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Study and Notes for the Freshwater Spercheidae, Dryopidae and Heteroceridae (Coleoptera) Fauna of Erzurum Province: A New Record for Türkiye

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Erzurum İli Tatlısu Spercheidae, Dryopidae ve Heteroceridae (Coleoptera) Faunası için Çalışma ve Notlar: Türkiye için Yeni Kayıt

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Abstract

In this study, samples of Dryopidae, Heteroceridae and Spercheidae (Coleoptera) were collected from the shallow areas of lakes, ponds, rivers and small puddles in Erzurum province (Türkiye) between 2015 and 2020 with sieves of 3.15 x 1 mm pore size (mesh size 500 µm). A total of 4 different species were found. Two individuals from *Dryops griseus* (Erichson, 1847) species; 1 individual from the species *Dryops jeanneli* Bollow 1938; 2 individuals of *Heterocerus fenestratus* Thunberg 1784; and 2 individuals of *Spercheus emarginatus* (Schaller, 1783) species were caught. The collected samples were evaluated based on their morphological and ecological characteristics. While *D. griseus* was recorded for the first time in Türkiye, *D. jeanneli* and *S. emarginatus* are the third examples of species recorded in Türkiye. Additionally, these two species were recorded for the first time in the Eastern Anatolia region. *H. fenestratus*, collected from the Eastern Anatolia Region by another researcher, was also found during the study. The lateral parameters of the species' aedeagophores collapse from the middle towards the interior. Aedeagophore photographs and distribution data in the country and worldwide are discussed in the article. The average temperature and chemical parameters (electrical conductivity, pH, total nitrogen, dissolved oxygen, total phosphorus and water temperature) of the water bodies where the four different species were collected were found to be close to each other. To comprehend the life cycle, ecological data, along with morphological descriptions and vegetation information for each species are described.

Keywords *Aquatic insects; Dryops; Heterocerus; New record; Spercheus; Türkiye.*

Öz

Bu çalışmada, Dryopidae, Heteroceridae ve Spercheidae (Coleoptera) örnekleri 2015-2020 yılları arasında Erzurum ilindeki (Türkiye) göl, gölet, nehir ve küçük su birikintilerinin sığ alanlarından 3.15 x 1 mm gözenek boyutuna sahip eleklerle (ağ boyutu 500 µm) toplanmıştır. Toplam 4 farklı tür bulunmuştur. *Dryops griseus* (Erichson, 1847) türünden 2 birey, *Dryops jeanneli* Bollow 1938 türünden 1 birey, *Heterocerus fenestratus* Thunberg 1784 türünden 2 birey ve *Spercheus emarginatus* (Schaller, 1783) türünden 2 birey yakalanmıştır. Toplanan örnekler morfolojik ve ekolojik özelliklerine göre değerlendirilmiştir. *D. griseus* Türkiye'de ilk kez kaydedilirken, *D. jeanneli* ve *S. emarginatus* Türkiye'de kaydedilen üçüncü tür örnekleridir. Ayrıca, bu iki tür Doğu Anadolu Bölgesi'nden ilk kez kaydedilmiştir. Doğu Anadolu Bölgesi'nden başka bir araştırmacı tarafından toplanan *H. fenestratus* da çalışma sırasında bulunmuştur. Türlerin adegoforlarının yanal parametreleri ortadan iç kısma doğru çökmektedir. Adegofor fotoğrafları ile ülke ve dünyadaki dağılım verileri makalede tartışılmıştır. Dört farklı türün toplandığı su kütlelerinin ortalama sıcaklık ve kimyasal parametrelerinin (elektriksel iletkenlik, pH, toplam azot, çözünmüş oksijen, toplam fosfor ve su sıcaklığı) birbirine yakın olduğu tespit edilmiştir. Yaşam döngüsünü anlamak için, her türün morfolojik tanımları ve vejetasyon bilgileri ile birlikte ekolojik veriler açıklanmıştır.

Anahtar Kelimeler *Dryops; Heterocerus; Sucul böcekler; Spercheus; Yeni kayıt; Türkiye.*

1. Introduction

Since the existence of many freshwater bodies is under threat due to various reasons (industrial and agricultural activities, etc.), hydrological and hydrobiological studies (Baltacı et al. 2007) need to be done to protect existing water resources (streams, lakes, streams, etc.), which further increases the importance of the studies (Sener and Kırlangıç 2014). Aquatic insects are one of the key components of freshwater ecosystems (Hotaling et al. 2020).

