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CONTRIBUTIONS TO THE BLACKFLY FAUNA (DIPTERA, SIMULIIDAE) OF TÜRKİYE WITH A NEW RECORD FROM THE WESTERN BLACK SEA REGION

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Abstract: Despite the rich biodiversity potential of Anatolia, the blackfly fauna of Türkiye has not been fully explored. In the present study, a sampling study for blackflies were performed in Western Black Sea Region in spring seasons from 2016 to 2018 and 15 blackfly species from 73 different lotic habitats have been reported. *Simulium (Nevermannia) carthusiense* Grenier & Dorier, 1959 is new for Turkish fauna. Ten species have been recorded from the region for the first time. Distributional remarks in Türkiye and the world are given along with brief taxonomic evaluations for each species.

Özet: Anadolu'nun zengin biyolojik çeşitlilik potansiyeline rağmen, Türkiye'nin siyah sivrisinek faunası henüz tam olarak keşfedilmemiştir. Bu çalışmada Batı Karadeniz Bölgesi'ndeki 73 farklı sucul habitattan 15 siyah sivrisinek türü rapor edilmektedir. Tespit edilen türlerden 10 tanesi çalışma bölgesinden ilk kez kaydedilmektedir ve *Simulium (Nevermannia) carthusiense* Grenier & Dorier, 1959 türü ise Türkiye için yeni kayıttır. Çalışma materyali bölgeden 2016 ve 2018 yılları arasında çoğunlukla bahar aylarında toplanmıştır. Her tür için kısa taksonomik değerlendirmelerle birlikte hem Türkiye'deki hem de Dünya'daki dağılımları verilmiştir.

Introduction

Blackflies (Diptera: Simuliidae) are small, black and inconspicuous nuisance flies which are important vectors of many organisms that cause diseases such as leucocytozoonosis and onchocerciasis (river blindness) all over the world (Adler *et al.* 2004). Rheophilic preadults inhabit various running waters (rivers, springs, etc.) and form the link in the trophic web between their predators and nutrients (Crosskey 1990). Adult (male and females) blackflies generally feed on nectars of flowering plants. Females of many species also have blood-sucking behavior. Such species can be defined as anthropophilic, ornithophilic or mammophilic based on this behaviour. Blood-sucking species are involved in the spread of many pathogens and parasites, such as viruses, protozoans and filarial worms. In addition, attacks of some blackfly species cause severe allergic reactions in humans and livestock (Adler *et al*. 2004). In order to solve and prevent the problems caused by these flies, it is necessary to know the species living in each region or country.

In the latest revision of the world blackfly inventory, the family is represented by 2,415 species (2,398 recent and 17 fossil species) throughout the world, of which 57 species are recorded in Türkiye (Adler 2022). Although the first information about blackflies in Anatolia was published by Austen (1925), Türkiye's blackfly fauna was neglected until the 1990s. Since then, many authors studied Simuliidae Fauna in Türkiye; Kazancı & Clergue-Gazeau (1990), Şirin & Şahin (2005), Crosskey & Zwick (2007), Çağlar & İpekdal (2009), Şirin *et al.* (2014, 2015), Şirin & Adler (2015), Başören & Kazancı (2016, 2020, 2021), Gazyağcı & Aydenizöz (2019), Onder *et al.* (2019), Özel *et al*. (2019), Fidan (2020) and Aslan (2021).

The number of blackfly species known from Türkiye corresponds to approximately 9% of the Palearctic fauna. Considering the environmental heterogeneity in Türkiye, it is highly probable that there are much more species (Çağlar & İpekdal 2009). So, faunistic studies are important to reveal the exact number of Simuliidae species in Türkiye.

Crosskey & Zwick (2007) recorded 9 black fly species so far in the Western Black Sea region only from Bolu province.

The aim of this study is to complete the list of Simuliidae species of the Western Black See Region of Türkiye.

Materials and Methods

Blackfly specimens were collected from 73 different lotic habitats in the Western Black Sea Region between 2016 and 2018. Preadult stages (larva and pupa) were found together in various types of natural flowing waters. All the specimens were gathered by forceps from the rocks, leaves and other substrates in the streams and directly fixed and preserved in 80% ethanol for taxonomical studies. Adults emerged from pharate pupae. The collecting sites are shown on a map created using Google Earth application (Fig. 1). The, province, locality, coordinates, altitudes and date of collecting sites are given in Table 1. The region includes the provinces of Zonguldak, Karabük, Bartın, Kastamonu, Çankırı, Sinop, Samsun, Tokat, Çorum and Amasya provinces, with an area of 74,178 km^2, constituting 9.5% of Türkiye's surface area (Kuşvuran *et al.* 2011).

The material is deposited in the Entomology Laboratory of Eskişehir Osmangazi University, Eskişehir, Türkiye. The material was investigated using a stereomicroscope (Leica MZ 16) Following relevant publications (Rubtsov 1956, Knoz 1965, Terteryan 1968, Crosskey 1990, 1998, 2002, Bass 1998, Crosskey & Malicky 2001, Yankovsky 2003, Crosskey & Zwick 2007). The nomenclature follows Adler (2022).

