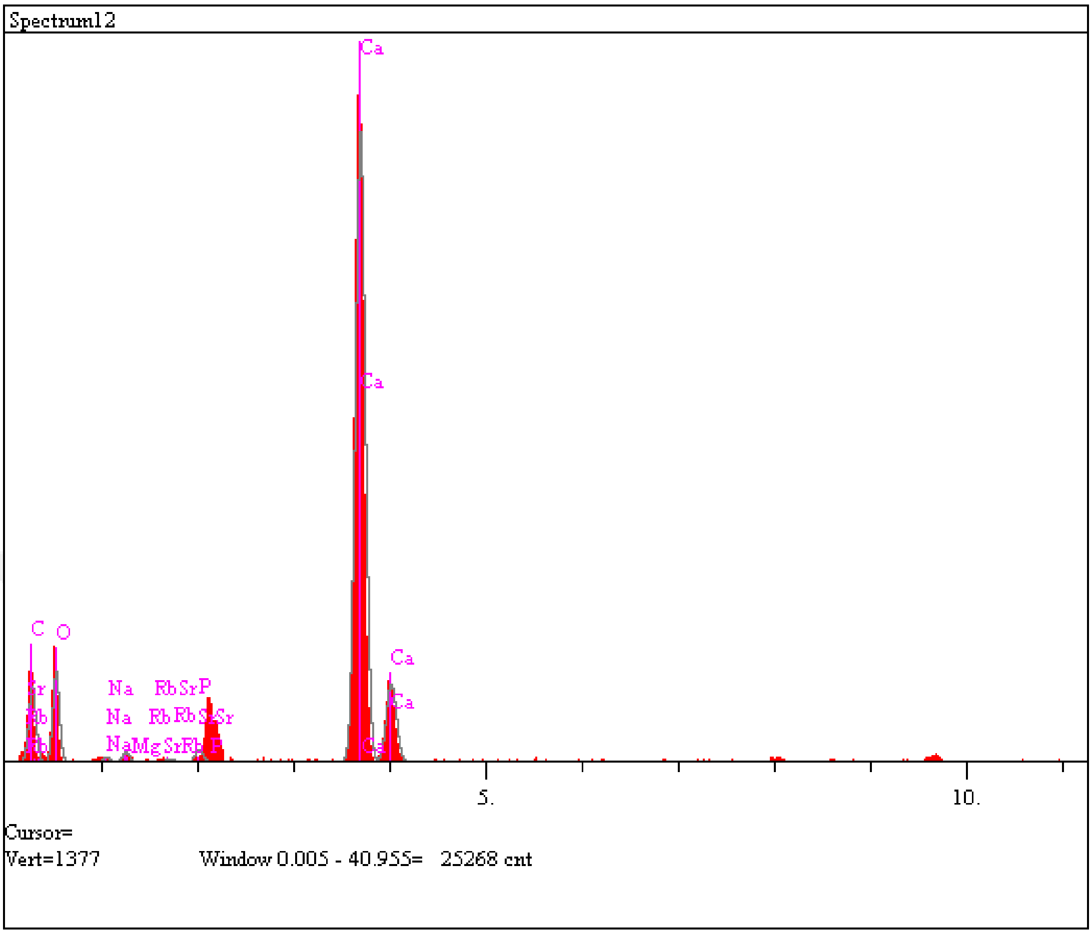
Elt.	Intensity (c/s)	Error 2-sig	Atomic %	Conc	
C	35.26	1.878	29.905	19.220	
O	41.06	2.026	53.562	45.856	
Na	2.32	0.482	0.319	0.393	
Mg	2.36	0.486	0.198	0.257	
P	4.69	0.685	0.205	0.340	
Ca	421.82	6.494	15.801	33.886	
Sr	0.25	0.157	0.010	0.048	
			100.000	100.000	Total

Appendix D.4. *Potamocypris fulva* from Sampling site 60



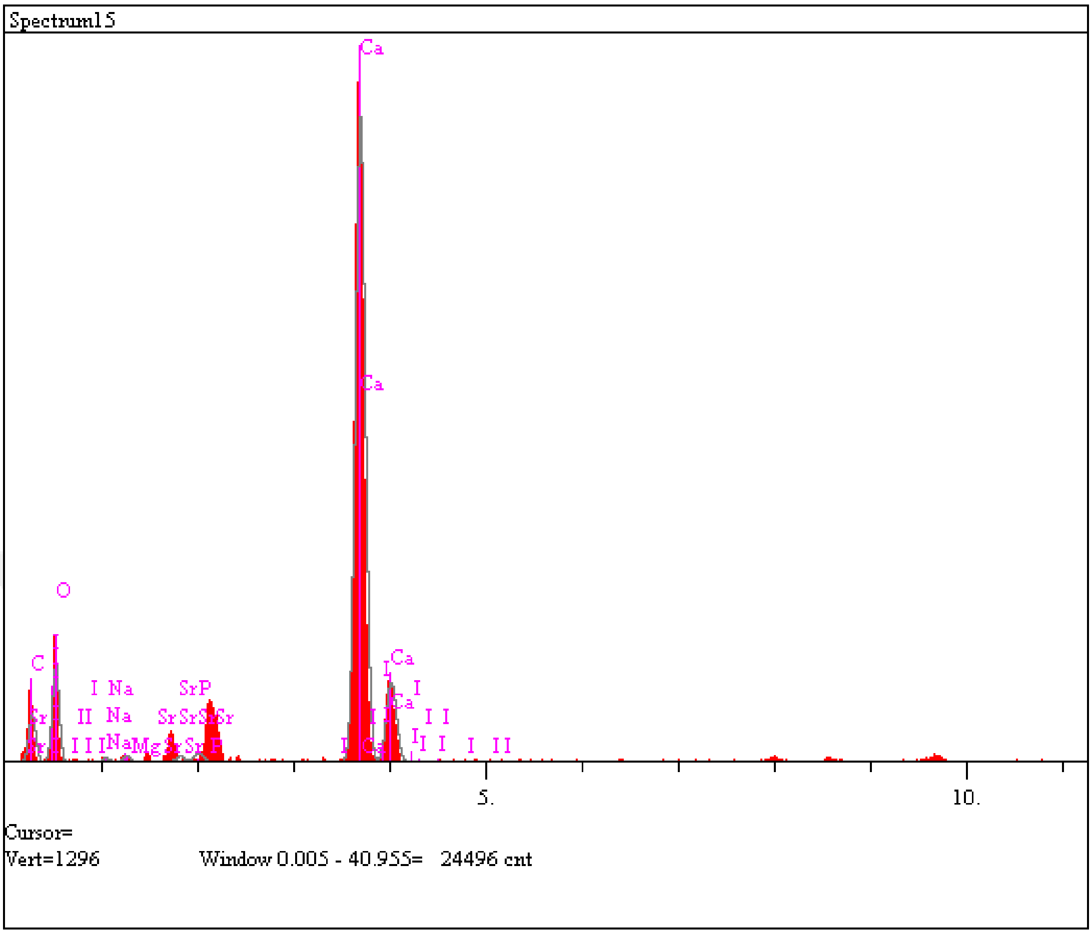
Elt.	Intensity (c/s)	Error 2-sig	Atomic %	Conc	
C	26.66	1.633	27.502	17.101	
O	32.96	1.815	53.715	44.491	
Na	1.84	0.429	0.302	0.360	
Mg	2.50	0.500	0.251	0.315	
P	5.00	0.707	0.261	0.418	
Ca	402.30	6.342	17.957	37.258	
Sr	0.26	0.160	0.012	0.057	
			100.000	100.000	Total