They comprise 10% of insect diversity (Hotaling et al. 2020). Coleoptera is one of the most abundant orders known (Popa et al. 2021, Bektas et al. 2022). This order plays an important role in ecosystem functioning, especially in cycling nutrients and materials (Khaghani et al. 2022). Their population includes the most species

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(Tezcan, 2020), since it includes 300,000 - 450,000 species around the Earth (Bouchard et al. 2017). It was recorded that Coleoptera are represented by 597 species in Türkiye (Darılmaz and Incekara 2011, Özgen et al. 2019).

The order Coleoptera is recognised to include 43 families (Jäch 1998) and 38,650 species (Slipinski 2011). Today, this order is represented by 20 superfamilies and 166 families (Gillott 2005, Jäch and Balke 2008, Bektas 2015). While the Spercheidae family is a subcategory of the Hydrophiloidea superfamily (Archangelsky et al. 2016), Dryopidae and Heteroceridae families are a subcategory of the superfamily Byrrhoidea (Aguilare et al. 1998).

Dryopidae, named long-toed water beetles, are seen predominantly in most Palearctic regions (Jäch and Balke 2008, Kodada et al. 2006). The Dryopidae family is less diverse in Palearctic regions (Kodada and Jäch 2005). This family includes 263 species (32 genera) (Kodada and Jäch 2005). Scientists have recognised these long-toed water bugs since 2007. There are currently about 300 described species worldwide. There are 33 genera (Jäch and Balke 2008). *Dryops* Olivier 1791 is very common throughout Türkiye. However, Taşar (2014, 2017, 2018) published very little about the Turkish species of *Dryops*. The first records of Dryopidae were noted in Tokat (Türkiye) in 1940 (Taşar 2018). Currently, 11 species in 3 genera are known from Türkiye (Taşar, 2014, 2017, 2018). It is expected that faunistic studies will be completed in Türkiye with the discovery of new species. The varicolored mud-loving beetles (Heteroceridae), living in habitats consisting of mud (Aguilera et al. 1998, Clarke 1973, Mascagni 1995), is a small family of Coleoptera (King et al. 2011). Both adults and larvae live on the banks of various water bodies (Shaznev and Dragon 2020) and in shallow galleries (Aguilera et al. 1998). This family is known to have 13 species in Türkiye (just 2 genera) (Mascagni 2006, Tasar 2018), while 200 species have been identified around the world (five genera) (Mascagni 1995, Tasar 2014).

Spercheidae, filter-feeding water scavenger beetles, are a small family. This family is a homogeneous group of insects. It has only one genus (*Spercheus* Kugelann, 1798) and 18 species (Archangelsky et al. 2005, Jäch and Balke 2008, Hansen 1991, Hebauer 1997). Their biology is slightly known and they prefer stagnant water (Archangelsky 2001, 2016). In faunistic studies, these family members are evaluated as a good opportunity when they are caught. So far; Darılmaz and Kıyak (2011) captured *S. emarginatus* from Türkiye, emphasizing that they were collected in vegetation and detritus. In Lazareva's study (2012), researchers discussed how abiotic factors like water temperature, competition with other filter feeders, and predation by invertebrates and fish affect the species as these factors usually affect insect communities and distribution (Mouhoubi et al. 2019). Aquatic creatures are vulnerable to undulations of dissolved oxygen (DO) levels in water (Meding and Jackson 2003, Robarts et al. 2005), so this chemical parameter is an essential resource in aquatic ecosystems (Heddam 2017). Moreover, total phosphorus (TO) and total nitrogen (TN) parameters indicate water quality (Khadyr and Elshemi 2017). To determine ecological risks (such as; WT, pH, TN, DO, EC and TP), samples were taken from surface sediments in the main areas of Erzurum around shallow aquatic areas.

The main aim of this study is to identify species belonging to families that are not frequently encountered among aquatic insects. The goal is to determine the relationships of species in Spercheidae, Dryopidae and Heteroceridae (Coleoptera) fauna with some chemical parameters obtained with a portable parameter measuring device.