Table 1. Detailed information of the collecting sites.

Loc.no	Province	Locality	Coordinate	Altitude	Date
1	Bolu	Bostancılar Vill.	40°23.828 N, 31°11.394 E	1010 m	9.06.2016
2	Bolu	Cepni Vill.	40°34.027 N, 31°15.256 E	948 m	9.06.2016
3	Bolu	Abant exit	40°37.475 N, 31°18.555 E	1140 m	9.06.2016
4	Bolu	Dereceören Stream	40°38.932 N, 31°22.296 E	967 m	9.06.2016
5	Bolu	Bürnük Stream	40°44.016 N, 31°48.208 E	810 m	10.06.2016
6	Bolu	Yeniçağa Stream	40°46.263 N, 31°59.259 E	999 m	10.06.2016
7	Bolu	Yumrutaş Stream	40°52.750 N, 32°05.488 E	707 m	10.06.2016
8	Bolu	Çubuk Stream	41°03.096 N, 32°04.380 E	604 m	10.06.2016
9	Zonguldak	ÖzpınarStream	41°09.507 N, 31°53.748 E	137 m	10.06.2016
10	Zonguldak	Sabunlar Stream	41°07.467 N, 31°53.267 E	41 m	10.06.2016
11	Zonguldak	Örmece Stream	41°19.472 N, 32°03.070 E	63 m	10.06.2016
12	Zonguldak	Beycuma Stream	41°20.843 N, 31°58.017 E	230 m	10.06.2016
13	Zonguldak	Torlaklar Stream	41°29.599 N, 32°06.673 E	26 m	10.06.2016
14	Bartın	Bartın Stream	41°31.255 N, 32°20.968 E	41 m	10.06.2016
15	Bartın	Karaçay Stream	41°39.348 N, 32°21.381 E	20 m	10.06.2016
16	Bartın	Gökırmak River	41°32.397 N, 32°26.349 E	50 m	11.06.2016
17	Bartın	Gökırmak River 2	41°31.329 N, 32°30.856 E	89 m	11.06.2016
18	Bartın	Çanakçar Stream	41°29.632 N, 32°35.397 E	162 m	11.06.2016
19	Karabük	Ovacuma Stream	41°26.326 N,32°45.290 E	372 m	11.06.2016
20	Karabük	Cumayanı Stream	41°05.939 N, 32°40.346 E	372 m	11.06.2016
21	Karabük	Karahasanlar Stream	40°59.552 N, 32°35.587 E	600 m	11.06.2016
22	Karabük	Iğdir Stream	41°13.382 N, 33°08.386 E	542 m	11.06.2016
23	Kastamonu	Kışla Stream	41°13.289 N, 33°09.621 E	551 m	11.06.2016
24	Kastamonu	Zala Stream	41°14.008 N, 33°18.483 E	644 m	11.06.2016
25	Kastamonu	Ortaköy Stream	41°18.281 N, 33°35.489 E	1043 m	11.06.2016
26	Kastamonu	Daday Stream	41°26.524 N, 33°47.789 E	719 m	12.06.2016
27	Kastamonu	Örcünler Stream	41°37.687 N, 33°42.889 E	1026 m	12.06.2016
28	Kastamonu	KurudereStream	41°28.896 N, 34°04.430 E	613 m	12.06.2016
29	Kastamonu	Taşköprü Stream	41°32.268 N, 34°13.554 E	553 m	12.06.2016
30	Kastamonu	KıvrımçayStream	41°35.925 N, 34°19.541 E	516 m	12.06.2016
31	Kastamonu	Gökçeağaç Stream	41°37.521 N, 34°30.569 E	410 m	12.06.2016
32	Sinop	30 km (N) to Gerze	41°42.040 N, 34°54.873 E	702 m	12.06.2016
33	Sinop	Kırcalı Stream	41°54.240 N, 34°58.600 E	105 m	12.06.2016
34	Sinop	Karasu Stream	41°53.578 N, 34°55.630 E	143 m	12.06.2016
35	Sinop	Asarak Stream	41°21.906 N, 34°49.159 E	389 m	13.06.2016
36	Sinop	Çalpınar Stream	41°17.010 N, 34°39.585 E	760 m	13.06.2016
37	Kastamonu	Devrez Stream	41°02.356 N, 34°13.798 E	472 m	13.06.2016
38	Kastamonu	Akbük Stream	40°57.088 N, 33°55.424 E	692 m	13.06.2016
39	Düzce	Melen Stream	41°03.027 N, 30°57.361 E	15 m	6.05.2017
40	Düzce	Kalkın Stream	41°03.184 N, 31°02.538 E	64 m	6.05.2017
41	Düzce	Tahirli Stream	41°03.307 N, 31°04.051 E	132 m	6.05.2017
42	Düzce	Boğaziçi Stream	40°56.400 N, 31°09.576 E	236 m	6.05.2017
43	Düzce	Melen Stream	40°56.362 N, 31°24.033 E	305 m	6.05.2017
44	Karabük	Şeker Stream	41°13.374 N, 32°10.569 E	266 m	7.05.2017
45	Zonguldak	Filyos Stream	41°18.199 N, 32°07.340 E	56 m	7.05.2017
46	Zonguldak	Perşembe Stream	41°24.306 N, 32°06.252 E	29 m	7.05.2017
47	Zonguldak	Terziler Stream	41°26.142 N, 32°13.586 E	43 m	7.05.2017

Table 1. Continued.

