Acta Aquatica Turcica

E-ISSN: 2651-5474

Home Page: https://dergipark.org.tr/actaquatr 19(3): 209-216, 2023 DOI: 10.22392/actaquatr.1068061

Research Article **Araştırma Makalesi**

Hirudinea Fauna of Lake Karagöl (Sındırgı-Balıkesir) and Lake Gölcük (Bigadiç-Balıkesir): A New Record for Türkiye

Karagöl (Sındırgı-Balıkesir) ve Gölcük Gölü (Bigadiç-Balıkesir) Hirudinea Faunası: Türkiye için Yeni Bir Kayıt

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Received: 04.02.2022 **Accepted:** 19.07.2023 **Published:** 01.09.2023

How to Cite: Ceylan, M. (2023). Hirudinea Fauna of Lake Karagöl (Sındırgı-Balıkesir) and Lake Gölcük (Bigadiç-Balıkesir): A New Record for Türkiye. *Acta Aquatica Turcica, 19*(3), 209-216. https://doi.org/10.22392/actaquatr.1068061

Abstract: This study was carried out to determine the Hirudinea fauna in Lake Karagöl (Sındırgı-Balıkesir, Türkiye) and Lake Gölcük (Bigadiç-Balıkesir, Türkiye), which has not been found in any limnological studies before. It was determined the species of *Placobdella costata*, *Helobdella stagnalis*, *Hirudo verbana*, *Haemopis sanguisuga* and *Dina punctata* in Lake Karagöl and *P. costata*, *Glossiphonia concolor*, *Dina lineata* and *D. punctata* in Lake Gölcük. According to the findings of the present study, *Dina punctata* was reported for the first time in the Turkish Hirudinea fauna.

Keywords
- Limnology
- *Dina punctate*
- First record

Özet: Bu çalışma, daha önce herhangi bir limnolojik çalışmaya rastlanmayan Karagöl (Sındırgı-Balıkesir) ve Gölcük Gölü (Bigadiç-Balıkesir)'nün Hirudinea faunasının belirlenmesi amacıyla yapılmıştır. Çalışma ile Karagöl'de *Placobdella costata*, *Helobdella stagnalis*, *Hirudo verbana*, *Haemopis sanguisuga* ve *Dina punctata*, Gölcük Gölü'nde ise *P. costata*, *Glossiphonia concolor*, *Dina lineata* ve *D. punctata* türleri tespit edilmiştir. Bu türlerden *D. punctata* Türkiye Hirudinea faunası için ilk kez rapor edilmiştir.

Anahtar kelimeler
- Limnoloji
- *Dina punctata*
- İlk kayıt

1. INTRODUCTION

Leeches have been on the agenda of humanity since ancient times. It is known that bloodletting was recommended by Hippocrates in the 5th century BC (Thearle, 1998). Leeches are parasitic on mammals, fish, amphibians, birds, and reptiles and are also among the diet of fish, crayfish, birds, aquatic insects, and other leech species (Sawyer, 1986). Since leeches can be found in a wide ecological range, it is not sufficient to evaluate them alone in water quality monitoring studies (Neubert and Nesemann, 1999; Kazancı et al., 2009). However, since using more species to monitor the water quality provides more reliable results, it is recommended to include Hirudinea members in the assessment of the water quality (Metcalfe et al., 1988; Bendell and McNicol, 1991; Scrimgeour et al., 1998; Ahmad et al., 2002; Koperski, 2005; Kazancı et al., 2009). Several countries include various leech species as water quality monitoring tools in line with the Water Framework Directive (Tempelman, 2008).

In parallel with intensive agricultural activities, deforestation, industry, urbanization, domestic wastes, and improper land use, changes and degradation occur in the physicochemical properties and biodiversity of aquatic environments (Adla et al., 2022). These changes cause significant changes in the qualitative and quantitative distribution of all ecosystems and aquatic organisms in particular (Kang et al., 2023). However, the efficient and rational evaluation of the ecological change process is closely linked to the knowledge of biological diversity (Yoccoz et al., 2001).