Appendix D.5. *Psycrodromus olivaceus* from Sampling site 13



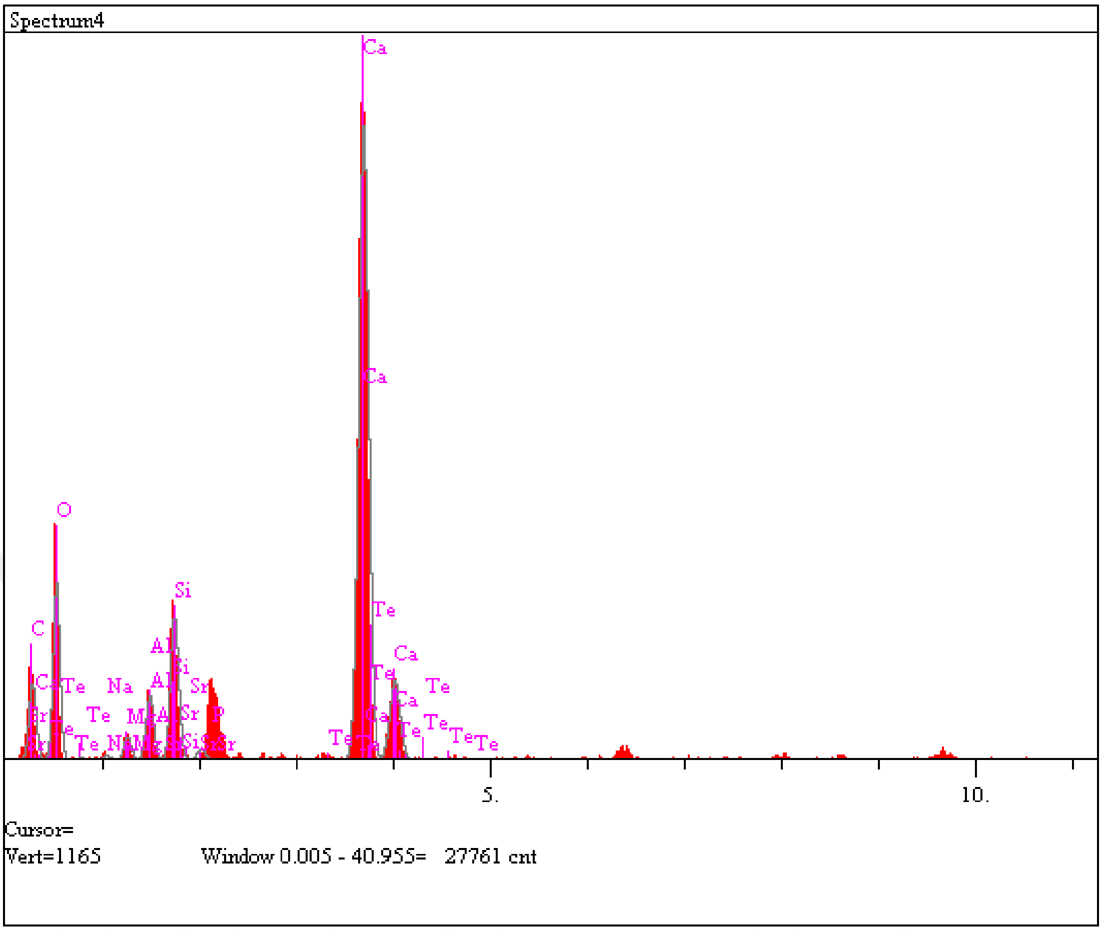
Elt.	Intensity (c/s)	Error 2-sig	Atomic %	Conc	
C	33.74	1.837	31.114	20.074	
O	37.32	1.932	52.382	45.018	
Na	2.24	0.473	0.328	0.406	
Mg	4.55	0.675	0.408	0.532	
P	6.28	0.792	0.297	0.494	
Ca	381.18	6.173	15.401	33.156	
Rb	1.42	0.377	0.070	0.320	
			100.000	100.000	Total

Appendix D.6. *Ilyocypris brehmi* from Sampling site 102



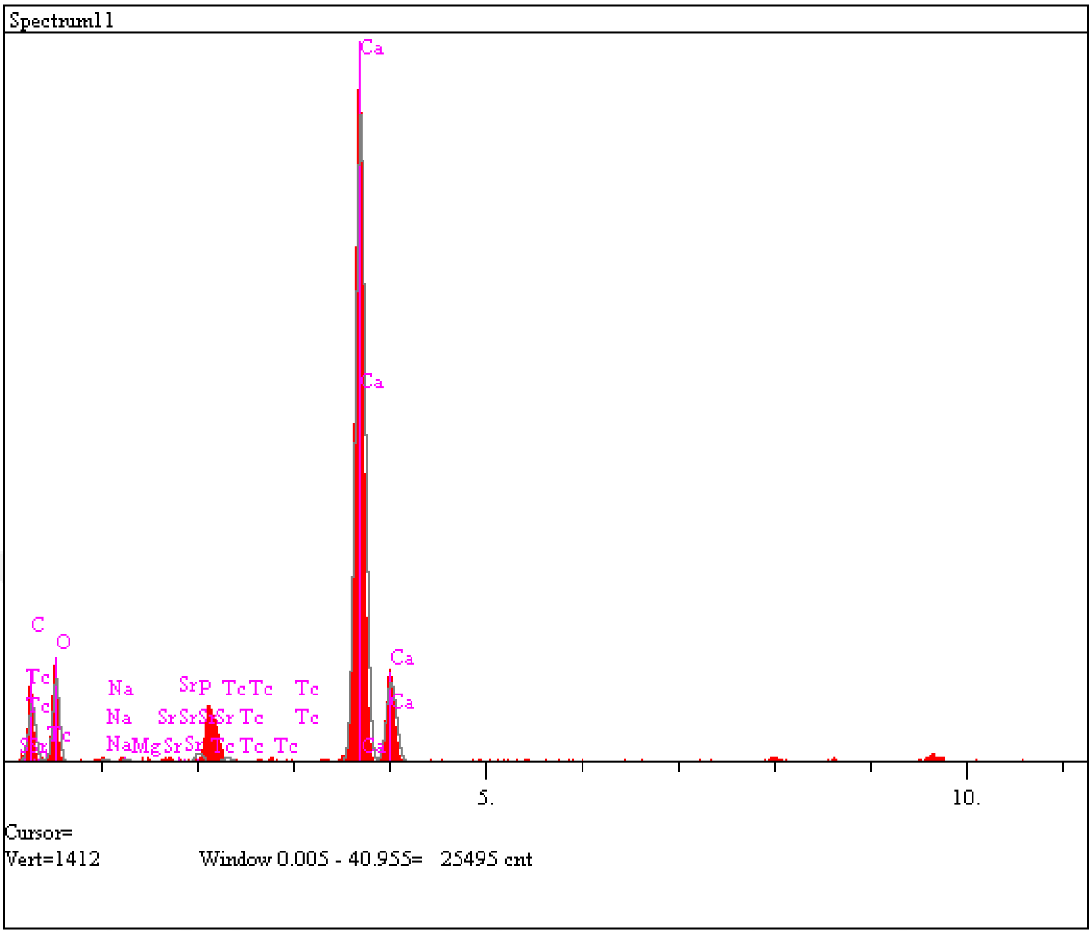
Elt.	**Intensity (c/s)**	**Error 2-sig**	**Atomic %**	**Conc**	
C	19.93	1.412	23.699	14.561	
O	33.98	1.843	57.375	46.959	
Na	1.87	0.432	0.336	0.395	
Mg	2.87	0.536	0.315	0.391	
P	4.85	0.697	0.279	0.441	
Ca	367.40	6.061	17.858	36.613	
Sr	2.46	0.496	0.132	0.591	
I	0.10	0.100	0.008	0.049	
			100.000	100.000	Total

