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Murgul Bakır Madeni Sahasından Etkilenen Sucul Entomofauna (Coleoptera) Dağılımının Araştırılması ve Artvin'deki Yeni Faunistik Kayıtlar

Zeynep AYDOĞAN[1*], Ümit İNCEKARA[2], Turgay ŞIŞMAN[2], Mustafa C. DARILMAZ[3], Özkan AKSAKAL[2]

ÖZET: Murgul'un (Artvin) sucul böcek (Coleoptera) faunasını belirlemek için Murgul Bakır Madeni civarındaki üç lokaliteden Haziran-Temmuz 2020 ayları arasında örnekleme yapıldı. Toplamda Dytiscidae ve Hydrophilidae ait 12 tür elde edildi. Bunlardan 9 tanesi Hydrophilidae (6 *Laccobius*, 1 *Enochrus*, 1 *Hydrobius*, 1 *Coelostoma*), ve 3 tanesi Dytiscidae (1 *Agabus*, 1 *Deronectes*, 1 *Hydroglyphus*) ait türlerdir. *Hydroglyphus pusillus*, *Laccobius (Dimorpholaccobius) sculptus* ve *Laccobius (Dimorpholaccobius) sulcatulus* türleri Artvin ilinden ilk kez kaydedilmiştir. Çalışma alanında tespit edilen altı tür ile *Laccobius*, diğer iki cinse göre sayı olarak fazladır. Bu çalışma, madenden etkilenen habitatların biyotik ve abiyotik örneklerde ağır metal konsantrasyonu açısından değerlendirilmesi ve izlenmesi gerektiğini vurgulamaktadır.

Anahtar Kelimeler: Bakır madeni, biyoçeşitlilik, dytiscidae, hydrophilidae, kirlilik, Artvin ili

Investigation of the Distribution of Aquatic Entomofauna (Coleoptera) Affected by Murgul Copper Mine Area, with New Faunistic Records in Artvin

ABSTRACT: 66 insect samples from three localities where vicinity of the Murgul copper mine were collected between June to September 2020 to investigate water beetle (Coleoptera) entomofauna of Murgul (Artvin). Totally twelve species, all of which belong to Dytiscidae and Hydrophilidae determined and reported here. Nine of them as Hydrophilidae (6 *Laccobius*, 1 *Enochrus*, 1 *Hydrobius*, 1 *Coelostoma*), and of which three as Dytiscidae (1 *Agabus*, 1 *Deronectes*, 1 *Hydroglyphus*) were determined. In addition, *Hydroglyphus pusillus*, *Laccobius* (*Dimorpholaccobius*) *sculptus* and *Laccobius* (*Dimorpholaccobius*) *sulcatulus* were recorded from Artvin for the first time. *Laccobius*, with six species, identified in the study area, is conspicuous compared to the other two genera. The study highlights that the mine affected habitats should be evaluated and monitored in terms of heavy metal concentration of biotic and abiotic environments.

Keywords: Copper mine, biodiversity, dytiscidae, hydrophilidae, pollution, Artvin province

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INTRODUCTION

Hydrophiloidea is cosmopolitan group and represented by more than 6600 described species (Slipinski and Lawrence 2019). Dytiscidae and Hydrophilidae are the two largest water beetle families of Coleoptera. The members of both are abundant in various of stagnant waters and streams. Dytiscidae or predaceous diving beetles might be one of the best known and largest insect family into the suborder Adephaga and currently known more than 4440 species form 182 genera of Dytiscidae in the world (Nilsson and Hájek 2018; Slipinski and Lawrence 2019). The current knowledge of the diving beetle fauna in Turkey is 149 species and subspecies belong to Dytiscidae (Tezcan 2020). Hydrophilidae or water scavenger beetles are the most diverse Polyphaga family, represented in all parts of the world, consisting of 169 genera and more than 2840 known species (Clarkson et al. 2018). The Turkish hydrophilid fauna currently comprises 163 species and subspecies (Tezcan 2020).

According to the peer reviewed literature, aquatic beetles are widely distributed in Artvin. There are 57 recorded species belong to Dytiscidae (30), Hydrophilidae (19), Helophoridae (6), Hydrochidae (2) in Artvin (Darılmaz and Kıyak 2009; Mart 2009; Darılmaz and İncekara 2011; Daşbaşı 2017; Yüncü 2019). These studies conducted in difference places of Artvin, however there is no study, which was made in Murgul before. The purpose of this contribution is to record the Coleopteran biodiversity in Murgul Stream and tributaries, determine the aquatic coleopterofauna of Murgul province, to report new records and to provide a complete list of the species of Coleopterofauna currently known from Artvin province and thereby to contribute to the aquatic Coleoptera fauna in Turkey. In addition, it is known the fact that, mining activities are degrading the physical, chemical and biological habitat quality of the environment (Kgotso 2018). Therefore, the study purpose is also an evaluation of Coleopterofauna biodiversity of Murgul mine area. To our knowledge, this study represents the first published data on aquatic insects in Murgul mine province.