2. Materials and Methods

Four different species of Spercheidae, Dryopidae and Heteroceridae (Coleoptera) fauna were collected from 5 different rivers in districts (Aşkale, Hınıs, Şenkaya, Tortum and Yakutiye) in Erzurum province. Three different points were sampled along the Karasu River.

2.1 Study area

Freshwater bodies are the most biologically generative ecosystems (Anonymous 2007). Erzurum city and surroundings, with geographic coordinates of 39°45'N - 41°15'E and surface area of 25.066 km^2 (Turgut and Yılmaz 2020), is located in the northeast region of Türkiye. The region is one of the biggest provinces in the area (Işık et al. 2009). There are several freshwater zones. These include lakes, rivers, dam lakes, irrigation ponds, dominant minor rivers, and temporary wetlands (Turgut and Yılmaz 2020). This aquatic area (river and floating island) is an ecologically valuable area protected for ecological sustainability (Figure 1 and 2). Sampling areas (Table 1) consist of herbaceous puddles, sandy, grassy ponds in streams (Melikoglu, Başköy Kaleboynu and Yellitepe creeks) and on the Karasu river within the borders of Erzurum province (Türkiye). Special scoops and water sieves were used to capture rare Spercheidae, Dryopidae and Heteroceridae (Coleoptera) fauna insects. Sampling was done three times in May, June, July, August and September. Individuals belonging to these families were not found in most samples.

Figure 1. Photos from the study areas.

2.2 Sample collection and chemical parameters

Tiny mesh sieves were used to collect specimens from two freshwater habitats in Erzurum province and its surroundings. According to the literature, the specimens were analyzed. Photographic recordings of aedeagophors were obtained under two different light microscopes. Scientists converted the identified species into museum material. The author deposited them in their collection. Samples were collected with standard sieves with 3.15 x 1 mm pores (mesh size 500 µm) in all seasons except winter (due to not being found in the winter) between 2015 and 2020 from freshwater areas in Erzurum province. These macroinvertebrates from each unique location were placed in separate small plastic bottles. The insects were firstly killed with ethyl acetate and stored in bottles in the research area, containing 96% ethanol to reach a final concentration of 70% ethanol. After sorting, these samples were cleaned with a brush before identification, and then the aedeagophors of the insects were dissected under a stereo microscope in the laboratory. Collected insects were identified using identification keys developed by Archangelsky (2001), Darilmaz and Kiyak (2011), Taşar (2014, 2018), Sazhnev (2019)., Sazhnev and Dragan (2020), Kodada and Jäch (1995), Kodada and Jäch (2005), Jäch and Balke (2008), Mascagni (1995), Mascagni and Giardini (2005), Mascagni (2006), Mascagni (2016), Sazhnev (2022), Ryndevich (2004), Ryndevich and Lundyshev (2005), Queney (2018), Özgen et al. (2019) and Olmi (1976). Identification was made at family, genus and species level, respectively.

Local environmental parameters were measured on each sampling occasion. Portable devices recorded these parameters (electrical conductivity-*EC*, pH, total nitrogen-*TN*, dissolved oxygen-*DO*, total phosphorus-*TP* and water temperature-*WT*). Vertical sampling points in streams were determined with a multi-parameter measuring device, and two water samples were taken from each sampling point in special containers from 0.5 m below the water surface, mixed and transported to the laboratory via a cold chain. In special bottles, water samples were collected and kept in the refrigerator before being taken to the Eastern Anatolia High Technology Application and Research Center (DAYTAM) laboratory and Hınıs Vocational College laboratory for measurements. Some measurements were completed in the DAYTAM laboratory through service procurement.

3. Results

In the present study, a total of four species of Coleoptera insects were identified (Table 1). Three of these species, *Dryops griseus* Erichson 1847, were recorded for the first time in Türkiye. In Türkiye, researchers also registered *Dryops jeanneli* Bollow 1938 and *Spercheus emarginatus* Schaller 1783. This is their third recorded sighting in the country. They were recorded for the first time in the Eastern Anatolian region in this study (initial sightings were in Denizli and Afyon provinces). For the Heteroceridae family, *Heterocerus fenestratus* Thunberg 1784 was collected for the first time in Eastern Anatolian by a local researcher (Taşar 2014).