48	Bartın	İnpiri Stream	41°44.141 N, 32°26.115 E	131 m	7.05.2017
49	Bartın	Karaman Stream	41°49.128 N, 32°37.375 E	225 m	7.05.2017
50	Kastamonu	A. Şenpazar Stream	41°47.129 N, 33°12.305 E	342 m	7.05.2017
51	Kastamonu	Valay Stream	41°49.325 N, 33°18.367 E	469 m	7.05.2017
52	Kastamonu	Dereli tekke Stream	41°46.247 N, 33°27.176 E	758 m	7.05.2017
53	Kastamonu	Kızkayası Stream	41°44.010 N, 33°30.143 E	1002 m	7.05.2017
54	Kastamonu	Azdavay Stream	41°38.342 N, 33°18.380 E	847 m	7.05.2017
55	Kastamonu	Bereketli Stream	41°41.378 N, 33°29.303 E	1072 m	7.05.2017
56	Kastamonu	Seydiler Stream	41°37.024 N, 33°43.161 E	1041 m	7.05.2017
57	Kastamonu	Göçen Stream	41°27.244 N, 33°41.390 E	757 m	8.05.2017
58	Kastamonu	Afurözü Stream	41°28.496 N, 33°34.367 E	824 m	8.05.2017
59	Kastamonu	Sarımsakcı Stream	41°28.544 N, 33°30.143 E	862 m	8.05.2017
60	Kastamonu	Oylak Stream	41°31.412 N, 33°46.143 E	974 m	8.05.2017
61	Kastamonu	Küre Stream	41°48.521 N, 33°42.481 E	821 m	8.05.2017
62	Kastamonu	Küre Stream 2	41°52.495 N, 33°42.382 E	913 m	8.05.2017
63	Kastamonu	Camili Stream	41°44.408 N, 33°41.011 E	1134 m	8.05.2017
64	Kastamonu	Devrekani Stream	41°37.187 N, 33°51.043 E	1062 m	8.05.2017
65	Kastamonu	Hacı Hasan Stream	41°42.413 N, 33°58.573 E	1217 m	8.05.2017
66	Kastamonu	Çatalzeytin Stream	41°56.594 N, 34°13.367 E	16 m	8.05.2017
67	Sinop	Gündoğdu Stream	41°56.260 N, 34°18.400 E	17 m	8.05.2017
68	Sinop	Taçahmet Stream	41°56.124 N, 34°24.241 E	30 m	8.05.2017
69	Sinop	Ömerdüz Stream	41°52.360 N, 34°31.116 E	350 m	8.05.2017
70	Sinop	Oluza Stream	41°56.405 N, 34°41.397 E	9 m	8.05.2017
71	Sinop	Sarımsaklı Stream	41°49.510 N, 35°08.380 E	30 m	9.05.2017
72	Kastamonu	Tunnel	41°12.479 N, 33°48.177 E	1007 m	30.04.2018
73	Sinop	Maruf Stream	41°33.313 N, 34°47.359 E	404 m	30.04.2018

Fig. 1. Map of the collecting sites of blackflies in Western Black Sea Region (Numbers on the map refer to the localities which are presented in Table 1); the red outline on the inset map indicates the borders of the studied area.

Results

A total of 14 species of the genus *Simulium* Latreille, 1802 belonging to 4 different subgenera (*Wilhelmia* Enderlein, 1921, *Nevermannia* Enderlein, 1921, *Eusimulium* Roubaud, 1906, and *Simulium* Latreille, 1802) and one species of the genus *Prosimulium* Roubaud, 1906 were recorded [1,515 larvae, 1,785 pupae, 22 adults (16 female and 6 male)]. The list of the species is provided below with the examined material, distributional data and brief taxonomical notes for each species.

Genus *Prosimulium* Roubaud, 1906

Prosimulium rachiliense Djafarov, 1954

Material examined: **(50)** 1 pupa; **(52)** 2 pupae; **(53)** 6 larvae, 6 pupae; **(54)** 9 pupae; **(55)** 88 larvae, 5 pupae; **(56)** 4 larvae, 16 pupae; **(63)** 109 larvae, 67 pupae; **(65)** 85 larvae, 11 pupae; **(72)** 15 larvae, 1 pupa.

Distribution in World: Azerbaijan; Armenia, Bulgaria, Georgia, Greece, Morocco, Romania, Russia (Caucasus), Türkiye (Adler 2022).