MATERIALS AND METHODS

Study area

Artvin is polymetallic in terms of mine and is rich in copper, lead, zinc, gold, and silver. Murgul is a district of Artvin at a distance of 24 km from the city, has a 396.7 m altitude, and has a 301 km^2 surface area and here copper processing is ongoing from 1945 until today and 130,000 tons of copper is produced annually. Murgul copper mine extraction is mainly made from two open pits (Anayatak and Çakmakkaya). Çarkbaşı copper-pyrite bed is not operated today. It is estimated that these mines, which have been operated previously and are still active today, have significant environmental impacts.

Sampling was conducted June to September 2020 at three sites spread along the entire length of the Murgul stream in Murgul (Artvin), in the vicinity of Murgul copper mine. These sites were selected according to the insect's existence (Figure 1). The fieldwork was concentrated on the Murgul Stream and tributaries close to the copper mine. That is why it did not cover the whole spectrum of water bodies in Murgul.

There is no settlement around in all stations. Station 1 (S-1) is a shallow stream without vegetation and pollution. Station 2 (S-2), pollution is present in the stream in the form of potential effluent from Murgul copper mine. In addition, there are hydropower regulators in stations S-2. Station 3 (S-3) is a small tributary, vegetation present and there is a cement plant (Table 1).

Table 1. Detailed information about sampling sites.

Stations	S-1	S-2	S-3
Coordinates	41°15'59"N 41°33'31"E	41°14'57"N 41°33'05"E	41°13'53"N 41°32'47"E
Altitude (m)	476	549	660
Classification	Stream	Stream	Stream
Description	Clean	Polluted by copper mine	Polluted by cement plant

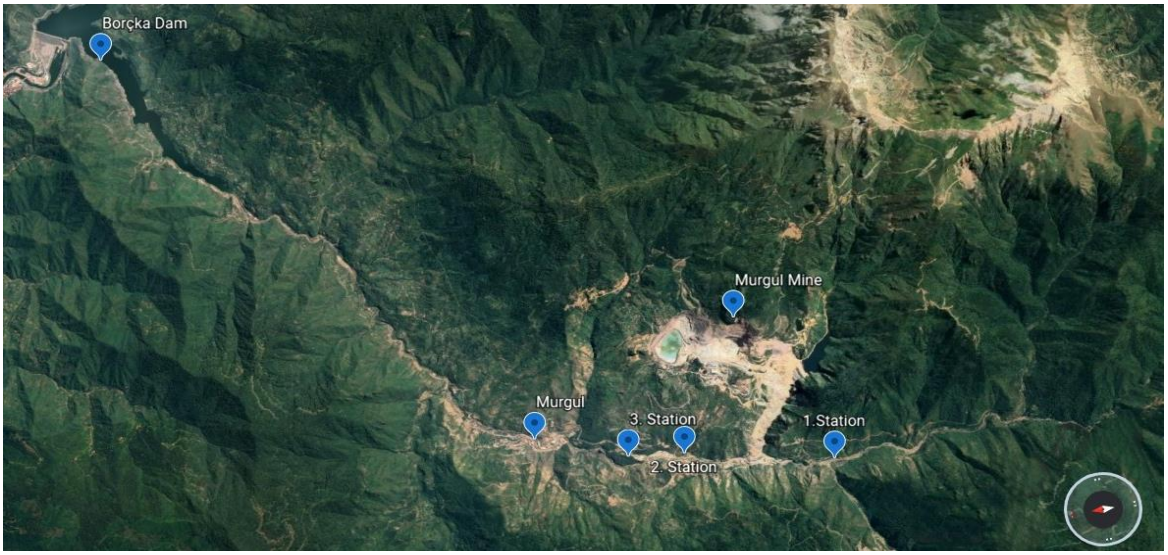

Figure 1. Map of Murgul Stream with marked localities (from Google Earth)

Data collection

Fieldwork was performed from June to September 2020 in Murgul. During the study, 66 beetle specimens were collected from three aquatic sampling points. The aquatic beetles were sampled with the help of a sieve having a mesh diameter of 1 mm from shallow areas of water ponds and wet habitats near the Murgul stream and tributaries (Figure 2). Samples were placed in washed glass jars, fixed in 70% ethanol, and transported back to the laboratory for further analyses.

In the laboratory, the aquatic insects were separated from clayey and muddy substances with the aid of a small paintbrush then they were identified with the aid of a microscope to the species level. Identification was carried out using aedeagophores and some other important morphological characters of the beetles.