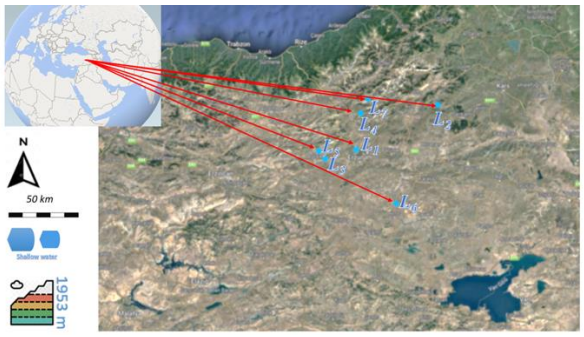

Figure 2. Study area: description of researching location.

3.1. Collected species

Family: Dryopidae Billberg 1820
Genus: *Dryops* A.G. Olivier 1791
Species: *Dryops griseus* (Erichson 1847)
Material examined: Türkiye, Eastern Anatolia, Erzurum, Yakutiye, Karasu river, Yolgeçti village, 40°03'01"N, 41°31'23"E, 1863m, 25.V.2019, 1 example; Erzurum, Şenkaya Melikoglu creek, Aksar, 41°15'05"N, 42°34'52"E, 1858m, 12.IX.2020, 1 individual.
Remarks: Scale of the body is 5.1 and 5.0 mm, it similar to Queney's specimens (Queney 2018). The body is generally blackish and the hairs yellow; the head, pronotum and elytra are black. The legs are brown. The shape of the aedeagus is characteristic, its size reaches 1.5 mm. The top of the parameres is thicker than that of *D. jeanneli*. The median lobe is more prominent and oval in ventral view, but its tip is slightly curved (Figure 4 a and Figure 5 a). This species was identified in Türkiye and the world (excluding the European continent) for the first time.

Distribution in Türkiye: It is a new record for Türkiye (Figure 3 a).

Distribution in the world: Aland Island, Austria, Belarus, Belgium, Brest region, United Kingdom, Croatia, Czech Republic, Denmark, Danish mainland, Estonia, Finland, France, Germany, Hungary, Latvia, Norwegian mainland, Luxembourg, Netherlands, Norway, Poland, Russian Federation, Slovakia, Spanish mainland (doubtfully) and Sweden (Fauna Europaea 2023, Thys 2017, Foster 2010).

Species: *Dryops jeanneli* Bollow 1939

Material examined: Türkiye, eastern Anatolia, Erzurum, Aşkale, Karasu river, Küçükgeçit, 40°43'00"N, 41°18'36"E, 1558m, 26.V.2020, 1 individual.

Remarks: Scale of the body is 5.1 mm. It has the same length as Tasar's specimen (Tasar 2014), according to Bollow (1938). The head, elytra and pronotum are black. Legs are more blackish or dark brown. The aedeagus is 1.41 mm in length. The median lobe and parameres terminate sharply at the distal apex (Figure 4 b). Researchers recorded data from Türkiye. This is the first collection in the Eastern Anatolian Region (see Figure 2, Figure 3 b and Figure 5 d).

Distribution in Türkiye: Adıyaman (Tasar 2014) (Figure 3 b).

Distribution in the world: Uzbekistan (Kodada and Jäch 2006), Türkiye (Tasar 2018).

Family: Heteroceridae Macleay 1825

Genus: *Heterocerus* Fabricius 1792

Species: *Heterocerus fenestratus* (Thunberg 1734)

Material examined: Türkiye, Erzurum, Tortum, Arılı, Yellitepe creek, 40°38'38"N, 41°32'49"E, 1453m, 22.VIII.2017, 2 individual.

Remarks: The aedeagophore of both individuals has a similar scale and view (Figure 5 b). Exceptionally, the parameres of the aedeagophores were collapsed inwards in the middle (Figure 4 c). It was caught by a local researcher for the first time in the Eastern Anatolia region and this is the second collection by a local researcher. [Ardahan: 06.VI.1989, leg. Schöumann and Schillhammer, 7 ex.; Kars: Digor, 1650 m., 15.VI.1986, leg. Besuchet, Löbl and Burckhardt, 1 ex., Lake Çıldır, 07.VI.1989, leg. Schöumann and Schillhammer, 5 ex., Lake Kuyucuk, 07.VI.1989, leg. M. Jäch, 3 ex.; Erzurum: Pazaryolu, 01.VI.1989, leg. Schöumann and Schillhammer, 1 ex. (Tasar 2018)].