Distribution in Türkiye: Ceyhan River Basin, Fırat River Basin, Göksu River Basin, Kızılırmak River Basin, Sakarya River Basin (Başören & Kazancı, 2016); Akşehir, Antalya, Aydın, Balıkesir, Bilecik Bayburt, Bursa, Çanakkale, Çorum, Denizli, Edirne, Eskişehir, Erzincan, Isparta, Kars, Kastamonu, Kayseri, Kırklareli, Kütahya, Muğla, Sivas, Yozgat, (Aslan 2021).

Remarks: Crosskey & Zwick (2007) recorded this species from Bolu province. This species is a new record for the remaining provinces of the study area. *Prosimulium rachiliense* also occurs mainly in Caucasia, Transcaucasia and the Balkan countries including the island of Rhodes. We identified our material as *P. rachiliense* using the illustrations and descriptions of *P. pronevitshae*, Rubtsov, 1955 which was synonymized with *P. rachiliense* by Crosskey & Howard (2004), in Terteryan (1968).

Genus *Simulium* Latreille, 1802

Simulium (Eusimulium) petricolum (Rivosecchi, 1963)

Material examined: (15) 6 pupae; **(18)** 7 pupae; **(71)** 4 larvae, 17 pupae.

Distribution in World: Algeria, Armenia, Austria, Bosnia and Herzegovina, Great Britain, Cyprus, Czech Republic, France, Greece, Ireland, Italy, Libya, Madeira, Morocco, Portugal, Serbia, Spain, Türkiye, Russia (Adler 2022).

Distribution in Türkiye: Afyon (Kalafat & Şirin 2011); Bilecik, Bursa, Kocaeli, Sakarya (Şirin *et al*. 2014).

Remarks: *Simulium petricolum* (Rivosecchi, 1963) can be distinguished from the other species of the *aureum*-species group by the blade-like structure of the ventral plate in the male genitalia and the projection of the anterior corner of the gonocoxite (Crosskey & Malicky 2001). In our material, there were three mature male pupae and their genitalia fit to the description.

Simulium (Nevermannia) carthusiense Grenier & Dorier, 1959

Material examined: **(18)** 2 pupae; **(25)** 13 larvae.

Distribution in World: Andorra, Austria, Czech Republic, France (incl. Corsica), Germany, Italy, Morocco, Poland, Slovakia, Spain, Switzerland, Ukraine (Adler 2022).

Distribution in Türkiye: New record for Türkiye.

Remarks: *Simulium carthusiense* is a member of the *vernum* species group, the largest species group in the genus *Simulium*. It is widely distributed generally in both Central and Mediterranean part of Europe (Adler 2022). According to Adler & Seitz (2014), it is the sister species of a clade that includes *S. beltukovae* (Rubtsov, 1956), the *S. cryophilum* complex, and *S. urbanum* Davies, 1966, considering its polytene chromosomal band-sequence. On the other hand, according to the identification keys published by Knoz (1965) and Jedlicka *et al*. (2004), the species is morphologically very similar to *S. brevidens* (Rubtsov, 1956) in the pupal stage. The main taxonomic characters of our material were in the pupal stage (Fig. 2): (1) the anterior dorsal projection of cocoon short and straight-sided, regular (Jedlicka *et al.* 2004); (2) surface of thoracic tubercles polygonal (papulose) (Jedlicka *et al.* 2004); (3) All gill filaments branched in vertical plane (Knoz 1965); (4) Upper and lower gill filament at an acute angle (Knoz 1965, Jedlićka *et al.* 2004).

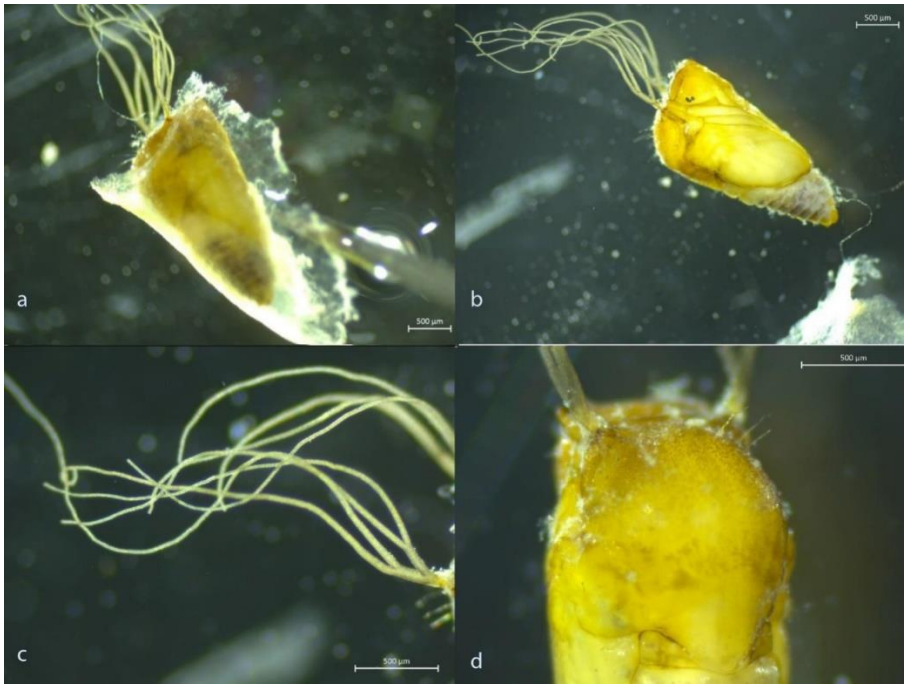

Fig. 2. Pupa of *S. carthusiense*. **a.** pupa and cocoon, lateral view, **b.** pupa, lateral view, **c.** Lateral view of gill respiratory filaments, **d.** thorasic plate with trichomes.