The first report of leech fauna in the inland waters of Türkiye was made by Deveciyan (1915), who reported the presence of medicinal leech (*Hirudo* sp.) in Bursa Yenişehir Lake. The first report of

leeches in the history of the Republic of Türkiye was made by Geldiay (1949) from Lake Eymir with the species *Hirudo medicinalis* and *Placobdella catenigera* (Syn: *Placobdella costata*). Following these studies, many studies have been carried out on the leech fauna in the wetlands of Türkiye. The first records for the wetlands of our country were reported by Sağlam (2001) for *P. costata*, Sağlam and Dörücü (2002) for *Helobdella stagnalis*, and Kazancı et al. (2009) for *Erpobdella vilnensis*. New species for the literature from the wetlands of our country were *Dina vignai* (Minelli, 1978), *Batracobdella euxina* (Neubert and Nesemann, 1995), and *Hirudo sulukii* (Sağlam et al., 2016).

With this study, it was aimed to contribute to the biodiversity of Turkiye by determining the Hirudinea fauna of Lake Karagöl (Sındırgı-Balıkesir) and Lake Gölcük (Bigadiç-Balıkesir), where no limnological study was found.

2. MATERIAL and METHODS

2.1. Study schedule

This study was carried out on 22.06.2012 and 11.07.2022.

2.2. Study field

This study was conducted in Lake Karagöl and Lake Gölcük. Lake Karagöl is located in Sındırgı (Balıkesir) district. With an altitude of 1020 m, the lake is located at the coordinates 39°19'12.5"N 28°30'46.7"E and extends in the east-west direction. It is 59 km from Sındırgı district center. The surface area of the lake is approximately 3 ha and the entire surface except the littoral zone is covered with lotus leaves. There are orchards around the lake and therefore the lake is used for irrigation purposes.

Lake Gölcük is located in Bigadiç (Balıkesir) district. The lake, which is 830 m above sea level, is located at the coordinates 39°20'19.7"N 28°29'05.0"E and extends in the southwest-northeast direction. The lake is 46 km from the Bigadiç district center, and its surface area is approximately 1 ha. The vegetation is predominantly reed plants; however, due to the excavation works, open water surfaces (lake mirrors) have been formed in places in the lake. The lake water is used for irrigation of the surrounding gardens. The lakes studied are connected to each other by a 9 km stabilized road. The locations of the lakes on the map are given in Figure 1.