Appendix D.7. *Ilyocypris bradyi* from Sampling site 71



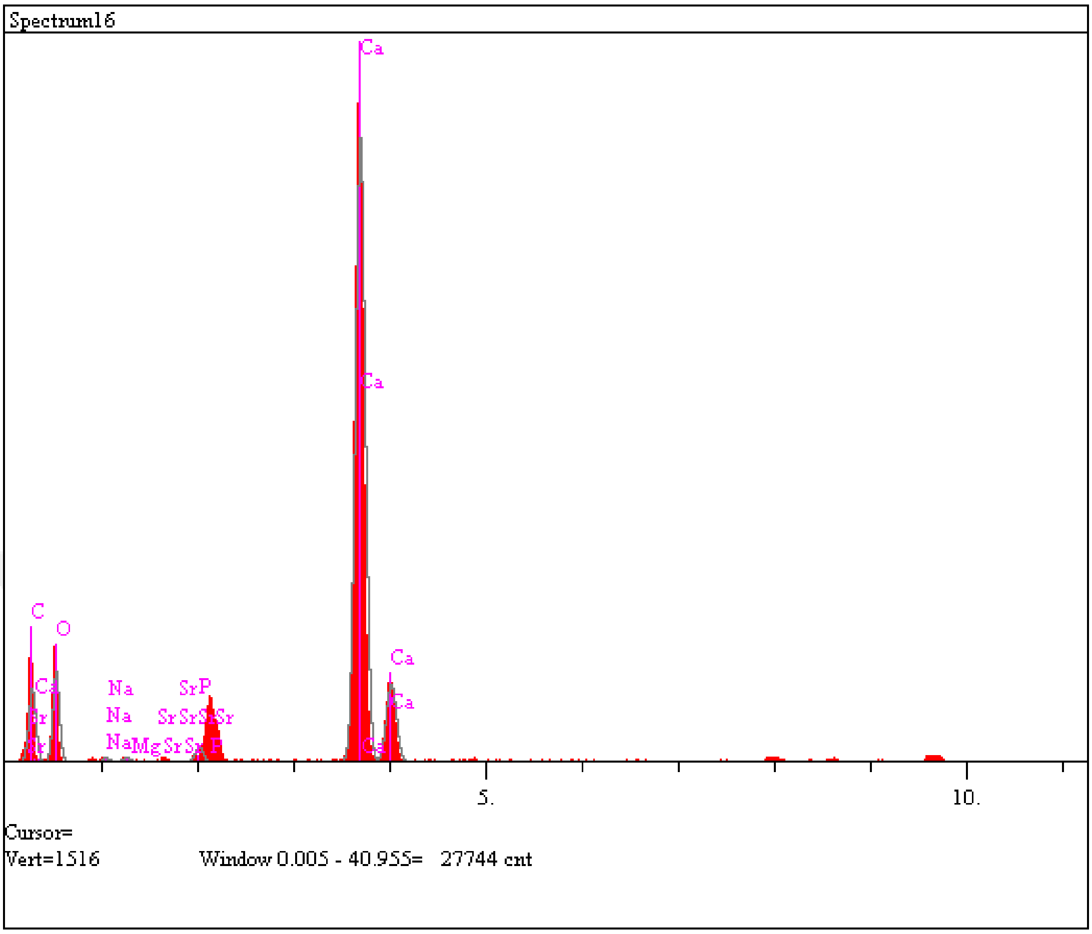
Elt.	Intensity (c/s)	Error 2-sig	Atomic %	Conc	
C	27.95	1.672	28.426	18.960	
O	60.91	2.468	55.915	49.681	
Na	1.65	0.407	0.191	0.243	
Mg	8.74	0.935	0.616	0.831	
Al	25.52	1.598	1.329	1.991	
Si	59.56	2.440	2.565	4.000	
P	4.73	0.688	0.193	0.331	
Ca	325.46	5.705	10.766	23.962	
			100.000	100.000	Total

Appendix D.8. *Pseudocandona albicans* from Sampling site 64



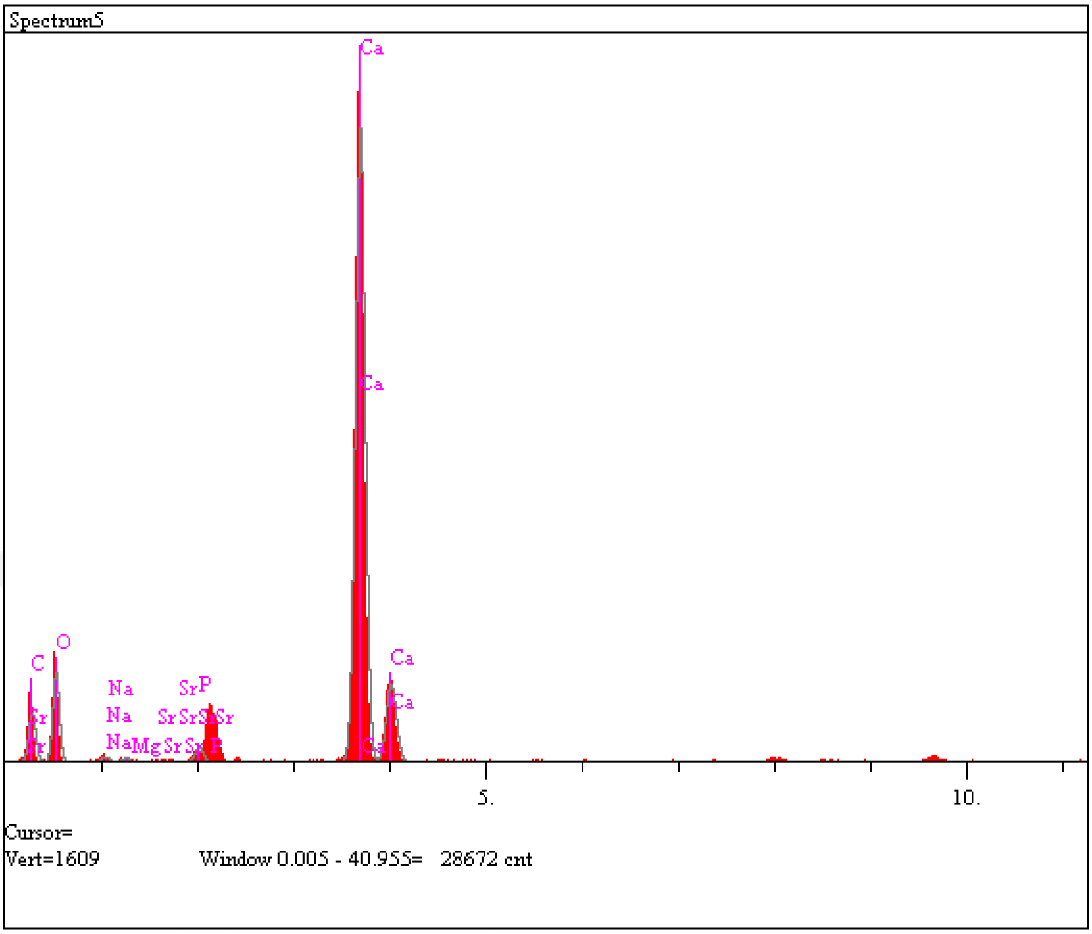
Elt.	Intensity (c/s)	Error 2-sig	Atomic %	Conc	
C	25.77	1.605	26.771	16.672	
O	35.15	1.875	54.821	45.478	
Na	1.65	0.407	0.267	0.318	
Mg	1.74	0.417	0.170	0.215	
P	4.79	0.692	0.245	0.393	
S	2.69	0.519	0.129	0.214	
Ca	401.24	6.334	17.543	36.456	
Sr	0.84	0.289	0.040	0.182	
Tc	0.42	0.204	0.014	0.073	
			100.000	100.000	Total