Simulium (Nevermannia) cryophilum (Rubtsov, 1959)

Material examined: **(6)** 1 pupa and 2 larvae.

World Distribution: Algeria, Andorra, Armenia, Austria, Belgium, Bosnia and Herzegovina, Great Britain, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lebanon, Luxembourg, Montenegro, Morocco, The Netherlands, Norway, Poland, Portugal, Russia, Scotland, Serbia, Slovakia, Slovenia, Spain (including Balearic Islands), Sweden, Switzerland, Tunisia, Türkiye, Ukraine (Adler 2022).

Distribution in Türkiye: Büyük Menderes River Basin, Eastern Black Sea Region (Başören & Kazancı 2016); Bilecik, Sakarya, Yalova (Şirin *et al.* 2014).

Remarks: This species, whose existence in Türkiye is known from previous studies, is also a member of the *vernum* group. The main taxonomic characters of the species, according to Bass (1998) and also observed in our material, are as follows: the shape and horizontal branching of the common stems of the pupal gill filaments, and the shape and length of the anterior protrusion of the cocoon and the postgenal cleft of the larva.

Simulium (Simulium) aureofulgens Terteryan, 1949

Material examined: (43) 12 pupae; **(44)** 3 females, 9 larvae, 37 pupae; **(66)** 18 pupae.

World Distribution: Armenia; Azerbaijan, Türkiye (Adler 2022).

Distribution in Türkiye: Kızılırmak River Basin, Sakarya River Basin (Başören & Kazancı 2016).

Remarks: *Simulium aureofulgens*, a species of Caucasian origin, is known to exist in two large river basins, Sakarya and Kızılırmak, close to the study area. Crosskey & Zwick (2007) recorded this species from Bolu province. This species is a new record for the remaining provinces of the study area. The observed larva, pupa and adult characteristics of the specimens examined in the study confirm the descriptions in Terteryan (1968).

Simulium (Simulium) alajense Rubtsov, 1938

Material examined: **(54)** 1 larva, 3 pupae; **(55),** 1 pupa.

World Distribution: Afghanistan, Armenia, Bulgaria, China, India, Iran, Kazakhstan, Kyrgyzstan, Mongolia, Pakistan, Tajikistan, Türkiye, Turkmenistan, Uzbekistan (Adler 2022).

Distribution in Türkiye: Kızılırmak River Basin, Sakarya River Basin (Başören & Kazancı 2016).

Remarks: This species is another member of the *bezzii* group known from Anatolia. According to Yankovsky (2003), it can be distinguished from *Simulium bezzii* (Corti, 1914) by relatively small fenestrations posterior to the cocoon rim and eight gill filaments of the pupae as observed in our material.

Simulium (Simulium) bezzii (Corti, 1914)

Material examined: (1) 3 pupae; **(2)** 1 larva; **(3)** 4 larvae; **(18)** 4 larvae, 4 pupae; **(32)** 1 larva; **(36)** 6 larvae, 4 pupae; **(38)** 10 larvae, 25 pupae; **(54)** pharate adult 1 female, 28 larvae, 55 pupae; **(58)** 122 larvae, 28 pupae; **(59)** 1 pupa; **(60)** 183 larvae, 111 pupae; **(64)** 1 pupa; **(66)** 1 pupa; **(67)** 2 pupae; **(68)** 1 pupa; **(69)** 10 larvae, 2 pupae; **(73)** 1 pupa.

World Distribution: Algeria, Andorra, Armenia, Austria, Azerbaijan, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, France, Georgia, Germany, Greece, Iran, Iraq, Israel, Lebanon, Macedonia, Morocco, Poland, Romania, Russia, Serbia, Spain, Switzerland, Türkiye, Ukraine, Uzbekistan (Adler 2022).

Distribution in Türkiye: Ceyhan River Basin, Çoruh River Basin, Göksu River Basin, Fırat River Basin, Kızılırmak River Basin Sakarya River Basin, Streams in Eastern Black Sea Region, Yuvarlakçay Stream, Yeşilırmak Stream (Başören & Kazancı 2016); Bursa, Yalova (Şirin *et al.* 2014).

Remarks: *Simulium bezzii* is common and widespread in both Türkiye and the southwestern Palearctic. According to Yankovsky (2003), the species can be distinguished from other "*bezzii* group species" by its distinctive pupal cocoon structure as in our material.