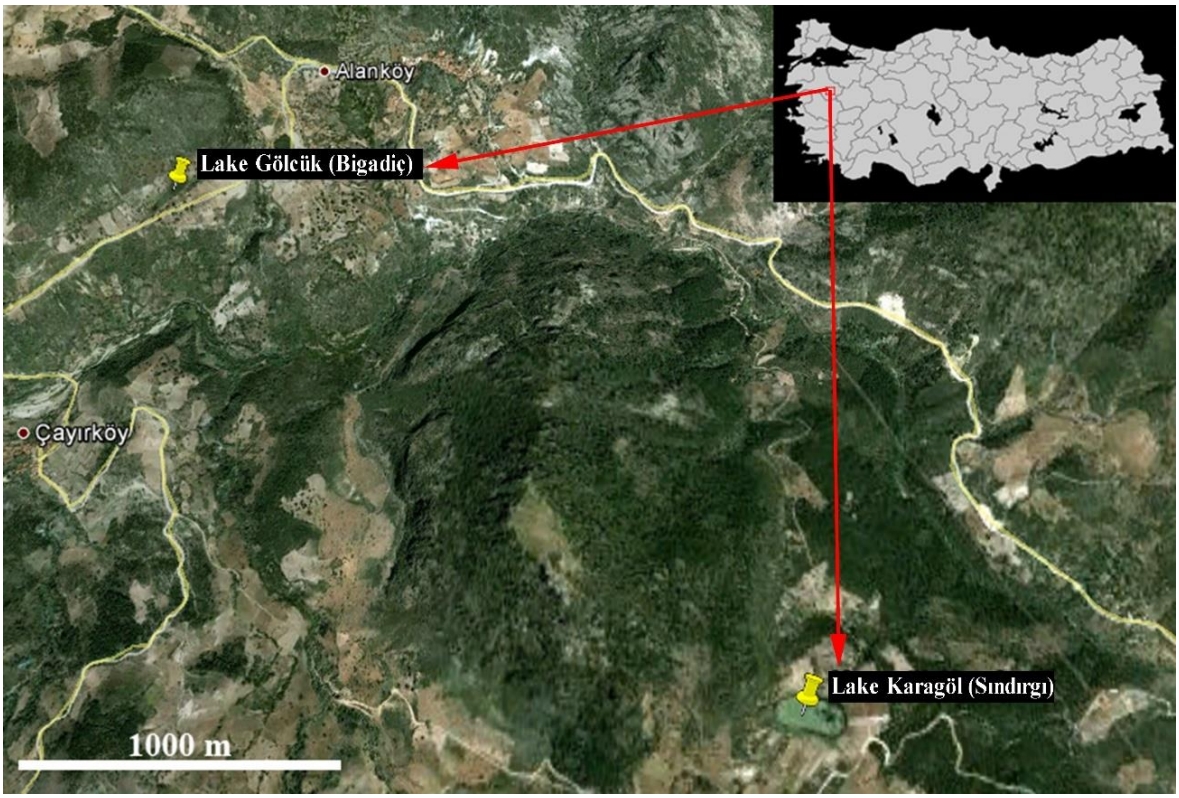

Figure 1. Map location of Lake Karagöl (Sındırgı, Balıkesir) and Lake Gölcük (Bigadiç, Balıkesir) where this study was conducted.

2.3. Sampling of leeches

While actively swimming individuals were collected by plastic sieve, passive specimens were collected by hand or with forceps from stones, plant leaves, and foreign objects with surface area such as wood, bags, sacks, etc. Since the colors of spot and papillae are also taken into consideration in the species identification of Hirudinea samples (Neubert and Nesemann, 1999), the specimens were transported live in different plastic jars with the locality information recorded to the Limnology Laboratory of Eğirdir Fisheries Research Institute Directorate.

2.4. Identification of leeches

Leeches were gradually anesthetized with 15% ethanol. Species identification was performed under an Olympus SZX2 stereo microscope according to Sawyer (1986), Davies (1991), Neubert and Nesemann (1999), and Sağlam (2004).

3. RESULTS

As a result of the species identification, 5 species belonging to 4 families were identified in Lake Karagöl and 4 species belonging to 2 families were identified in Lake Gölcük. The identified species are given in Table 1.

Among the species identified in this study, *D. punctata* is the first record for the Hirudinea fauna of Türkiye (Figure 2). While all identified species could be sampled in 2012, *H. stagnalis*, *H. sanguisuga* could not be sampled for both lakes, and *D. punctata* could not be sampled in Lake Karagöl in 2022.

D. punctata is a medium-sized leech with a body length of up to 85 mm. Although the anterior part of the body is more or less cylindrical, the anterior cecum is long and protruding and the pseudognatha are well developed. The genital cavities are separated from each other by 1.5-2 annuli; usually, the male genital cavity is located at b2/a2, sometimes at the beginning of a2. The female genital cavity is always located on the b5/b6 border. The coloration of living individuals varies considerably. They are mostly dark red-brown and black. The dorsal surface is covered with yellow reddish spots on the anterior part of the body. These spots are irregularly arranged in two transverse rows on the a2 annuli. On the dorsal surface, there is a pair of paramedian stripes that fade in the posterior part of the body. The body surface is covered with small papillae, so it appears rough (Nesemann, 1993; Neubert and Nesemann, 1999).