Appendix D.9. *Potamocypris villosa* from Sampling site 6



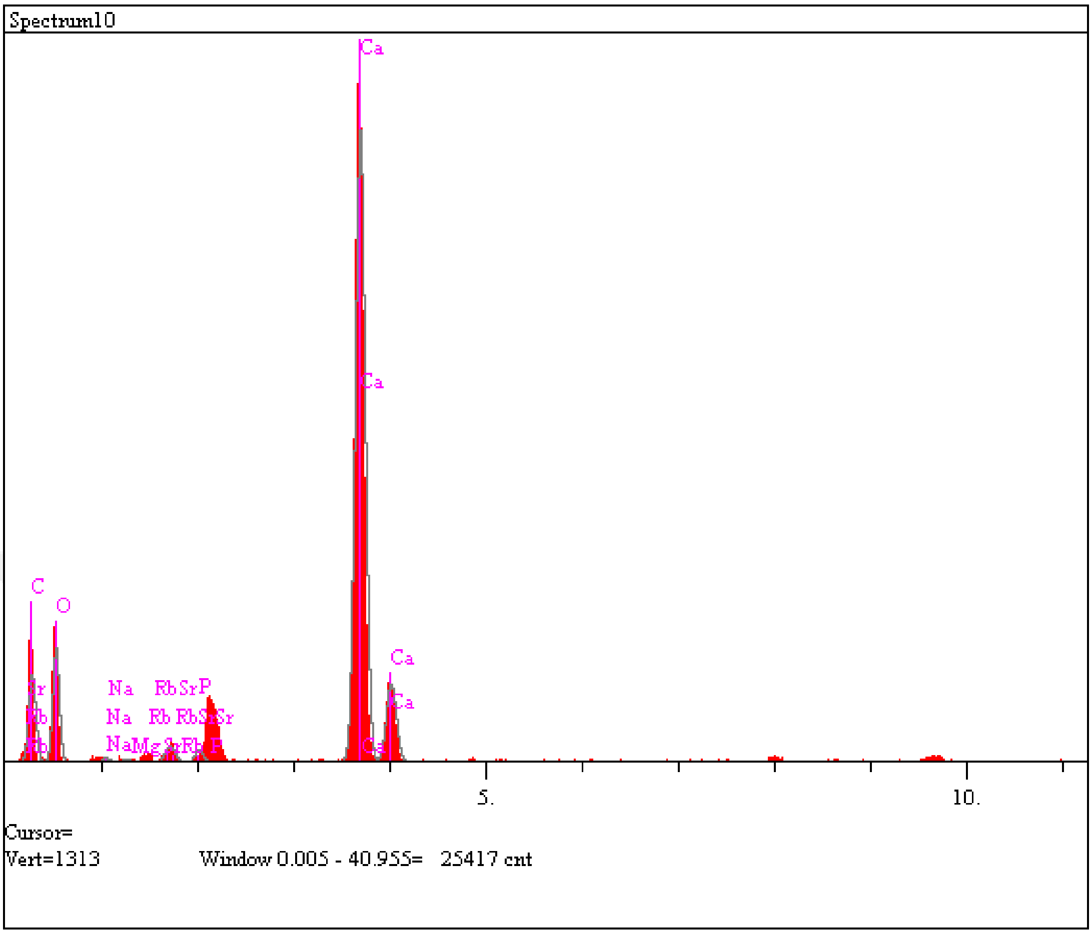
Elt.	Intensity (c/s)	Error 2-sig	Atomic %	Conc	
C	35.48	1.883	30.574	19.706	
O	40.37	2.009	52.974	45.483	
Na	2.04	0.452	0.281	0.347	
Mg	2.30	0.480	0.193	0.251	
P	8.04	0.896	0.352	0.586	
Ca	415.31	6.444	15.620	33.596	
Sr	0.16	0.126	0.007	0.031	
			100.000	100.000	Total