Figure 2. Habitats of the insects and their collection

RESULTS AND DISCUSSION

The sampling areas were explored very carefully and it is assumed that the major part of the study area was evaluated. However, the insects could only be collected from three locations. The study mainly focused on species spectrum and diversity, and only adult specimens were used. The study area was restricted to only three locations (S1, S2, S3), due to low biodiversity in the area. Aquatic insects belonging to Hydrophilidae and Dytiscidae were collected from Murgul (Artvin) based on a field survey, which was carried out from June to September 2020. In total, 66 individuals of aquatic Coleoptera were retrieved for this study. Two beetle families have been detected: Hydrophilidae (9 species) and Dytiscidae (3 species). 12 species of water scavenger and diving beetles belonging to 7 genera were identified (Table 2). Of them, 9 species reported earlier, 3 species reported from the study area for the first time. The new records for Artvin (Murgul) province are *Hydroglyphus pusillus*, *Laccobius* (*D.*) *sculptus* and *Laccobius* (*D.*) *sulcatulus*). The genera of Hydrophilidae represented by more than one species were *Laccobius*. The rest of the genesis were represented each by a single species. The dominant group throughout the study was the *Laccobius*, of which there were six species. Dytiscidae was represented by 3 species, found only in one site (S-3) in minimal numbers.

In totally, 12 species of aquatic insects were found. The highest numbers of specimens were showed station 1 with 32 specimens, the lowest number of specimen at station 3 with 13 specimens. In this present study, two families of aquatic beetles (Coleoptera), Hydrophilidae (9 species) and Dytiscidae (3 species) have been provided along with their current scientific names and were listed in Table 2.

Table 2. Coleopterofauna of the study area, captured numbers of the insects and information about the stations.

Family	Species	Station	Numbers	Altitude (m)	Coordinates
Dytiscidae	*Agabus biguttatus*	S-3	2	660	41º13'53"N 41º32'47"E
	Deronectes doriae	S-3	1		
	Hydroglyphus pusillus	S-3	1		
Hydrophilidae	*Laccobius gracilis*	S-1/2/3	7-3-2	476 549 660	41º15'59"N 41º33'31"E 41º14'57"N 41º33'05"E 41º13'53"N 41º32'47"E
	Laccobius syriacus	S-1/2/3	4-3-1		
	Laccobius simulatrix	S-1/2/3	8-4-1		
	Laccobius bipunctatus	S-1	4		
	Laccobius sculptus	S-1/3	4-2		
	Laccobius sulcatulus	S-1/3	6-3		
	Hydrobius fuscipes	S-2	2	549	41º14'57"N 41º33'05"E
	Enochrus fuscipennis		4		
	Coelostoma orbiculare		5		
			Total 66		

Order: Coleoptera

Suborder: Polyphaga

Family: Hydrophilidae Latreille, 1802

Subfamily: Sphaeridiinae

Genus: *Coelostoma* Brullé, 1835

***Coelostoma orbiculare* (Fabricius, 1775)**

Material examined: S-2, 3♂ 2♀, 41º14'57"N 41º33'05"E, 549 m, 01.IIIV.2020.

Distribution in Turkey: Adıyaman, Afyon, Ankara, Antalya, Artvin, Batman, Bayburt, Bingöl, Bitlis, Burdur, Bursa, Çanakkale, Çorum, Denizli, Diyarbakır, Elazığ, Erzincan, Erzurum, Giresun,

Gümüşhane, İçel, Isparta, Kars, Kayseri, Kütahya, Manisa, Mersin, Muş, Ordu, Samsun, Sivas, Şanlıurfa, Tokat, Trabzon, Van (Mart et al. 2014; Yılmaz and Aslan 2014; Akünal and Aslan 2017; Taşar 2018).

Subfamily: Hydrophilinae

Genus: *Laccobius* Erichson, 1837

Subgenus *Microlaccobius* Gentili, 1976

***Laccobius gracilis* Motschulsky, 1855**

Material examined: S-1, 4♂ 3♀, 41º15'59"N 41º33'31"E, 476 m, 01.IIV.2020; S-2, 3♂, 41º14'57"N 41º33'05"E, 549 m, 01.IIV.2020; S-3, 1♂, 41º14'57"N 41º33'05"E, 549 m, 01.IIV.2020; S-3, 1♂, 41º13'53"N 41º32'47"E, 660 m, 01.IIIV.2020.

Distribution in Turkey: Adana, Adıyaman, Afyon, Ankara, Antakya, Antalya, Artvin, Aydın, Balıkesir, Batman, Bayburt, Bilecik, Bingöl, Bitlis, Bolu, Burdur, Bursa, Çanakkale, Çorum, Denizli, Diyarbakır, Edirne, Erzincan, Erzurum, Gaziantep, Giresun, Gümüşhane, Hakkâri, Hatay, Isparta, İçel, İstanbul, İzmir, Kars, Kastamonu, Kayseri, Kilis, Kocaeli, Kütahya, Manisa, Mardin, Mersin, Muğla, Muş, Niğde, Ordu, Rize, Samsun, Sinop, Sivas, Şanlıurfa, Şırnak, Tokat, Trabzon, Toros dağları, Van, Yozgat (Darılmaz and İncekara 2011; Taşar 2018).