G. concolor is a small-sized leech with a maximum body length of 35 mm. The head is slightly detached from the body. It has three pairs of eyes. The genital cavities are separated from each other by 2 annuli, the male genital cavity is located at XI a3/XII a1, and the female genital cavity at XII a2/a3. The color of living individuals is yellowish and brownish. There are 3 pairs of dark stripes, of which the inner paramedian pair is very prominent and irregularly interrupted at the a2 annuli. The dorsal surface is completely covered with small yellow dots. The body surface is smooth, and papillae are absent in young individuals, whereas papillae may be present in adults. There may be a stripe up to the anterior half of the ventral region of the body (Nesemann, 1990; Neubert and Nesemann, 1999; Sawyer, 1986; Elliott and Dobson, 2015; Grosser et al., 2016).

Table 1. Leech species and sample numbers in Lake Karagöl and Lake Gölcük by sampling period.

Wetlands	Familia	Species	Number of leeches collected	
			2012	2022
Lake Karagöl	Glossiphonidae	*Placobdella costata* (Müller, 1846)	5	4
		Helobdella stagnalis (Linnaeus, 1758)	1	-
	Hirudinidae	*Hirudo verbana* Carena, 1820	21	2
	Haemopidae	*Haemopis sanguisuga* (Linnaeus, 1758)	4	-
	Erpobdellidae	*Dina punctata* Johansson, 1927	54	8
Lake Gölcük	Glossiphonidae	*Placobdella costata* (Müller, 1846)	6	11
		Glossiphonia concolor (Apáthy, 1888)	1	7
	Erpobdellidae	*Dina punctata* Johansson 1927	4	-
		Dina lineata (Müller, 1774)	3	1