Appendix D.10. *Heterocypris salina* from Sampling site 60



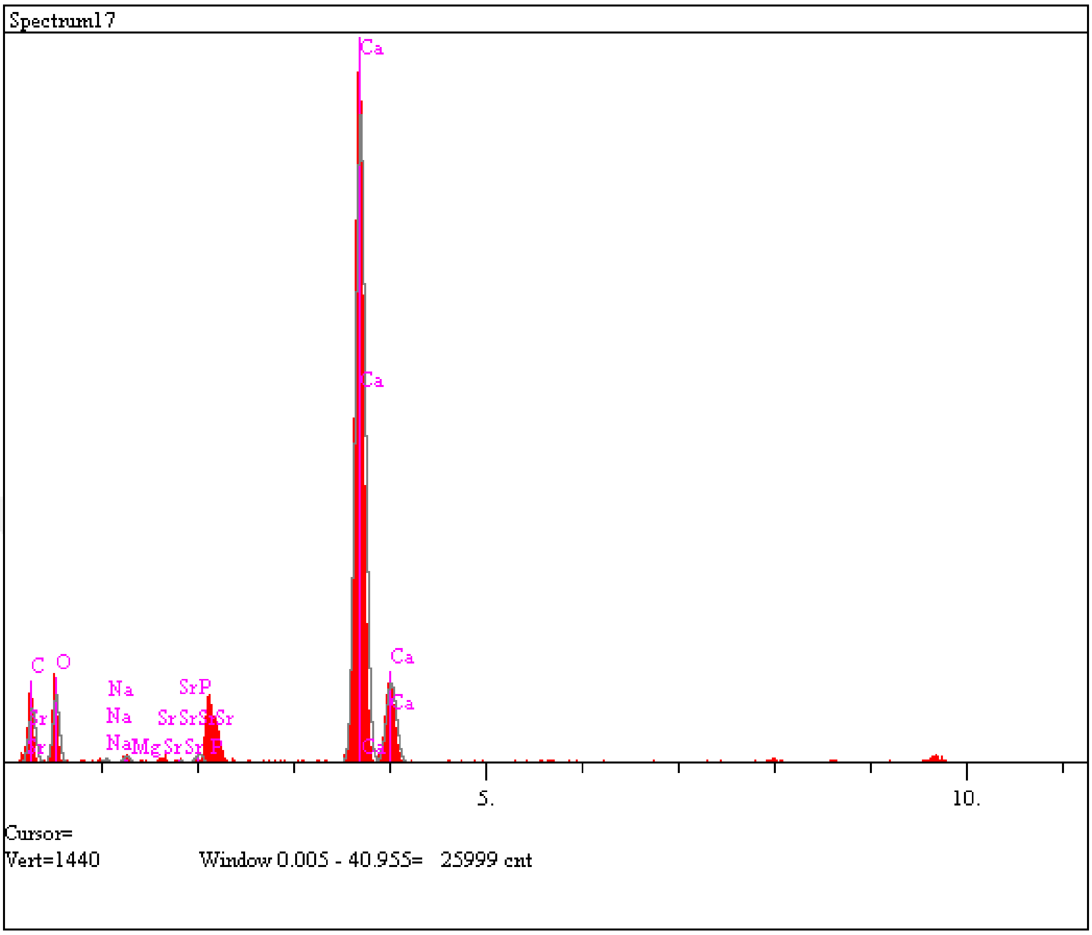
Elt.	Intensity (c/s)	Error 2-sig	Atomic %	Conc	
C	25.50	1.597	23.651	14.657	
O	42.96	2.072	57.834	47.744	
Na	2.89	0.537	0.419	0.497	
Mg	2.11	0.459	0.186	0.234	
P	8.67	0.931	0.397	0.635	
Ca	447.90	6.692	17.504	36.197	
Sr	0.19	0.137	0.008	0.036	
			100.000	100.000	Total

Appendix D.11. *Ilyocypris inermis* from Sampling site 74



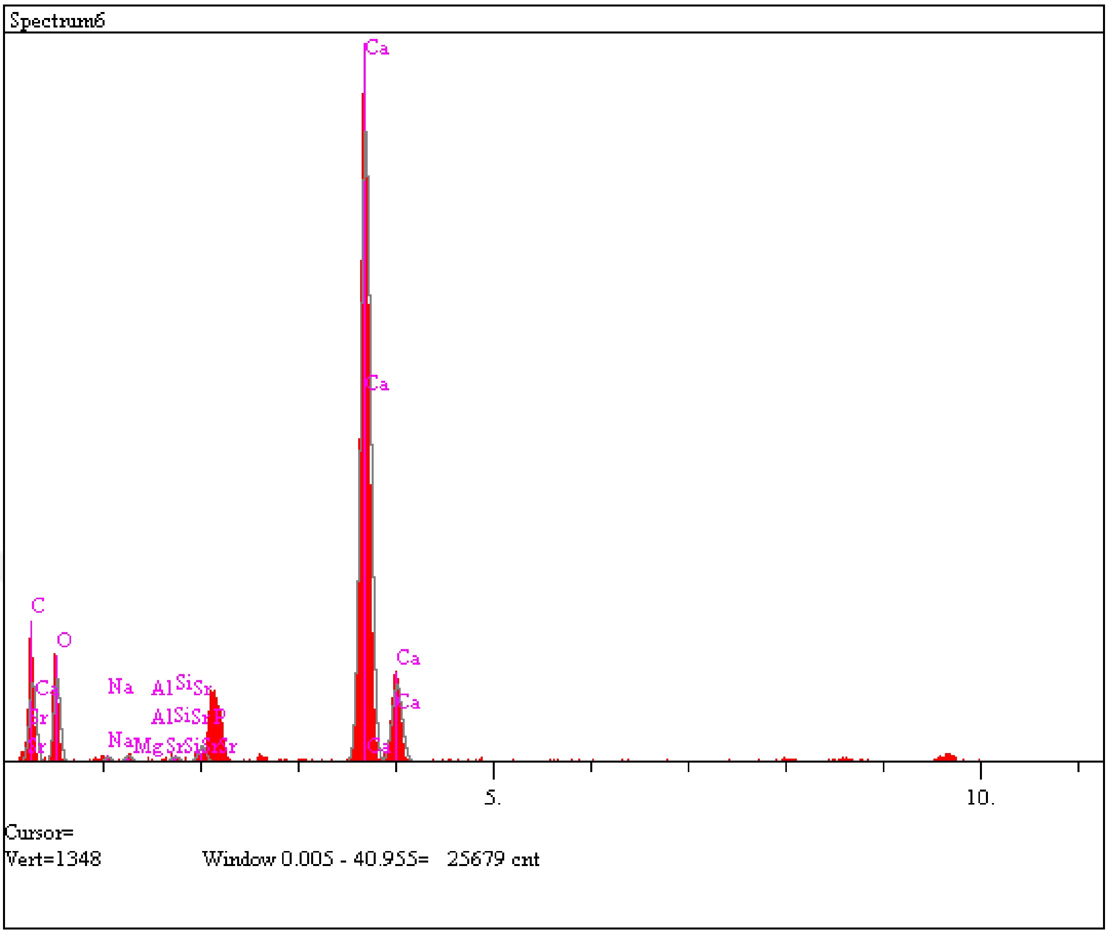
Elt.	Intensity (c/s)	Error 2-sig	Atomic %	Conc	
C	36.87	1.920	31.049	20.320	
O	44.27	2.104	54.246	47.292	
Na	1.76	0.420	0.241	0.302	
Mg	1.46	0.383	0.122	0.162	
P	6.01	0.775	0.268	0.453	
Ca	364.58	6.038	13.777	30.086	
Rb	6.10	0.781	0.280	1.306	
Sr	0.40	0.200	0.017	0.081	
			100.000	100.000	Total

