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Hirudinea (Annelida) Fauna of Some Wetlands in Bingöl Province

Bingöl İlindeki Bazı Sulak Alanların Hirudinea (Annelida) Faunası

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ABSTRACT

Objective: Leeches are important and reliable indicators of water quality and biodiversity in the ecosystem, so the presence of specific leech species is often closely related to basic water conditions and the presence of certain animals. This study was carried out in 2017 and 2018 in order to determine the Hirudinea fauna of some wetlands in Bingöl province. The investigation was conducted on a total of 13 stations.
Methods: The water parameters of the stations were measured and recorded *in situ*. The collected specimens were brought alive to the Zoology Laboratory of Bingöl University Biology Department and kept alive under room temperature conditions. The diagnosis of leech samples was made through the living samples, and they were identified at the level of family, genus, and species.
Results: During the study, seven species, belonging to six genera and in four families were recorded. These are; *Hirudo verbana* Carena, 1820, *Glossiphonia complanata* (L. 1758), *Theromyzon tessulatum* (O. F. Müller, 1774), *Placopdella costata* (Fr. Müller, 1846), *Erpobdella octoculata* (L., 1758), *Erpobdella testacea* (Savigny, 1820), *Piscicola geometra* (L., 1761).
Conclusion: The locations where the study was carried out are new records for the detected leech species.
Keywords: Hirudinea, annelida, fauna, wetland, Bingöl

ÖZ

Amaç: Bu çalışma Bingöl ilindeki bazı sulak alanların Hirudinea faunasını belirlemek amacıyla, 2017 ve 2018 yıllarında iki yıllık arazi çalışması ile gerçekleştirilmiş olup, 13 istasyonda yürütülmüştür.
Yöntemler: İstasyonlara ait su parametreleri yerinde ölçülerek kaydedilmiştir. Sülük örnekleri Bingöl Üniversitesi Biyoloji Bölümü Zooloji Laboratuvarı'na canlı olarak getirilip oda sıcaklığı koşullarında çalışma süresince canlı olarak muhafaza edilmiş olup, tür teşhisleri canlı örnekler üzerinden yapılmıştır. Toplanan sülük örneklerinin familya, cins ve tür düzeyinde teşhisleri yapılmıştır.
Bulgular: Çalışmada dört familyada altı cinse ait yedi tür kaydedilmiştir. Bunlar *Erpobdella octoculata* (L., 1758), *Erpobdella testacea* (Savigny, 1822), *Glossiphonia complanata* (L. 1758), *Hirudo verbana* Carena, 1820, *Piscicola geometra* (L., 1761), *Placobdella costata* (Fr. Müller, 1846), *Theromyzon tessulatum* (O. F. Müller, 1774) türleridir.
Sonuç: Tespit edilen sülük türleri verilen lokasyonlar için ilk kayıt olmaktadır.
Anahtar Kelimeler: Hirudinea, annelida, fauna, sulak alan, Bingöl

INTRODUCTION

Leeches are important indicators for water quality and biodiversity in the ecosystem and are closely related to basic water conditions and the presence of certain animals (1). These creatures are usually annular worms known as ectoparasites that feed on blood sucking. Parasitic leeches can greatly affect the fitness of their hosts depending on environmental conditions and frequency (2). More than 650 leech species have been identified by now and 15 of them are reported to be used for medicinal purposes (3). Most leeches live in burrows dug into mud at the bottom of fresh water during the hot and dry days of summer. It has been reported that organic pollutants do not harm the leeches, but the increase in acid values of the waters causes a decrease in the leech fauna (4).

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Türkiye PARAZİTOLOJİ Dergisi

Parasitic leeches have economic importance as they are used in the treatment of some diseases. It is known that leeches collected for medical purposes have been exported and become commercial products. For these reasons, *H. medicinalis* was classified as Endangered in Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) according to the International Union for Conservation of Nature (IUCN) an international convention and it was taken under protection.

Wells and Coombes (5) reported that little is known about medicinal leeches in European and eastern Mediterranean countries. Kasparek (6) emphasized that although the country of origin of medicinal leeches is defined as Turkiye, almost no information is available. Over twenty-five years after Kasparek (6), many studies have been carried out and many new records have been identified, including two new species.