Genus: *Laccobius* Erichson, 1837

Subgenus: *Dimorpholaccobius* Zaitzev, 1938

***Laccobius syriacus* Guillebeau, 1896**

Material examined: S-1, 3♂ 1♀, 41º15'59"N 41º33'31"E, 476 m, 01.IIV.2020; S-2, 1♂ 2♀, 41º14'57"N 41º33'05"E, 549 m, 01.IIIV.2020; S-3, 1♂, 41º13'53"N 41º32'47"E, 660 m, 01.IV.2020.

Distribution in Turkey: Adana, Adıyaman, Afyon, Aksaray, Ankara, Antakya, Antalya, Artvin, Aydın, Balıkesir, Batman, Bayburt, Bilecik, Bingöl, Bitlis, Bolu, Burdur, Bursa, Çorum, Denizli, Diyarbakır, Edirne, Eğirdir, Elazığ, Erzincan, Erzurum, Gaziantep, Giresun, Gümüşhane, Hakkâri, Hatay, Isparta, İçel, İzmir, Kahramanmaraş, Kars, Kayseri, Kastamonu, Kocaeli, Konya, Kütahya, Malatya, Manisa, Mardin, Mersin, Muğla, Muş, Ordu, Osmaniye, Rize, Sakarya, Samsun, Sinop, Sivas, Şanlıurfa, Tokat, Trabzon, Uşak, Toros Mountains and Van (Mart et al. 2014; Akünal and Aslan 2017; Taşar 2018; Özcan et al. 2021).

***Laccobius simulatrix* D'orchymont, 1932**

Material examined: S-1, 3♂ 5♀, 41º15'59"N 41º33'31"E, 476 m, 01.IIV.2020; S-2, 2♂ 2♀, 41º14'57"N 41º33'05"E, 549 m, 01.IIIV.2020; S-3, 1♂, 41º13'53"N 41º32'47"E, 660 m, 01.IIV.2020.

Distribution in Turkey: Adana, Afyon, Ağrı, Aksaray, Ankara, Antalya, Artvin, Aydın, Balıkesir, Bayburt, Bingöl, Bitlis, Bolu, Bursa, Çanakkale, Çorum, Denizli, Diyarbakır, Edirne, Elazığ, Erzincan, Erzurum, Giresun, Gümüşhane, Hakkâri, Isparta, İçel, İstanbul, İzmir, Kahramanmaraş, Kars, Kayseri, Kırklareli, Kırşehir, Kocaeli, Kütahya, Manisa, Muğla, Muş, Niğde, Ordu, Osmaniye, Samsun, Sivas, Tokat, Trabzon, Toros dağları, Uşak, Van, Yozgat (Darılmaz and İncekara, 2011; Mart et al. 2014; Taşar 2018).

***Laccobius bipunctatus* (Fabricius, 1775)**

Material examined: S-1, 3♂ 1♀, 41º15'59"N 41º33'31"E, 476 m, 01.IIV.2020.

Distribution in Turkey: Adıyaman, Afyon, Artvin, Balıkesir, Bayburt, Batman, Bingöl, Bitlis, Bolu, Çorum, Diyarbakır, Elazığ, Erzincan, Erzurum, Giresun, Gümüşhane, Isparta, Kars, Kastamonu,

Kütahya, Muş, Ordu, Siirt, Sivas, Şanlıurfa, Trabzon, Van (Mart et al. 2014; Yılmaz and Aslan 2014; Taşar 2018).

***Laccobius sculptus* D'orchymont, 1935**

Material examined: S-1, 2♂ 2♀, 41º15'59"N 41º33'31"E, 476 m, 01.IIIV.2020; S-3, 2♂, 41º13'53"N 41º32'47"E, 660m, 01.IX.2020.

Distribution in Turkey: Bingöl, Bitlis, Elazığ, Diyarbakır, Muş, Şanlıurfa (Mart et al. 2014).

Remarks: It is the first records for Artvin province.

***Laccobius sulcatulus* Reitter, 1909**

Material examined: S-1, 5♂ 1♀, 41º15'59"N 41º33'31"E, 476 m, 01.IIV.2020; S-3, 3♂, 41º13'53"N 41º32'47"E, 660m, 01.IV.2020.

Distribution in Turkey: Afyon, Amasya, Ankara, Antalya, Ardahan, Bayburt, Bingöl, Bitlis, Burdur, Denizli, Diyarbakır, Erzincan, Erzurum, Gümüşhane, Isparta, Kars, Kahramanmaraş, Kayseri, Konya, Kütahya, Manisa, Muş, Samsun, Sivas, Uşak, Toros mountains and Van (Darılmaz and İncekara 2011; Yılmaz and Aslan 2014).

Remarks: It is the first record for Artvin province.