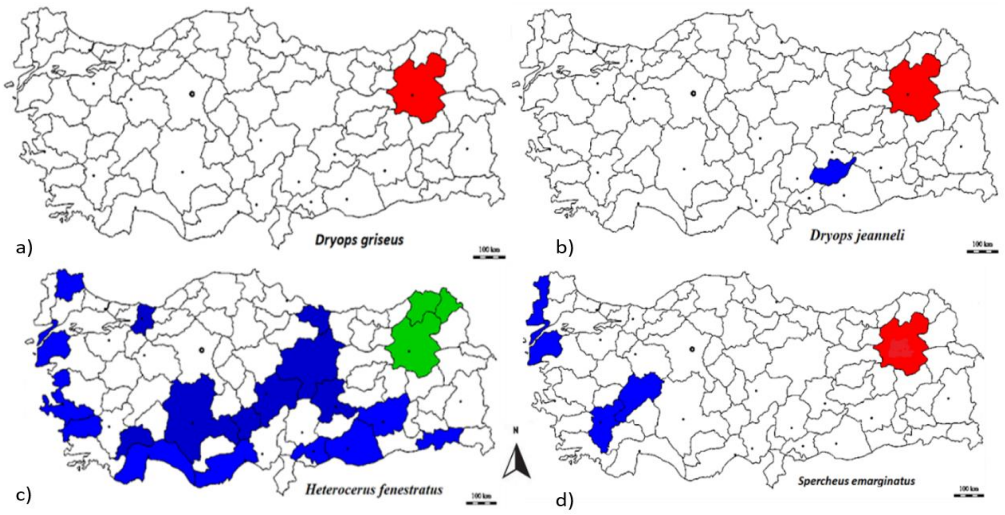

Figure 3. Distributional map of species on Türkiye provinces (red zone: first record; blue zone: previous known records; green zone: first-time capture by local researcher): **a** – *Dryops griceus*; **b** – *D. jeanneli*; **c** – *Heterocerus fenetstratus*; **d** – *Spercheus emarginatus*.

Distribution in Türkiye: İstanbul, Kırklareli (Mascagni and Giardini 2005), Adana, Adapazarı, Afyon, Antalya, Ardahan, Aydın, Batman, Burdur, Çanakkale, Diyarbakır, Erzurum, İzmir, Gaziantep, Kars, Kayseri, Konya, Malatya, Mersin, Niğde, Sivas, Ordu, Şanlıurfa and Şırnak (Tasar 2018) (Figure 3 c).

Distribution in the world: Afghanistan, Albania, Algeria, Armenia, Austria, Azerbaijan, Belgium, Bosnia Herzegovina, Bulgaria, Belarus, Canada, Chile, China, Taiwan, Xizang, Croatia, Cyprus, Czech Republic, Egypt, Finland, France, Georgia, Germany, Great Britain, Greece, Hungary, Iran, Iraq, Ireland, Israel, Italy, Japan, Jordan, Kazakhstan, Kyrgyzstan, Laos, Latvia, Lebanon, Lithuania, Malaysia, Moldavia, Mongolia, Montenegro, Morocco, Netherlands, North Korea, Philippines, Poland, Portugal, Romania, Russia, Saudi Arabia, Slovakia, Slovenia, South Korea, Spain, Sweden, Switzerland, Syria, Tajikistan, Thailand, Tunisia, Türkiye, Turkmenistan, Ukraine, United

States of Amerika, Uzbekistan, Vietnam, Yemen and the Southern Hemisphere (Charpentier 1979, Mascagni 2003, 2006, 2016, King and Lago 2012, Sazhnev 2019, Sazhnev and Dragan 2020, Sazhnev 2022).