Appendix D.12. *Psycrodromus fontinalis* from Sampling site 98



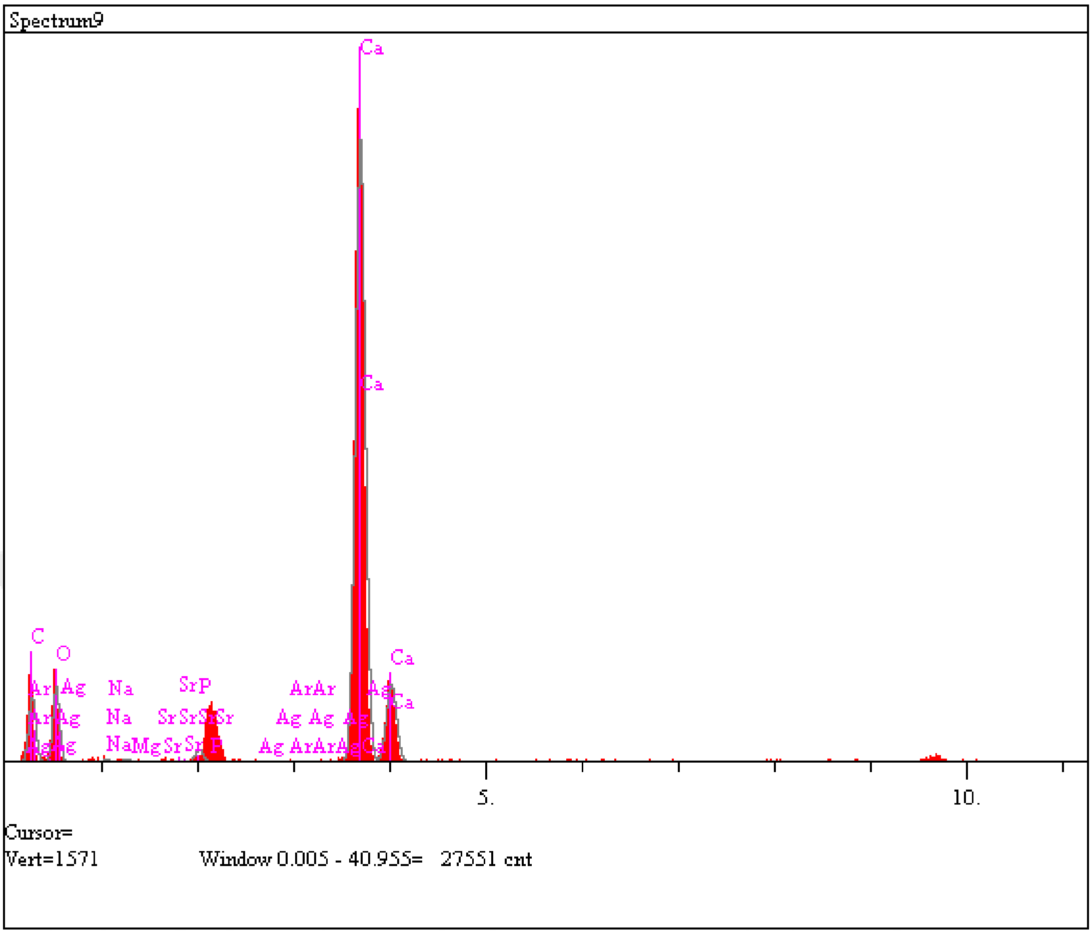
Elt.	Intensity (c/s)	Error 2-sig	Atomic %	Conc	
C	24.76	1.573	27.585	16.825	
O	28.79	1.697	52.062	42.299	
Na	1.74	0.417	0.302	0.352	
Mg	3.39	0.582	0.359	0.443	
P	4.73	0.687	0.262	0.412	
Ca	409.18	6.396	19.380	39.443	
Sr	0.99	0.315	0.051	0.226	
			100.000	100.000	Total

Appendix D.13. *Cypridopsis vidua* from Sampling site 102



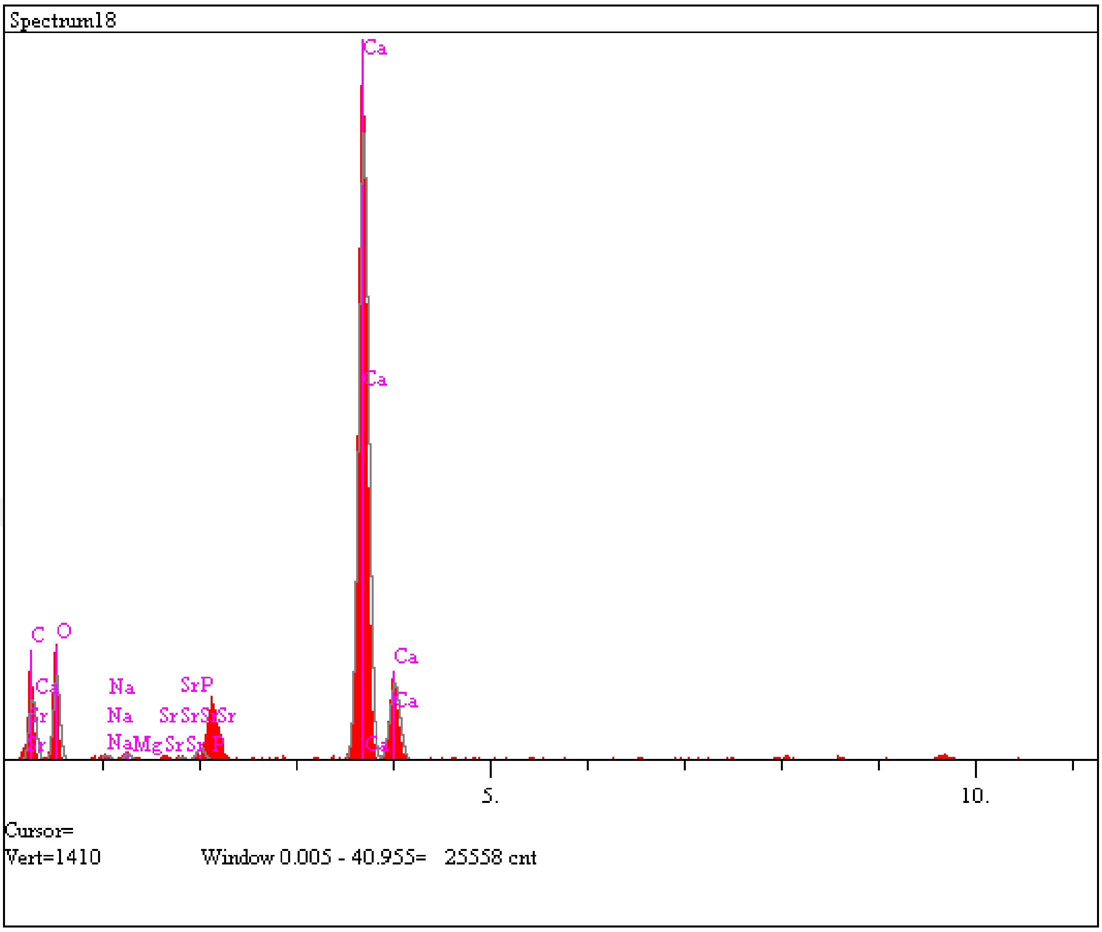
Elt.	Intensity (c/s)	Error 2-sig	Atomic %	Conc	
C	34.28	1.851	33.279	21.531	
O	33.07	1.818	49.880	42.990	
Na	2.42	0.492	0.366	0.453	
Mg	2.99	0.547	0.277	0.362	
Al	0.64	0.254	0.043	0.063	
Si	2.71	0.521	0.146	0.221	
P	7.72	0.879	0.377	0.629	
Ca	373.36	6.110	15.633	33.750	
			100.000	100.000	Total