Genus: *Enochrus* Thomson, 1859

Subgenus: *Lumetus* Zaitzev, 1908

***Enochrus fuscipennis* (Thomson, 1884)**

Material examined: S-2, 1♂ 1♀, 41º14'57"N 41º33'05"E, 549 m, 01.IV.2020; 1♀, 41º14'57"N 41º33'05"E, 549 m, 01.IIV.2020; 1♀, 41º13'53"N 41º32'47"E, 660m, 01.IIIV.2020.

Distribution in Turkey: Afyon, Artvin, Aksaray, Ankara, Aydın, Balıkesir, Bayburt, Bingöl, Bitlis, Burdur, Bursa, Çanakkale, Çorum, Denizli, Elazığ, Erzincan, Erzurum, Giresun, Gümüşhane, Hakkari, Hatay, Isparta, İzmir, Kars, Kayseri, Kütahya, Malatya, Manisa, Muş, Ordu, Rize, Sivas, Trabzon, Uşak, Van (Mart et al. 2014; Yılmaz and Aslan 2014; Akünal and Aslan 2017; Özcan et al. 2021).

Genus: *Hydrobius* Leach, 1815

***Hydrobius fuscipes* (Linnaeus, 1758)**

Material examined: S-2, 1♂, 41º14'57"N 41º33'05"E, 549 m, 01.IV.2020; 1♂, 41º14'57"N 41º33'05"E, 549 m, 01.IIV.2020.

Distribution in Turkey: Adıyaman, Afyon, Ankara, Artvin, Aydın, Bayburt, Batman, Bilecik, Bingöl, Bitlis, Burdur, Çorum, Denizli, Elazığ, Erzincan, Erzurum, Giresun, Gümüşhane, Hakkari, Hatay, Isparta, İçel, İzmir, Kars, Kayseri, Konya, Kütahya, Mersin, Muş, Ordu, Rize, Samsun, Sivas, Tokat, Trabzon, Van (Mart et al. 2014; Yılmaz and Aslan 2014; Akünal and Aslan 2017; Taşar 2018).

Order COLEOPTERA

Suborder ADEPHAGA

Family Dytiscidae Leach, 1815

Subfamily Agabinae Thomson, 1867

Genus *Agabus* Leach, 1817

***Agabus biguttatus* (Olivier, 1795)**

Material examined: S-3; 2♂, 41º13'53"N 41º32'47"E, 660 m, 31.VIII.2020.

Distribution in Turkey: Adana, Afyon, Aksaray, Ankara, Artvin, Balıkesir, Bayburt, Bilecik, Bingöl, Bursa, Çankırı, Çorum, Denizli, Diyarbakır, Elazığ, Erzurum, Gaziantep, Giresun, Gümüşhane, Hatay, Isparta, İçel, İzmir, Kahramanmaraş, Kastamonu, Kayseri, Mersin, Osmaniye, Rize, Sakarya, Trabzon, Yozgat, Toros Mountains, Karaboğa Mountains (Kıyak et al. 2007; Aykut 2018; Darılmaz et al. 2018).

Subfamily Hydroporinae Aubé, 1836

Genus: *Deronectes* Sharp, 1882

***Deronectes doriae* Sharp, 1882**

Material examined: S-3; 1♂, 41º13'53"N 41º32'47"E, 660 m, 31.VIII.2020.

Distribution in Turkey: Ankara, Artvin, Bilecik, Bursa, Erzurum, Gümüşhane, Kars, Muğla (Darılmaz and Kıyak 2009).

Genus: *Hydroglyphus* Motschulsky, 1853

***Hydroglyphus pusillus* (Fabricius, 1781)**

Material examined S-3; 1♂, 41º13'53"N 41º32'47"E, 660 m, 31.VIII.2020.

Distribution in Turkey: Adana, Aksaray, Antalya, Aydın, Balıkesir, Bolu, Bursa, Edirne, Eskişehir, Erzurum, Gümüşhane, Isparta, İzmir, Kastamonu, Kilis, Konya, Manisa, Mersin, Nevşehir, Toros Mountains, Trabzon (Erman 2000).

Remarks: It is the first record for Artvin province.

Recent Data

According to the results, the most common and dominant genus in the research area was *Laccobius* being in all three station and habitat preference generally including shallow waters and puddles. The genus *Laccobius* is represented by 28 species in all over Turkey among them 11 species recorded before from Artvin (Darılmaz and İncekara, 2011), and six of them were captured with this study from Murgul. *H. pusillus, L.* (*D.*) *sculptus* and *L.* (*D.*) *sulcatulus* were recorded from Artvin for the first time. *L. gracilis, L. smulatrix, L. syriacus* were the common species recorded from the all three localities. The genera *Coleostoma, Hydrobius, Enochrus, Hydroglyphus, Deronectes* and *Agabus* are all represented by single species. *Coelostoma* is terrestrial taxa, generally found just away from the water unlike other hydrophilids. *C. orbiculare* was sampled in semi-aquatic habitats near the water source, under the decomposing plant debris or compost. *Coelostoma* is represented by two species in Turkey (Darılmaz and İncekara, 2011). *Hydrobius* is represented by three species in Turkey (Darılmaz and İncekara, 2011) and one of them was recorded from Artvin province. *Enochrus* species generally are common in many kinds of vegetated, stagnant and running waters. Up to date, 16 species of *Enochrus* have been recorded from Turkey (Polat et al 2015; Darılmaz and İncekara 2011) and one of them was recorded from Artvin province.