Family: Spercheidae Erichson 1837
Genus: *Spercheus* Kugelann 1798
Species: *Spercheus emarginatus* (Schaller 1783)
Material examined: Türkiye, Eastern Anatolia, Erzurum, Tortum, Şenyurt, Kaleboynu creek, 40°43'21"N, 41°44'21"E, 1441 m, 22.VIII.2015 (L_7), 1 individual; Hınıs, Ovaçevirme, Başköy creek, 39°33'10"N, 42°19'30"E, 1722 m, 15.VI.2020, 1 individual.
Remarks: The body is pale in color, its 5.6-7.2 mm long. The pronotum is slightly sharper than previous species but the color is cerise. Elytra is deep brown with small black spots and normal elevated ridges situated along the suture; antennae are blackish; and legs dirty brown. The aedeagophore has a similar shape to previously collected samples (Figure 4 d). It was registered for the third record in Türkiye and newly recorded in the Eastern Anatolian Region. Scale of the body is 5.1 mm. It has the same length as Tasar's specimen (Tasar 2014) and to Bollow (1938). The head, elytra and pronotum are black. Legs are dark brown or blackish (Figure 5 c). The aedeagus is 1.41 mm in length. The median lobe and parameres terminate the distal apex sharply (Figure 4 d). This was the second record from Türkiye and the first collection in the Eastern Anatolian Region (Figure 2).
Distribution in the world: Austria, Azerbaijan, Belgium, Bulgaria, Belarus, Croatia, Czechia, Denmark, France, Great Britain, Germany, Greece, Hungary, Iran, Italy, Kazakhstan, Latvia, Lithuania, Netherlands, Poland, Romania, Russia, Slovakia, Sweden, Switzerland, Türkiye and Ukraine (Hebauer 1997, Darılmaz *et al.* 2018).
Distribution in Türkiye: Afyon, Denizli, Edirne (Darılmaz and Incekara 2011), Çanakkale (Topkara and Ustaoğlu 2014) (Figure 2 and Figure 3 d).

3.2. Chemical analysis

Since data for chemical parameters were obtained during daylight hours, temperature and pH values were found to be daytime values. Average water temperature was 20 ℃ due to the collection of samples on particularly hot days (non-rainy days) from May to September. The average value of EC was found to be 190 µs/cm, and the pH was slightly alkaline and measured as 7.40. Average DO was 8.15 mg/L, but a value of DO 13.7 mg/L was observed in Şenkaya Akşar stream (at L_2 location) with an altitude of 1858 meters. Average values were calculated as TN 5.13 mg/L and TP 0.24 mg/L.

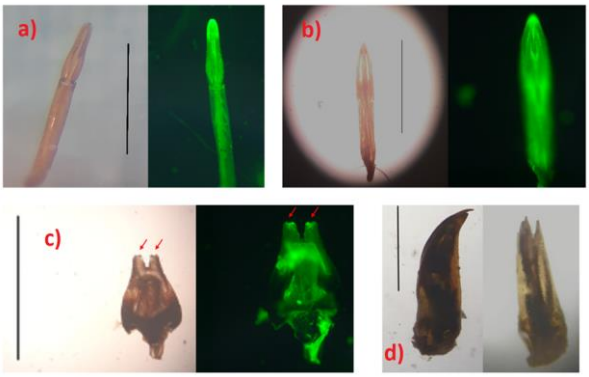

Figure 4. Aedeagus (male-sexual organs): **a** – aedeagus of *Dryops griseus*, dorsal view; **b** – aedeagus of *Dryops jeanneli*, dorsal view; **c** – aedeagus of *Heterocerus fenestratus*, dorsal view (red arrows indicate burrows in the paramers); **d** – aedeagus of *Spercheus emarginatus*, lateral view (Scale: 1mm).
** Green images were obtained with a fluorescence microscope to more clearly distinguish aedeagophore structures.*

Figure 5. Collected insects: **a** –*Dryops griseus*; **b** – *Heterocerus fenestratus*; **c** – *Spercheus emarginatus*; **d** – *D. jeanneli* (Scale: 10mm).

4. Discussions

Erzurum is known as a continental climate crossroads, reflecting the Caucasian, Middle Eastern and Mediterranean climates. Due to its interesting geographical location, varied terrain and cold climate, it is predicted that this difference will also contribute to insect diversity. In Türkiye, the order Coleoptera has not been fully investigated by researchers yet. In this study, four species belonging to Dryopidae (2), Spercheidae (1) and Heteroceridae (1) were detected in the aquatic environs within Erzurum province, Türkiye. The collected individuals were found only in rivers and creeks. They were not found in lakes.