Simulium (Simulium) degrangei Dorier & Grenier, 1960

Material examined: (7) 2 larvae; **(44)** 2 larvae, 28 pupae; **(50)** 1 male, 16 larvae, 29 pupae; **(51)** 5 larvae, 21 pupae; **(52)** 5 females, 3 males, 5 larvae, 178 pupae; **(53)** 9 larvae, 20 pupae; **(54)** 12 pupae; **(66)** 83 pupae.

World Distribution: Austria, Bosnia and Herzegovina, Bulgaria, France, Georgia, Germany, Greece, Italy, Montenegro, Serbia, Slovakia, Switzerland, Ukraine, Türkiye (Adler 2022).

Distribution in Türkiye: Büyük Menderes River Basin (Başören & Kazancı 2016).

Remarks: *Simulium degrangei* is one of the three known species of the "*bukovskii* species group" (Adler 2022). Although Başören & Kazancı (2016) reported that the species exists in the Büyük Menderes basin, Adler (2022) does not include Türkiye among the countries where this species is distributed in the latest version of the world checklist. On the other hand, *Simulium bukovskii* Rubtsov, 1940 another member of the species group, is known from both Anatolia and Turkish Thrace (Şirin *et al.* 2015). The basic morphological characters that can be used to distinguish these two species are pupal cocoon structures and filament branching structures (Yankovsky 2003). Unlike *S. bukovskii*, the cocoon of *S. degrangei* has two spoon-like projections anteriorly above and below its anterior opening. However, there are 4-5 very short common stems at the bases of the gill filaments. The pupal characters of our material confirm these descriptions. On the other hand, Crosskey & Zwick (2007) emphasized the similarity of the two species and that synonymy should be

considered. Therefore, comprehensive phylogenetic studies based on DNA data are needed to reveal the taxonomic status of these two species.

Simulium (Simulium) kiritshenkoi Rubtsov, 1940

Material examined: **(1)** 77 pupae, 75 larvae; **(2)** 2 pupae, 53 larvae; **(4)** 9 larvae, 7 pupae; **(5)** 35 larvae, 20 pupae; **(6)** 2 pupae; **(8)** 1 pupa; **(10)** 2 pupae; **(12)** 6 larvae, 1 pupa; **(15)** 1 pupa; **(18)** 3 larvae, 9 pupae; **(28)** 28 larvae, 5 pupae; **(38)** 26 larvae, 51 pupae; **(41)** 9 pupae; **(44)** 6 larvae, 2 pupae; **(47)** 2 larvae, 8 pupae; **(69)** 14 larvae, 5 pupae; **(70)** 5 pupae; **(71)** 1 larva, 1 pupa.

World Distribution: Iran; Armenia, Azerbaijan, Bulgaria, Cyprus, Georgia, Iraq, Pakistan, Romania, Russia (Caucasus), Tajikistan, Türkiye, Ukraine (Adler 2022).

Distribution in Türkiye: Marmara River Basin (Şirin *et al.* 2014); Büyük Menderes River Basin, Ceyhan River Basin, Fırat River Basin, Kızılırmak River Basin, Sakarya River Basin, Yeşilırmak River Basin, Zamantı River (Başören & Kazancı 2016).

Remarks: The presence of *Simulium kiritshenkoi* in Anatolia has been known since 1975. Jedlicka (1975) first reported this species as the synonym *Odagmia ornata caucasica* Rubtsov, 1940 from Afyon province. The species is currently known as one of the most common species in Türkiye (Şirin *et al.* 2015). Crosskey & Zwick (2007) recorded this species from Bolu province. This species is a new record for the remaining provinces of the study area. *Simulium kiritshenkoi* is a member of the *ornatum* species group, which is one of the most populous and taxonomically complex species groups of Simuliidae in the Palearctic region of the family. In our study, we identified the specimens of this species according to Rubtsov (1956) by considering the following characters; ventral plate shape of mature male pupa, common stem structures of pupal gill filaments, dome-shaped thoracic tubercles of pupa.

Simulium (Simulium) ornatum species complex

Material examined: **(11)** 1 pupa; **(27)** 57 larvae, 43 pupae; **(40)** 8 larvae, 2 pupae; **(33)** 75 larvae, 21 pupae; **(47)** 2 larvae, 8 pupae; **(64)** 2 larvae, 5 pupae; **(68)** 20 larvae, 19 pupae.

Remarks: These specimens belongs to the *S. ornatum* species complex, and were found at 7 different localities. They are similar morphologically to *S. kiritshenkoi* but differ in the common stems and height of the pupal gill filaments. Since there are no mature larvae, pupae or adults in our material of this species for more accurate identification, we preferred to give the species as *S. ornatum* species complex.

Simulium (Simulium) variegatum Meigen, 1818

Material examined: **(4)** 13 larvae, 6 pupae; **(5**) 28 larvae, 11 pupae; **(7)** 14 pupae; **(22)** 14 larvae, 3 pupae; **(25)** 47 larvae; **(66)** 4 pupae; **(70)** 24 larvae.