According to literature, 19 species of *Agabus,* 4 species of *Hydroglyphus* and 24 species of *Deronectes* have been recorded from Turkey so far and one *Agabus* and *Hydroglyphus,* two *Deronectes* species were recorded from Artvin province until now (Fery and Hosseinie 1998; Darılmaz and Kıyak 2009; Aykut et al. 2018; Aykut et al 2019; Salur and Darılmaz 2021).

Previous Data

Aquatic Coleoptera diversity was determined in Artvin province previously. On the basis of several publications mentioned below, 57 species of aquatic insects of both running and standing waters, have been found in Artvin province up to date (Table 3). In Table 3, the species were reported before in

Artvin province, however, none of these species were encountered in the research area of the present study. In addition, there is no record about Gyrinidae, Haliplidae, Noteridae, Heteroceridae and Hydraenidae in Artvin province.

Table 3. Checklist of all aquatic insect species known from Artvin province and literature data.

No	Taxon	Artvin Province Literature Data
	DYTISCIDAE	
1	*Agabus bipustulatus* (Linnaeus, 1767)	
2	*Agabus glacialis* Hochhuth, 1846	
3	*Agabus paludosus* (Fabricius, 1801)	
4	*Agabus biguttatus* (Olivier, 1795)*****	
5	*Ilybius fuliginosus fuliginosus* (Fabricius, 1792)	
6	*Ilybius satunini* (Zaitzev, 1913)	
7	*Ilybius wewalkai* (Fery and Nilsson, 1993)	
8	*Platambus lunulatus* (Fischer von Waldheim, 1829)	
9	*Acilius sulcatus* (Linnaeus, 1758)	
10	*Hydroglyphus geminus* (Fabricius, 1792)	
11	***Hydroglyphus pusillus* (Fabricius, 1781)***	
12	*Deronectes parvicollis* (Schaum, 1864)	
13	*Deronectes doriae* Sharp, 1882*****	
14	*Hydroporus discretus* Fairmaire and Brisout, 1859	
15	*Hydroporus kozlovskii* Zaitzev, 1927	Darılmaz and Kıyak (2009)
16	*Hydroporus palustris* (Linnaeus, 1761)	Daşbaşı (2017)
17	*Hydroporus planus* (Fabricius, 1782)	Yüncü (2019)
18	*Hydroporus pubescens* (Gyllenhal, 1808)	
19	*Hydroporus thracicus* Guéorguiev, 1966	
20	*Hydroporus transgrediens* Gschwendtner, 1923	
21	*Hydroporus incognitus* Sharp,1869	
22	*Nebrioporus airumlus* (Kolenati, 1845)	
23	*Nebrioporus turca* (Seidlitz, 1887)	
24	*Nebrioporus stearinus stearinus* (Kolenati 1845)	
25	*Oreodytes davisii davisii* (Curtis, 1831)	
26	*Scarodytes halensis halensis* (Fabricius, 1787)	
27	*Hygrotus armeniacus* (Zaitzev, 1927)	
28	*Hygrotus inaequalis* (Fabricius, 1777)	
29	*Laccophilus hyalinus* hyalinus (De Geer, 1774)	
30	*Laccophilus minutus* (Linnaeus, 1758)	
	HYDROPHILIDAE	
1	*Cercyon ustulatus* (Preyssler, 1790)	
2	*Anacaena lutescens* (Stephens, 1829)	
3	*Anacaena limbata* (Fabricius, 1792)	
4	*Berosus luridus* (Linnaeus, 1761)	
5	*Helochares punctatus* Sharp, 1869	
6	*Laccobius hindukuschi Chiesa, 1966*	
7	*Laccobius hopaensis Mart, Incekara and Erman, 2003*	
8	*Laccobius obscuratus aegaeus Gentili, 1974*	
9	*Laccobius sipylus d'Orchymont, 1939*	Mart (2009)
10	*Laccobius striatulus (Fabricius, 1801)*	Darılmaz and İncekara (2011)
11	***Laccobius sulcatulus* Reitter, 1909***	
12	***Laccobius sculptus* D'orchymont, 1935***	
13	*Laccobius simulatrix* D'orchymont, 1932*	
14	*Laccobius syriacus* Guillebeau, 1896*	
15	*Laccobius bipunctatus* (Fabricius, 1775)*	
16	*Laccobius gracilis* Motschulsky, 1855*	
17	*Hydrobius fuscipes* (Linnaeus, 1758)*	
18	*Enochrus fuscipennis* (Thomson, 1884)*	
19	*Coelostoma orbiculare* (Fabricius, 1775)*	
	HELOPHORIDAE	
1	*Helophorus armeniacus* Ganglbauer, 1901	
2	*Helophorus brevipalpis brevipalpis* Bedel, 1881	
3	*Helophorus discrepans* Rey, 1885	Darılmaz and İncekara (2011)
4	*Helophorus faustianus* (Sharp, 1916)	
5	*Helophorus obscurus* Mulsant, 1844	
6	*Helophorus ponticus* Angus, 1988	
	HYDROCHIDAE	
1	*Hydrochus brevis* (Herbst, 1793)	Darılmaz and İncekara (2011)
2	*Hydrochus ignicollis* Motschulsky, 1860	