Researchers recorded *Dryops jeanneli* Bollow 1938 for the third time in Türkiye. Members of Dryopidae are abundant and are similar to each other. They prefer herbaceous vegetation. *Dryops griseus* is a vulnerable long-toed water beetle, and both (*D. griseus* and *D. jeanneli*) are considered to be relict fen indicator species (Olmi 1976, Hammond 2018).

Heteroceridae, variegated mud-loving beetles, are widespread on every continent. Since there are very few studies, researchers know about these families from Türkiye. Two studies from Türkiye (Mascagni 1991,

Mascagni and Giardini 2005) focused on Heteroceridae. In males of *Heterocerus fenestratus*, parameres show variation with a hollow in the middle. This makes it different from previously-identified species. Local researchers collected *Heterocerus fenestratus* Thunberg 1784 from the Eastern Region of Turkey. This is the first time it has been found in this location. Furthermore, the researchers recorded *Spercheus emarginatus* (Schaller 1783) in Turkey for the third time. The researchers recorded the species in the Eastern Anatolian region for the first time.

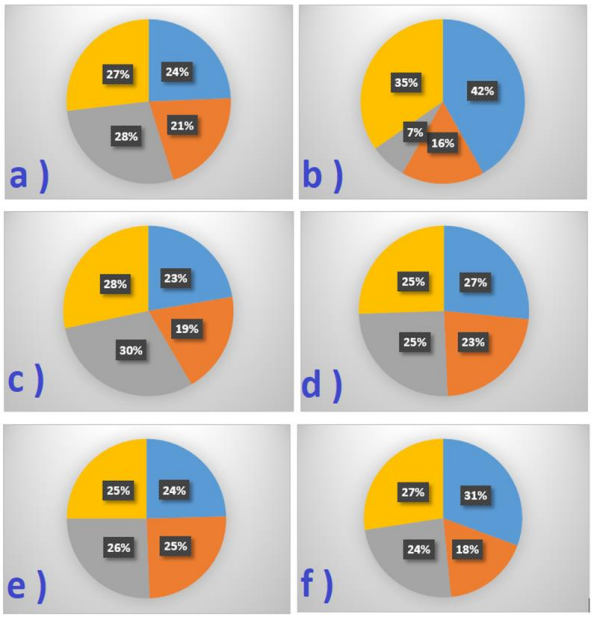

Figure 6. Percentage differences of chemical parameters according to species (blue: *Dryops jaenneli*; orange: *Dryops griseus*; yellow: *Specrhus emarginatus* and grey: *Heterocerus fenestratus*): **a** – WT (^{0}C); **b** – pH; **c** – TN (mg/L), **d** – DO (mg/L), **e** – EC (µs/cm) and **f** – TP (mg/L)).

Food resources and other changes vary through time due to seasonal shifts (Beche et al. 2006). These vicissitudes strongly control environmental structures and aquatic metacommunities (Diniz et al. 2021 and Lansac-Toha et al. 2021). Both faunistic and ecological studies should focus on understanding how insects are distributed and on decision-making in additional chemical contexts (Valone 2006). Therefore, insect distributions should be investigated together with the existing ecological parameters. In subarctic lakes, plants are poorly developed or absent; therefore, the abundance and diversity of littoral macrofauna taxa (primarily insects) are reduced (Chertoprud et al. 2021). Similar weaknesses of both vegetation and macrofauna are observed in our study region (semi-glacial lake). The EC parameter had close values for all four species. However, the TP value was slightly lower in research areas (freshwater) where *D. griseus* was caught. Additionally, *H. fenestratus* was detected in waters that are more acidic in terms of pH. These ecological results are expected to help detect bio-indicator species for the sustainability of freshwater ecosystems. EC, pH, TN, DO, TP and WT were detected at close levels for all four species. However, in stagnant aquatic areas, *H. fenestratus* species, which is found in sandy environments with less vegetation, was detected at a slightly lower rate in terms of pH (Figure 6 a b c d e).