World Distribution: Algeria, Andorra, Armenia, Austria, Azerbaijan, Belgium, Bosnia and Herzegovina, Great Britain, Bulgaria, Croatia, Czech Republic, France, Georgia, Germany, Greece, Hungary, Iran, Ireland, Italy, Lebanon, Montenegro, Morocco, Poland, Portugal, Romania, Russia, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye, Ukraine (Adler 2022).

Distribution in Türkiye: Kocaeli (Şirin *et al.* 2014), Altındere Stream (in Trabzon), Ceyhan River Basin, Çoruh River Basin, Dicle River Basin, Fırat River Basin, Fırtına Stream, Köyceğiz Protected Area, Sakarya River Basin, Salda Lake Basin, Zap River (Başören & Kazancı 2016).

Remarks: *Simulium variegatum* is characterized with the presence of two large thoracic bulges (patagia) of pupae (Bass, 1998). Crosskey & Zwick (2007) recorded this species from Bolu province. Besides, this species is a new record for the remaining provinces of the study area. This species is widely distributed in Türkiye (Başören & Kazancı 2016) and also common in the western Palearctic Region (Adler 2022).

Simulium (Wilhelmia) balcanicum (Enderlein, 1924)

Material examined: **(9)** 1 pupa; **(11)** 1 female, 4 pupae; **(13)** 30 pupae, 10 larvae; **(14)** 5 pupae; **(15)** 1 pupa; **(16)** 6 pupae; **(17)** 6 pupae; **(27)** 3 pupae; **(29)** 3 pupae, 84 larvae; **(34)** 11 pupae; **(37)** 6 pupae; **(39)** 1 pupa; **(45)** 16 pupae.

World Distribution: Albania, Austria, Bulgaria, Belarus, Bosnia and Herzegovina, Croatia, Germany, Greece, Hungary, Italy, Macedonia, Moldova, Montenegro, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, Türkiye, Ukraine (Adler 2022).

Distribution in Türkiye: Büyük Menderes River Basin, Eastern Black Sea region, Kızılırmak River Basin, Sakarya River Basin, Yeşilırmak River Basin (Başören & Kazancı 2016).

Remarks: *Simulium balcanicum* is a common species both in Türkiye and in the countries around it. Crosskey & Zwick (2007) recorded this species from Bolu province. This species is a new record for the remaining provinces of the study area. Unlike other species of the subgenus *Wilhelmia* Enderlein, 1921, two of the six tubular filaments of this species are located on a common stem. This feature was also clearly observed in our pupae.

Simulium (Wilhelmia) equinum (Linnaeus, 1758)

Material examined: **(27)** 13 pupae.

World Distribution: Armenia, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Great Britain, Bulgaria, Czech Republic, China, Croatia, Denmark, Estonia, Finland, France, Georgia, Germany, Hungary, Ireland, Italy (incl. Sardinia), Kazakhstan, Latvia, Liechtenstein, Lithuania, Macedonia, Moldova, Montenegro, Morocco, The Netherlands, Norway, Poland, Portugal, Romania, Russia, Serbia, Siberia,

Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye, Ukraine (Adler 2022).

Distribution in Türkiye: Sakarya River Basin (Şirin & Şahin, 2005) and Kızılcahamam (Ankara) Crosskey & Zwick (2007).

Remarks: It can be easily identified by the banana-like gill branches of the pupae of *Simulium equinum* which is the first described species of the family. This species was recorded for the first time in Anatolia from the Sakarya River Basin by Şirin & Şahin (2005). Crosskey & Zwick (2007) also found it in a river near Ankara, Kızılcahamam. Although the species is rare in Mediterranean countries, it has a wide distribution in the Palearctic (Crosskey & Zwick 2007).

Simulium (Wilhelmia) pseudequinum Seguy, 1921

Material examined: **(6)** 1 larvae; **(9**) 6 pupae; **(11)** 3 pupae; **(13)** 5 pupae; **(14)** 11 pupae; **(15)** 16 pupae; **(16)** 2 females, 167 pupae; **(17)** 47 larvae, 11 pupae; **(18)**, 2 pupae; **(20)** 59 larvae, 32 pupae; **(21)** 3 larvae, 9 pupae; **(23)** 3 larvae, 4 pupae; **(24)** 4 larvae; **(26)** 15 pupae; **(27)** 22 pupae; **(28)** 2 pupae; **(29)** 43 pupae; **(30)** 25 pupae; **(31)** 1 pupa; **(34)** 12 pupae; **(35)** 23 pupae; **(37)** 2 pupae; **(38)** 9 pupae; **(39)** 24 pupae; **(41)** 2 larvae; **(42)** 1 pupa; **(45)** 3 females , 2 males 50 pupae; **(46)** 6 larvae; **(47)** 1 female, 6 larvae, 5 pupae; **(48)** 3 larvae, 1 pupa; **(57)** 2 larvae; **(59)** 1 pupa; **(64)** 2 pupae.