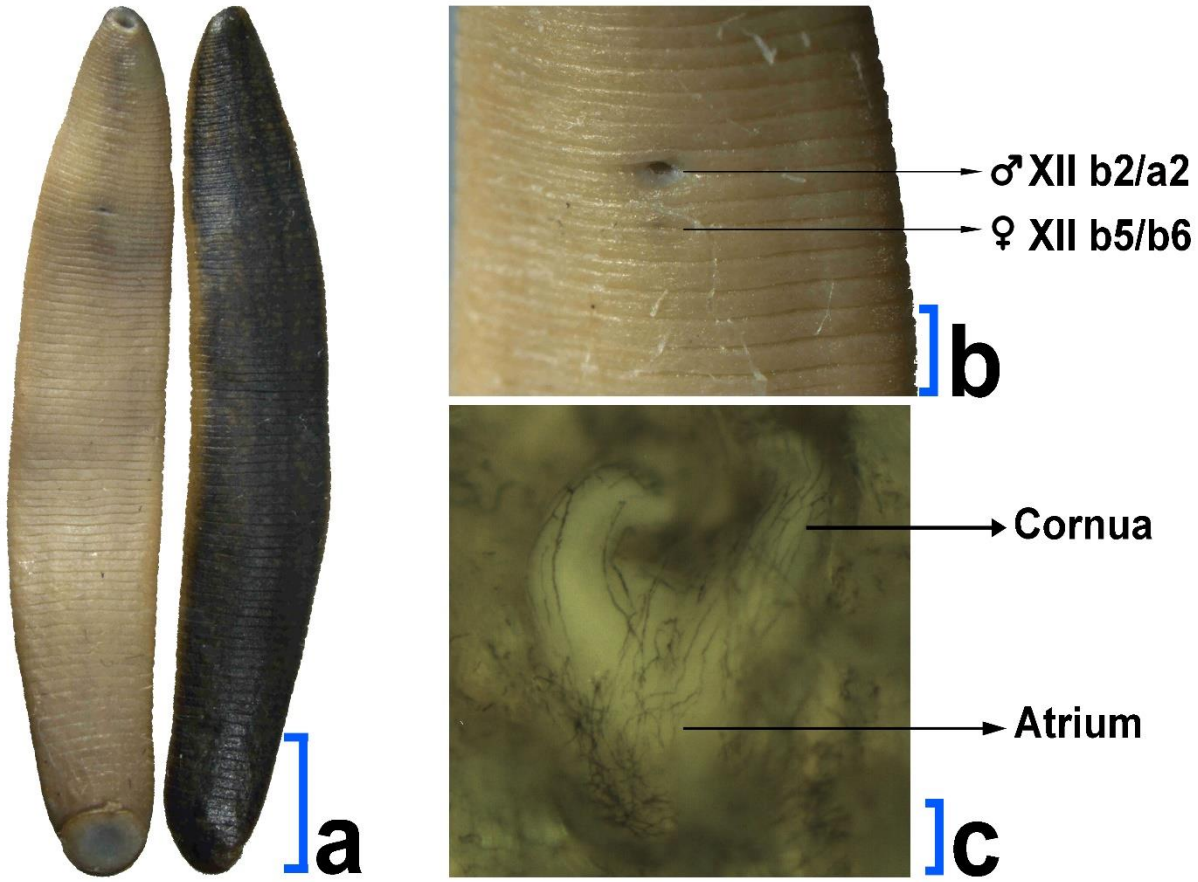

Figure 2. *Dina punctata* Johansson, 1927: A new record for the Hirudinea fauna of Türkiye.
a: Ventral (left) and dorsal (right) view of the leech; the upper part of the leech shows the anterior region (Bar: 5 mm). b: The genital pores are separated from each other with two annuli (Bar: 1 mm). c: Atrium and cornua of the leech (Bar: 1 mm).

Among the leech species sampled, *P. costata* was found under the stones and attached to the boot. *H. stagnalis* and *G. concolor* individuals were found on the surface of stones. *H. sanguisuga* was sampled passively under the stones on the shoreline of Lake Karagöl. The leeches belonging to *D. punctata* were the dominant leech species in Lake Karagöl; they were found under stones. Individuals of *D. lineata* were sampled under stones. *H. verbana* individuals were sampled with a plastic sieve while actively swimming toward the wave source formed by mixing the water. They were also found among the submersed plants in Lake Karagöl and clinging to the boots.

4. DISCUSSION

P. costata is a leech species that mostly prefers turtles as hosts, but can also survive on amphibians, fish, reptiles, birds, and mammals (Sawyer, 1986; Sağlam, 2001). Interestingly, individuals of this leech species have been also reported to parasitize humans (Cichocka et al., 2021). The species, whose type locality is the Crimean Peninsula, is distributed in the Palearctic geography (Neubert and Nesemann, 1999; Kvist et al., 2022). In this study, it was the most collected leech species in Lake Gölcük.

H. stagnalis is a species with high ecological tolerance and is known to be distributed even in wetlands with a salinity of ‰3.6 (Neubert and Nesemann, 1999). It can be sampled under stones in stagnant waters with high macrophyte density (Özbek and Sarı, 2007). The most important parameter determining the distribution of the species has been reported as the presence of food (Sawyer, 1986; Sağlam and Dörücü, 2002). Its diet is dominated by macroinvertebrates of Chironomidae and Oligochaeta, but also includes Gastropoda, Amphipoda, Copepoda, and Cladocera (Davies et al., 1979). The species is distributed in Palearctic and Nearctic regions (Neubert and Nesemann, 1999).

H. verbana is one of the two medicinal leech species distributed in Turkish wetlands with *Hirudo sulukii* (Sağlam et al., 2016; Ceylan et al., 2021a). The reason for the use of the species in the field of