Chemical analyses are important for determining the health and quality of aquatic ecosystems. These analyses are used to monitor water quality in aquatic ecosystems, assessing water nutrients, pollution levels and environmental impacts. For example; EC determines the amount of dissolved ions in water. This usually indicates the salinity level of the water. EC is important in monitoring salinity changes as well as mineral content and pollution of water. The pH level indicates whether the water is acidic or alkaline. The appropriate pH range is important for aquatic creatures because overly acidic or alkaline environments can be harmful to living organisms. The pH level also affects the chemical balance of water (Figure 6 b). TN and TP are the basis of the food chain in aquatic ecosystems and can lead to decreased water quality and imbalance in the ecosystem. DO is vital for aquatic organisms. Low DO levels can be life-threatening for aquatic creatures. WT affects the metabolism, reproductive cycles and life cycles of aquatic organisms. The ideal temperature range is important for the healthy continuation of aquatic life (Harrison 2001, Erban and Hubert 2010, Hep et al. 2013, Prommi and Payakka 2015). 15).

All four species were caught in water with similar EC values. In terms of pH values, *D. jaenneli* was caught in slightly acidic waters (pH: 6.8) and *H. fenestratus* species was caught in slightly alkaline waters (7.35 and 7.40) (Figure 6 e). TN, TP and DO had close values in the waters where all four different species were present, and *H. fenestratus* was observed to prefer sandy waters and waters with slightly more total nitrogen. The impact of these chemical analyses on species diversity is complex. Water quality affects the living conditions of organisms in aquatic ecosystems. High pollution levels or poor water quality can cause some species to become extinct or their populations to decline. On the other hand, it is known that some organisms can adapt to these changes or that some organisms may be better suited to certain conditions. Therefore, chemical analyses can have complex and diverse effects on species diversity (Popoola and Otalekor 2011; McNamara et al. 2021).

In general, the chemical values for the samples with captured insect samples were within average limits. Since measurements were made with a portable device and only the values at the time the sample were taken were taken into consideration, they are not included in Table 1.

Table 1. Systematic of Coleoptera samples and location information of collected insects (* first record)

Insect species	Coordinats	Altitude (metre) Sampling time	Location / code / Vegetation (Erzurum /Türkiye)
D. griseus **(Erichson, 1847)***	40^{0}03^I 01^{II}N 41^0 31^I 23^{II} E	1853 25.05.2019	Karasu river / Yolgeçti village / Yakutiye / ***L$_1$*** / Herbaceous puddles
	41^{0}15^I 05^{II} N 42^0 34^I 52^{II} E	1858 12.09.2020	Melikoglu creek / Aksar / Şenkaya /***L$_2$*** / Herbaceous puddles
D. jeanneli **Bollow, 1938**	40^{0}43^I 00^{II} N 41^0 18^I 36^{II} E	1558 26.05.2020	Karasu river/ Küçükgeçit/ Aşkale / ***L$_5$*** / Herbaceous puddles
H. fenestratus **Thunberg, 1784**	40^{0}43^I 01^{II}N 41^{0}18^{I}36^{II} E	1555 25.05.2019	Karasu river / Küçükgeçit/ Aşkale/ ***L$_3$*** / sandy and grassy ponds
	40^{0}38^I 38^{II} N 41^0 32^I 49^{II} E	1451 22.08.2017	Yellitepe creek / Arılı / Tortum / ***L$_4$*** / sandy and grassy ponds
S. emarginatus **(Schaller, 1783)**	39^{0}33^I 10^{II} N 42^0 19^I 30^{II} E	1722 15.07.2020	Başköy creek/ Ovaçevirme / Hınıs / ***L$_6$*** / Herbaceous puddles
	40^{0}43^I 21^{II} N 41^0 44^I 21^{II} E	1443 22.08.2015	Kaleboynu creek / Şenyurt / Tortum / ***L$_7$*** / Herbaceous puddles

5. Conclusions

This is the first time that *D*. *griseus* was identified in the world outside the European continent. If quantitively rare species are investigated along with their ecological parameters, faunistic contributions will be made to both Europe and other continents. Therefore, more faunistic knowledge of Dryopidae, Spercheidae and Heteroceridae was achieved with these new distributional records. Chemical parameters, along with supporting information about the biology and ecology of aquatic insects were obtained. There is a need for more studies about Coleoptera fauna in Türkiye.

Declaration of Ethical Standards
The authors declare that they comply with all ethical standards

Credit Authorship Contribution Statement
Author: Conceptualization, investigation, methodology and software, visualization and writing – original draft, supervision and writing – review and editing.

Declaration of Competing Interest
The authors have no conflicts of interest to declare regarding the content of this article.

Data Availability Statement
All data generated or analyzed during this study are included in this published article.

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