World Distribution: Algeria, Armenia, Austria, Azerbaijan, Bosnia and Herzegovina, Great Britain, Bulgaria, China (Sx, Xi), Croatia, Cyprus, France, Georgia, Greece (incl. Andros, Chios, Crete, Ikaria, Lesbos, Naxos, Rhodes), India (Kashmir, Pu), Iran, Iraq, Israel, Italy, Jordan, Kazakhstan, Kyrgyzstan, Lebanon, Libya, Macedonia, Moldova, Montenegro, Morocco, Pakistan, Portugal, Romania, Russia (Caucasus), Serbia, Slovakia, Slovenia, Spain (including Canary Islands-Gran Canaria, Gomera, Tenerife), Tajikistan, Tunisia, Türkiye, Turkmenistan, Ukraine Uzbekistan (Adler 2022).

Distribution in Türkiye: Marmara River Basin (Şirin *et al.* 2014); Ankara Stream, Büyük Menderes River Basin, Çoruh River Basin, Eastern Black Sea Region, Fırat River Basin, Namnam Stream, Sakarya River Basin, Seyhan River Basin, Yeşilırmak River Basin, Yuvarlakçay Stream, Zamantı River (Başören & Kazancı 2016).

Remarks: *Simulium pseudequinum* is the most abundant species in the study area and was sampled from 33 river sources. It is not surprising that this species, which is the most common species in Anatolia and the Palearctic region, is also the dominant species in the study area. Crosskey & Zwick (2007) recorded this species from Bolu province. This species is a new record for the remaining provinces of the study area. *Simulium pseudequinum* differs from other species of the Subgenus *Wilhelmia* Enderlein, 1921, especially in the shape of the ventral plate in the male genitalia and the shirred bases of the tubular gill filaments (Crosskey & Malicky 2001). These features were observed in our material.

Simulium (Wilhelmia) turgaicum Rubtsov, 1940

Material examined: **(27)** 2 larvae, 1 pupa.

World Distribution: Afghanistan, Armenia, Azerbaijan, Bosnia and Herzegovina, China, Iran, Iraq, Kyrgyzstan, Lebanon, Pakistan, Slovenia, Tajikistan, Türkiye, Turkmenistan, Ukraine, Uzbekistan (Adler 2022).

Distribution in Türkiye: Büyük Menderes River Basin, Çoruh River Basin, Kızılırmak River Basin, Sakarya River Basin, Yeşilırmak River Basin, Yuvarlakçay Stream (Başören & Kazancı 2016).

Remarks: *Simulium turgaicum* was recorded as *S. lineatum* (Meigen, 1804) from the major river basins in Türkiye in previous studies (Başören & Kazancı 2016). The most distinctive feature of the species is the presence of finger-shaped tubular gill filaments, which is also observed in our samples. On the other hand, Adler *et al.* (2015) suggested the use of the name *S. turgaicum*, which is a synonym for the Anatolian populations of *S. lineatum* in their study in which they revealed the cytogenetic phylogeny of *Wilhelmia* Enderlein, 1921 species disturbed in the Palearctic. It is also in the latest version of the world checklist published by Adler (2022).

Discussion

In the present study, new contributions were provided for the distributional data of 14 black fly species in Anatolia. *Simulium (Nevermannia) carthusiense* Grenier & Dorier, 1959 was reported for the first time from the country.

Simulium carthusiense has a wide distribution in Europe (Fig. 3) [(Andorra, Austria, Czech Republic, France (incl. Corsica), Germany, Italy, Morocco, Poland, Slovakia, Spain, Switzerland, Ukraine (Adler 2022)]. Our record constitutes the eastern border of the distribution of this species. Larvae and pupae were collected from Çanakçar Stream (Bartın province) and Ortaköy Stream (Kastamonu province) from 162 m and 1,043 m above sea level, respectively. According to Adler & Seitz (2014), preadult stages of the species are mostly found in fast-flowing mountain streams at elevations of 300-2,500 m, and pupae occurs in June. In the present study this species was found on 11 June and in two different rapid flowing watercourses.

In this study, species identifications were done by using only morphotaxonomic methods. However, it is known that cryptic diversity is very common in the Simuliidae, and both cytogenetic and DNA-based data are needed to determine the taxonomic status of some species belonging to species complexes and species groups (Adler *et al.* 2004). Similarly, we think that further taxonomic studies using cytogenetic and molecular techniques should be carried out to establish

the taxonomic status of species belonging to the species groups such as *S. ornatum* and *S. vernum* identified in the study.

According to the results of present study, bloodsucking species such as *Simulium bezzii*, *S. kiritshenkoi* and *S. turgaicum* are distributed in the region. An outbreak of *S. bezzii* occurred in the Eastern Anatolia region in previous years and it caused the death of more than 100 cattle (Şirin *et al.* 2015). So, monitoring methods should be developed for pest populations of black flies in the region to ensure public health and protection of livestock.

Fig. 3. Distribution map of *S. carthusiense.*

Ethics Committee Approval: Since the article does not contain any studies with human or animal subject, its approval to the ethics committee was not required.

Author Contributions: All authors contributed equally to this manuscript in its all stages.

Conflict of Interest: The authors have no conflicts of interest to declare.

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