medicine is the bioactive substance content in its secretions (Singh, 2010; Liu et al., 2019). Since the exposure of its habitats to various pollutants and overfishing have caused *H. verbana* populations to weaken, the cultivation of the species has gained importance (Sağlam, 2018; Ceylan, 2020). International trade of the species is carried out with certain quotas under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (Sağlam, 2011; Williams et al., 2020; Ceylan and Çetinkaya, 2021). Depending on their developmental stages, mammals, reptiles, birds, fish, and amphibians are the main hosts preferred in nature (Wilkin and Scofield, 1990; Manav et al., 2019). In this study, it could only be sampled from Lake Karagöl. It is thought that the remote location of Lake Karagöl from the settlement both partially protected the lake from human intervention and provided an opportunity for wild animals, which are among its hosts, to colonize more easily. It is thought that the interventions made to Lake Gölcük, which was previously reported to have medicinal leeches by the local people, destroyed the habitat, and it is thought that the water withdrawal from the lake with pumps both changed the water regime of the habitat, and it is possible that the leeches were removed from the lake by the pump.

H. sanguisuga is a predatory leech that feeds on both terrestrial and aquatic invertebrates. It is naturally distributed in many habitat types of the Palearctic geography with stagnant and flowing systems (Neubert and Nesemann, 1999). It is frequently found in the littoral zone of wetlands and can also be sampled in waterfowl nests (Ceylan et al., 2021b). Since it has the potential to be used as live feed in fish aquaculture, it is one of the leech species that can be brought into aquaculture (Ceylan et al., 2017).

D. punctata, which was reported for the first time in Türkiye with this study, was the most frequently sampled species in Lake Karagöl. This species lives in both aquatic and moist terrestrial environments (Ben Ahmed et al., 2015). The species, whose type locality is Barcelona Guardiola (Spain), was previously reported to be distributed in wetlands in France, Italy, Switzerland, Liechtenstein, Hungary, Austria, Slovakia, Tunisia, Algeria, Iran, and Iraq (Nesemann and Neubert, 1994; Neubert and Nesemann, 1999; Beracko and Košel, 2011; Ben Ahmed et al., 2013; Ben Ahmed et al., 2015; Darabi-Darestani et al., 2016; Bilal et al., 2017). With this study, it was determined that the species is also distributed in the wetlands of Türkiye.

G. concolor is a predatory species feeding on small Molluscs. The species, whose type locality is the Danube at Dunaharaszti (Hungary), has a wide distribution in Europe and can be found in lakes, ponds, and rivers (Nesemann, 1990; Neubert and Nesemann, 1999). Apart from Europe, it has also been reported in Iran (Darabi-Darestani et al., 2016; Darabi-Darestani et al., 2021), indicating that the distribution of the species also includes Asian countries.

D. lineata lives in both terrestrial and aquatic environments. This species is distributed in the Mediterranean and Middle East (Neubert and Nesemann, 1999).

5. CONCLUSION

Studies on Hirudinea fauna in Turkish wetlands are limited due to the low number of researchers working on leeches. Recently, studies supported by molecular methods (Sağlam et al., 2016) have contributed both to the disclosure of the Hirudinea fauna in the wetlands of Türkiye and to the introduction of new leech species to the literature. This study, in which a new leech species was reported for the Hirudinea fauna of Türkiye, indicates that our country can make important contributions to the science of leeches.

ACKNOWLEDGMENT

This study was presented at the II. International Symposium on Limnology and Freshwater Fisheries. I would like to thank Mr. Zekeriya AVCU, Mr. Recep GÜNDÜZ, and Mr. Ömer AVCU and Mr. Muhammed AVCU from Panayır Village (Bigadiç-Balıkesir) and Mr. Yusuf YİĞİT from Alanköy (Bigadiç-Balıkesir) for their support in conducting the field study.

FUNDING

No financial support was received for this study.

CONFLICT OF INTEREST

The author declares that there are no financial interests or personal relationships that may have influenced this work.

AUTHOR CONTRIBUTIONS

All work packages in this study were performed by the author.

ETHICAL STATEMENTS

Local Ethics Committee Approval was not obtained because experimental animals were not used in this study.

DATA AVAILABILITY STATEMENT

The data used in this study are available on the Figshare platform with the DOI address https://doi.org/10.6084/m9.figshare.23369570

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