Appendix D.14. *Psycrodromus olivaceus* from Sampling site 24



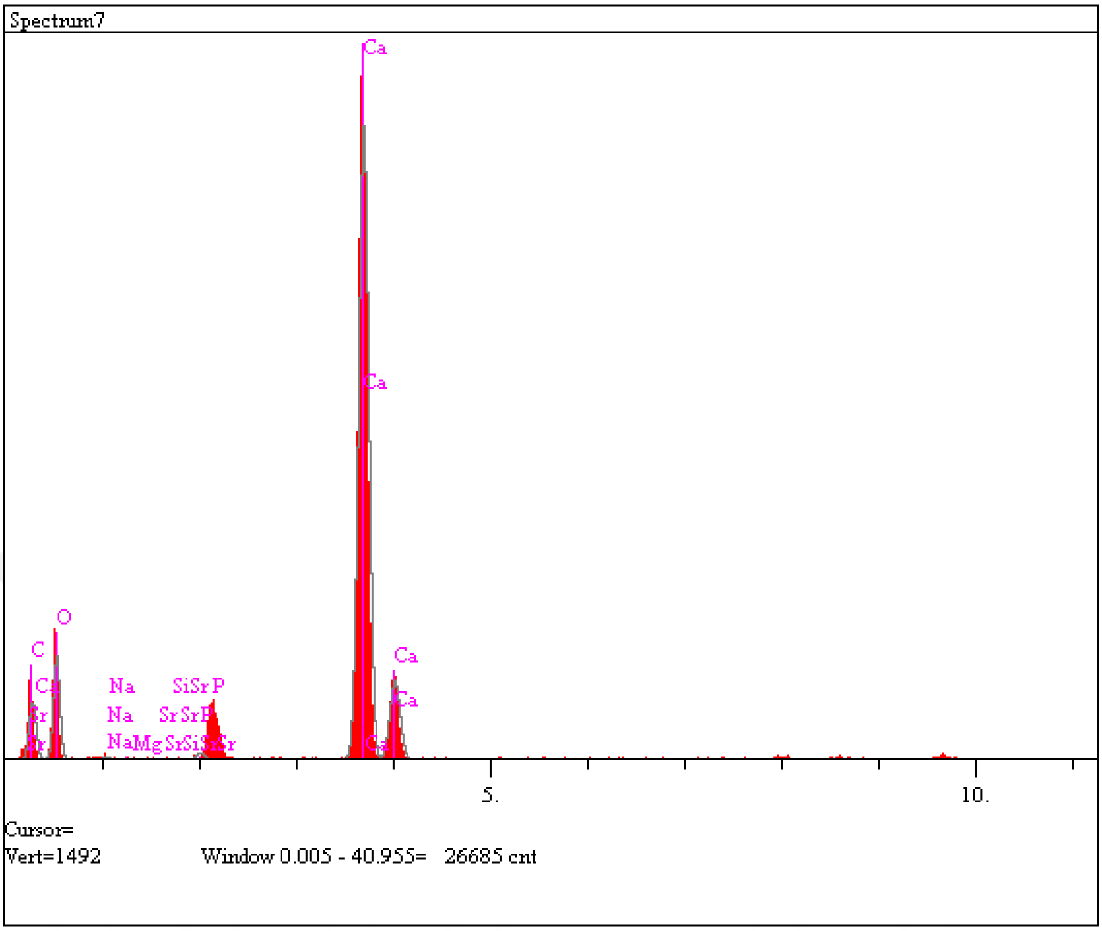
Elt.	Intensity (c/s)	Error 2-sig	Atomic %	Conc	
C	32.54	1.804	30.190	19.012	
O	34.98	1.870	51.757	43.418	
Na	1.42	0.377	0.209	0.252	
Mg	1.81	0.426	0.162	0.207	
P	7.19	0.848	0.337	0.548	
Ar	0.17	0.130	0.006	0.013	
Ca	429.18	6.551	17.297	36.348	
Sr	0.56	0.237	0.025	0.113	
Ag	0.60	0.246	0.016	0.088	
			100.000	100.000	Total

Appendix D.15. *Herpetocypris Intermedia* from Sampling site 102



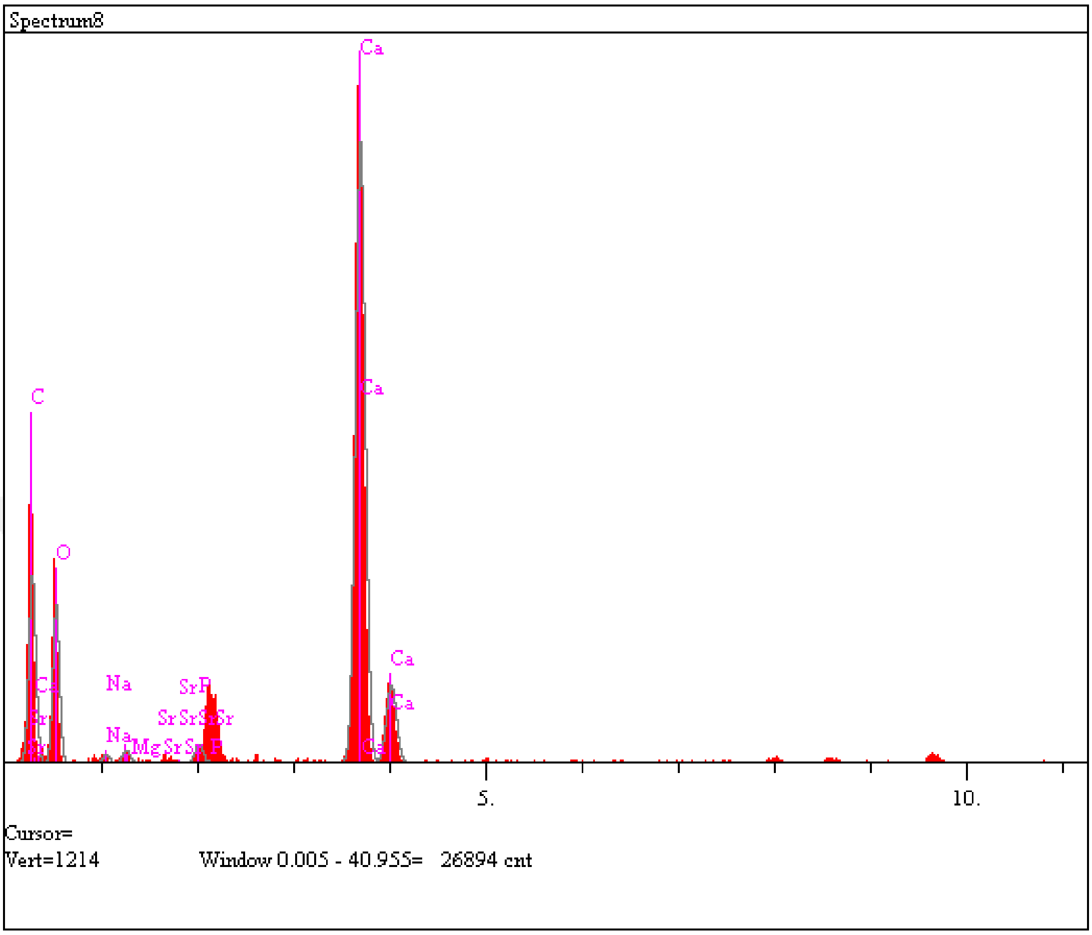
Elt.	Intensity (c/s)	Error 2-sig	Atomic %	Conc	
C	27.48	1.658	28.122	17.720	
O	35.60	1.887	54.018	45.341	
Na	2.54	0.504	0.401	0.483	
Mg	3.21	0.566	0.309	0.393	
P	6.69	0.818	0.338	0.549	
Ca	388.86	6.235	16.749	35.217	
Sr	1.36	0.369	0.064	0.296	
			100.000	100.000	Total