Bold font: Species, which are recorded for the first time in Artvin (Murgul).
Asterisk: Species, which are recorded with this study from Murgul.

CONCLUSION

Adephagan and Polyphagan beetles were generally widespread across a number of waterbodies, and the beetles were previously recorded from Artvin province. Twelve species under two families of aquatic beetles were recorded with the study. The species, which were captured during the study, are widely distributed in Turkey and nine of them determined before in Artvin province. S-1 was a clean location and 32 specimens captured. S-2 and S-3 were pollution effected areas and 21 and 13 specimens captured respectively. Despite the relatively high number of beetle species recorded previously from Artvin province, for almost one fourth of the species captured with this study.

Aquatic insects have high potential mobility due to their power of flight. Thus if there is any changes (such as vegetation, water type or water quality) in their habitats they live, the species with low tolerance levels will strongly affected by the changes and will move to more suitable environments. This movement may lead to a loss of species from part or the entire of aquatic habitat. There are copper mine, cement plant and many hydropower regulators in the study area. These anthropogenic events may have contributed to major changes in water quality, therefore insects' biodiversity.

The study provides a real picture of the beetle fauna inhabiting running and stagnant waters of Murgul stream and tributaries. Such environmental measurements can help to explain and predict anthropogenic-induced changes. Hence, additional studies are needed to better understand the biodiversity of the aquatic beetles in the studied province. Thus, biologic diversity, both terrestrially and aquatic, including abiotic factors of Murgul stream should be monitored long term.

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Conflict of Interest

The article authors declare that there is no conflict of interest between them.

Author's Contributions

ZA: She designed the project, conceived the work's central idea, carried out the biological data collection, analysed and identified the biological data, execution, development, tabulation, interpreted and analysis of the results and the final article's writing. **Üİ:** He participated in the project elaboration and execution, carried out the biological data collection, identified the biological data, participated in the discussion of the results, edited and reviewed the article. **TŞ:** He participated in the project elaboration and execution, carried out the biological data collection, analysed the histopathological data and identified the biological data, interpreted and analysis of the results, edited and reviewed the article. **MCD:** He participated in the discussion of the results, edited and reviewed the article. **ÖA:** He identified the plant samples, edited and reviewed the article. All authors have read and agreed to the published version of the final manuscript.

REFERENCES

Akünal AY, Aslan EG. 2017. Aquatic Beetles (Coleoptera: Hydrophilidae, Helophoridae) of İzmir, Manisa and Aydın Provinces (Turkey) with New Locality Records for the Aegean Region. Turkish Journal of Fisheries and Aquatic Sciences, 17, 777-787. Doi: 10.4194/1303-2712-v17_4_13.

Aykut M. 2018. The Diving Beetle Fauna of Diyarbakır and Bingöl Provinces, Turkey (Coleoptera: Dytiscidae) with a New Record. Pakistan J. Zool., 50(1), pp 65-74. Doi: http://dx.doi.org/10.17582/journal.pjz/2018.50.1.65.74.

Aykut M, Taşar GE, Fery H. 2018. *Deronectes taron* sp. n. from the eastern Anatolian region of Turkey (Coleoptera, Dytiscidae, Hydroporinae). Zootaxa 4422 (3): 403–410. https://doi.org/10.11646/zootaxa.4422.3.6

Aykut, M., Yıldırım Hİ, Tusun, S & Fery, H. (2019). *Deronectes kabilcevz* sp. n. and *D. propedoriae* sp. n. from south-eastern Anatolia (Turkey)(Coleoptera, Dytiscidae, Hydroporinae). *Zootaxa*, *4691*(5), zootaxa-4691.

Clarkson, B., Archangelsky, M., Torres, P. L., & Short, A. E. (2018). Family Hydrophilidae. In *Thorp and Covich's Freshwater Invertebrates* (pp. 561-576). Academic Press.