Appendix D.16. *Heterocypris incongruens* from Sampling site 92



Elt.	Intensity (c/s)	Error 2-sig	Atomic %	Conc	
C	27.01	1.643	24.151	15.271	
O	45.96	2.143	59.124	49.799	
Na	1.68	0.410	0.245	0.296	
Mg	0.84	0.290	0.075	0.095	
Si	0.34	0.183	0.017	0.025	
P	4.05	0.637	0.185	0.302	
Ca	415.79	6.447	16.193	34.165	
Sr	0.23	0.151	0.010	0.045	
			100.000	100.000	Total

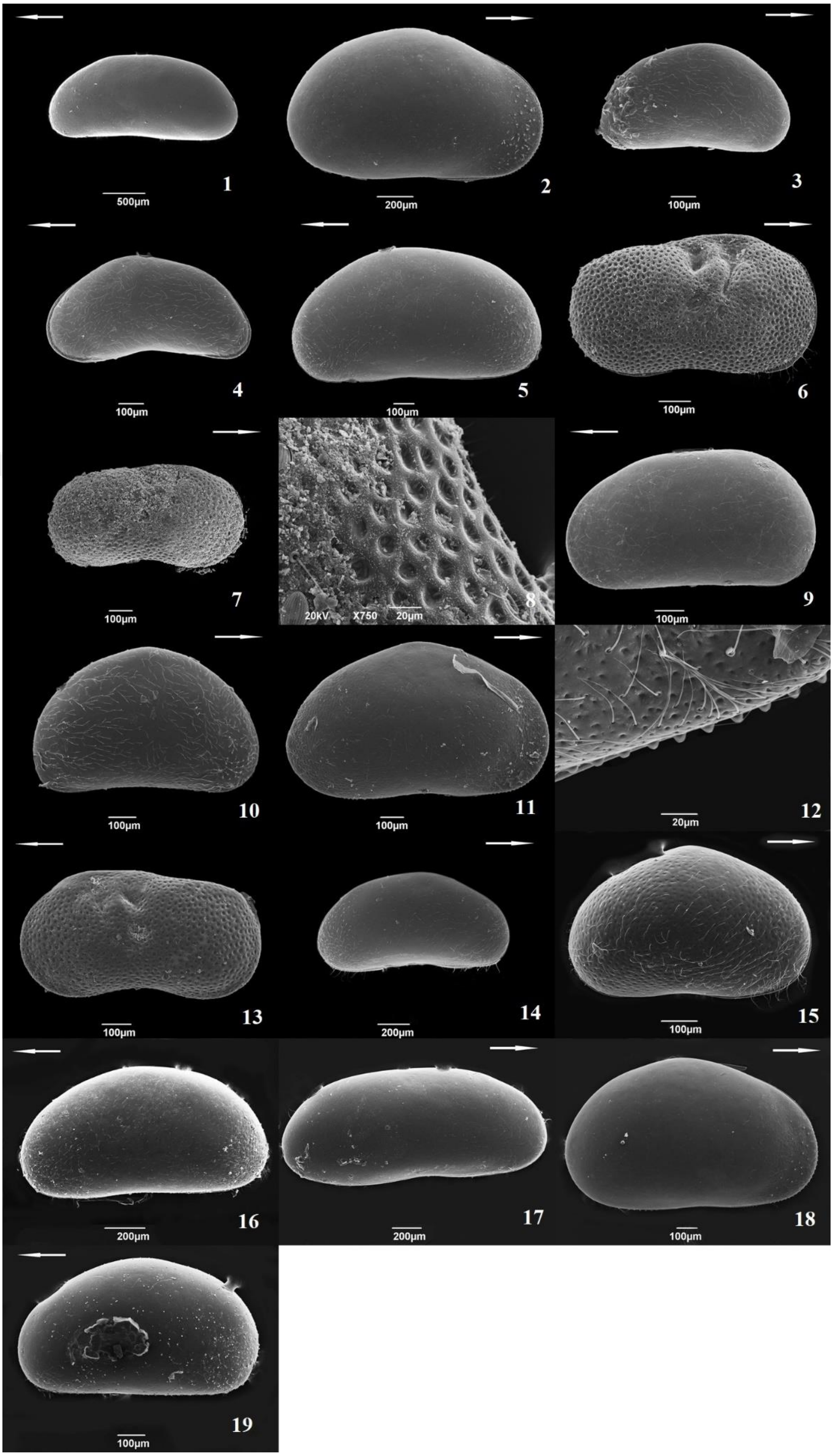
Appendix D.17. *Scottia pseudobrowniana* from Samplig site 15



Elt.	Intensity (c/s)	Error 2-sig	Atomic %	Conc	
C	72.88	2.699	42.552	30.865	
O	56.95	2.386	47.583	45.975	
Na	3.45	0.587	0.329	0.457	
Mg	5.30	0.728	0.310	0.455	
P	8.11	0.900	0.255	0.476	
Ca	330.60	5.750	8.951	21.665	
Sr	0.66	0.256	0.020	0.107	
			100.000	100.000	Total

Appendix E SEM photographs of some ostracods in this study (1: *Herpetocypris reptans,* 2: *Heterocypris incongruens,* 3: *Potamocypris fallax,* 4: *Potamocypris fulva,* 5: *Psychrodromus olivaceus,* 6: *Ilyocypris brehmi* 7,8: *Ilyocypris bradyi,* 9: *Pseudocandona albicans,* 10: *Potamocypris villosa,* 11,12: *Heterocypris salina,* 13: *Ilyocypris inermis,* 14: *Psychrodromus fontinalis,* 15: *Cypridopsis vidua,* 16: *Psychrodromus olivaceus,* 17: *Herpetocypris intermedia*, 18: *Heterocypris incongruens*, 19: *Scottia pseudobrowniana).*

Appendix E (Continued)



Appendix F Photographs of sone sampling sites in the study.

1	Sampling site 1	(3.10.2015)
2	Sampling site 15	(4.10.2015)
3	Sampling site 19	(4.10.2015)
4	Sampling site 20	(4.10.2015)
5	Sampling site 25	(4.10.2015)
6	Sampling site 37	(5.10.2015)
7	Sampling site 40	(5.10.2015)
8	Sampling site 44	(5.10.2015)
9	Sampling site 46	(6.10.2015)
10	Sampling site 47	(6.10.2015)
11	Sampling site 57	(6.10.2015)
12	Sampling site 77	(7.10.2015)
13	Sampling site 78	(7.10.2015)
14	Sampling site 86	(7.10.2015)
15	Sampling site 103	(8.10.2015)
16	Sampling site 105	(8.10.2015)

Appendix F (Continued)

Appendix F (Continued)