Darılmaz MC, Kıyak S. (2009). Checklist of Gyrinidae, Haliplidae, Noteridae and Dytiscidae of Turkey (Coleoptera: Adephaga), Journal of Natural History, 43:25-26, 1585-1636, Doi: 10.1080/00222930902993682.

Darılmaz, M.C. and İncekara, Ü. (2011). Checklist of Hydrophiloidea of Turkey (Coleoptera: Polyphaga). J. Nat. Hist., 45: 685–735.

Darılmaz, M.C., Polat, A. and İncekara, Ü. (2018). Faunistic Study on Aquatic Coleoptera of the Eastern Mediterranean Region of Turkey. Turk. J. Fish.& Aquat. Sci. 19(5), 409-421. doi.org/10.4194/1303-2712-v19_5_06

Daşbaşı E. 2017. Gümüşhane İli Dytiscidae (Coleoptera) Türleri Üzerine Faunistik Araştırma. Atatürk Üniversitesi Fen Bilimleri Enstitüsü, Yüksek Lisans Tezi, Erzurum.

Erman ÖK. 2000. Erzurum İli Dytiscidae (Coleoptera) türleri üzerine sistematik araştırmalar. Atatürk Üniversitesi, Fen Bilimleri Enstitüsü, Yüksek Lisans Tezi, Erzurum.

Fery H, and Hosseinie SH. 1998. A taxonomic revision of *Deronectes* SHARP, 1882 (Insecta: Coleoptera: Dytiscidae) (part II). Ann. Naturhist. Mus. Wien, 100, 219-290.

Gentili, E., Ostovan, H., Ghahari, H., Komarek, A. (2018). Annotated checklist of Iranian Hydrophilidae (Coleoptera: Polyphaga: Hydrophiloidea). Aquatic Insects, 39(1), 55-88.

Kgotso, S. (2018). The effect of heavy metals associated with Acid Mine Drainage (AMD) on select aquatic insects in the Tweelopiespruit, Rietspruit and Bloubankspruit river system on the West Rand, Gauteng (Doctoral dissertation, University of Johannesburg (South Africa)).

Mart A. 2009. Water Scavenger Beetles (Coleoptera: Hydrophilidae) Provinces of Central Black Sea Region of Turkey. J. Ent. Res. Soc., 11(1): 47-70

Mart A, Tolan R, Caf F, Koyun M. 2014. A Faunistic Study on Aquatic Coleoptera (Helophoridae: Hydrophilidae) Species in Elazığ Province, Turkey. Pakistan J. Zool., vol. 46(3), pp. 681-696, 2014.

Nilsson AN and Hájek J. 2018. A World Catalogue of the Family Dytiscidae, or the Diving Beetles (Coleoptera, Adephaga). Version 1.I.2018, 306 pp. URL: http://www.norrent.se & http://www.waterbeetles.eu

Özcan S, Yıldız N, Polat A, İncekara Ü. 2021. Erzurum Jeolojik Oluşumları ve Muş Hamurpet Gölü Helophoridae, Hydrochidae, Hydrophilidae (Coleoptera) Üzerine Faunistik Bir Çalışma . Journal of the Institute of Science and Technology, 11 (1), 75-90 . DOI: 10.21597/jist.717830

Polat A, Taşar G, İncekara Ü. 2015. A New Record of *Enochrus* Thomson, 1859 (Coleoptera: Hydrophilidae) for the Turkish Fauna. Turkish Journal of Science & Technology, 10(1), 9-12

Salur A, Darılmaz MC. 2021. Fauna Turkey. Accessed in 29.01.2021 from; http://www.faunaturkey.com/aquatic-coleoptera/

Slipinski, A., & Lawrence, J. (Eds.). (2019). Australian Beetles Volume 2: Archostemata, Myxophaga, Adephaga, Polyphaga (part). Csiro Publishing, 792 pp.

Taşar GE. 2018. Contributions to the knowledge of Aquatic Coleoptera Fauna (Dryopidae, Helophoridae, Heteroceridae, Hydrochidae, Hydrophilidae, Gyrinidae, Haliplidae and Noteridae) of Diyarbakır, Mardin and Batman Provinces (Turkey). Turkish Journal of Fisheries and Aquatic Sciences, 18, 927-936. Doi: 10.4194/1303-2712-v18_8_01

Tezcan, S. 2020. Analysis of the insect fauna of Turkey and suggestions for future studies. Munis Entomology & Zoology, 15 (2): 690-710

Yılmaz, A., & Aslan, E. G. (2014). Faunistical and Ecological Investigations on Water Scavenger Beetles (Coleoptera: Hydrophilidae) of Isparta Province, Turkey. Pakistan Journal of Zoology, 46(6), 1663-1671.

Yüncü H. 2019. Çat Barajı Ve Derelerinin (Erzurum) Dytiscidae Coleoptera) Türleri Üzerine Faunistik Bir Araştırma. Atatürk Üniversitesi Fen Bilimleri Enstitüsü Yüksek Lisans Tezi, Erzurum.