Species recorded for Turkish leech fauna are; *Actinobdella* sp., *Alboglossiphonia heteroclite, Batracobdella euxina, Cystobranchus respirans, Dina lineata, Dina lineata lineata, Dina lineata concolor, Dina stschegolewi, Dina vignai, Erpobdella octoculata, Erpobdella vilnensis, Erpobdella testacea, Glossiphonia complanata, Haemopis sanguisuga, Haementaria costata, Helobdella stagnalis, Hemiclepsis marginata, Hirudo medicinalis, Hirudo sulukii, Hirudo verbana, Limnatis nilotica, Limnatis paluda, Piscicola geometra, Placobdella costata, Nephelopsis obscura, Trachellobdella torquate, Theromyzon tessulatum* and *Trocheta* sp.. Among these species, the species known as medicinal leeches and used for this purpose are *H. medicinalis, H. verbana* and *H. sulukii*.

Considering these studies in the Turkish leech literature, the absence of any study on the leech fauna of Bingöl necessitated a study in Bingöl, which has an important place in the Eastern Anatolia region with its wetlands.

METHODS

Study Area

The study was carried out in 2017 (June, July, August, September) and 2018 (April, May, June, July, August, September) to determine the Hirudinea fauna of some wetlands in Bingöl province and was carried out in a total of 13 stations (Figure 1). The water parameters of the stations were measured and recorded on-site using AZ 8361 conductivity meters and AZ 8685 pH meters, and the coordinates of the stations were determined by GPS. The sampling stations and various data of these stations are presented in the table below (Table 1).

Collection and Preservation of Leeches

The samples were collected from the stations in monthly periods. The leech samples were classified according to family, genus and species categories, the collected samples were kept alive in plastic bottles, and their diagnosis was made on these live samples. The metric and meristic measurements of the morphological features of the leech samples were recorded. In order to determine the biological diversity of the leech fauna of Bingöl province, 4 samples from different species belonging to each station were stored in 70% alcohol. No leeches were killed except for 4 samples from each station in the sample stock operations. Ethics committee approval was obtained from Bingöl University Local Ethics Committee for this study (with the meeting numbered 2017/06, dated 09/06/2017, and decision numbered 06/04).

Diagnosing of Leeches

Identification of the samples was made under the Olympus SZ51 stereo binocular microscope in the Bingöl University Research Laboratory, using Sawyer (7), Elliott and Mann (8), Sládeček and Košel (9), Davies (10), Neubert and Nesemann (11) and Sağlam (12).

Statistical Analysis

IBM SPSS 25 statistical software was used to determine the relationship of leech diversity and populations with Altitude, Water Temperature, pH and Electrical Conductivity.

RESULTS

During the study, a total of 525 samples were collected from the study area and as a result of the identification of the samples, 7

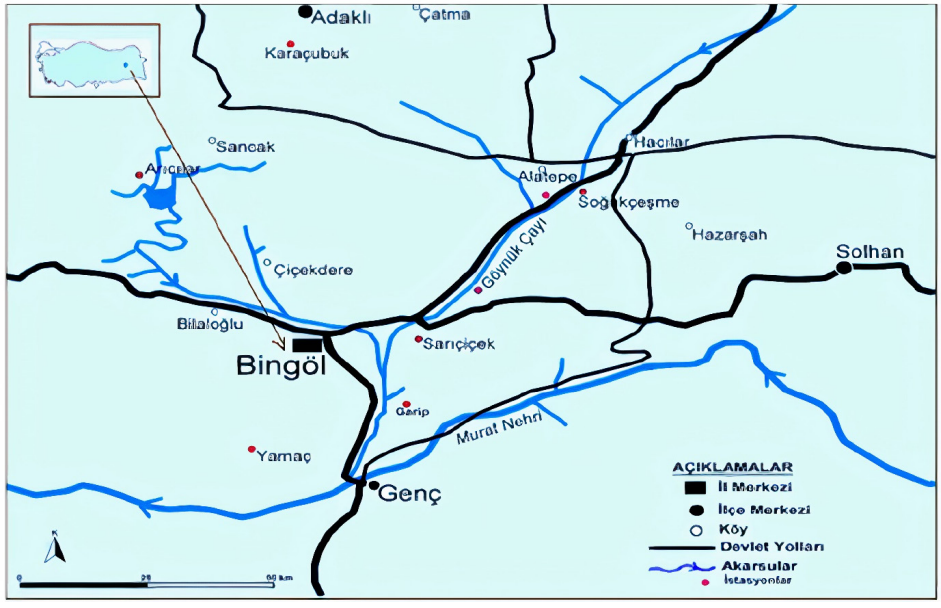

Figure 1. Study area (marked with red points)

Table 1. Locations of the stations and water parameters

N	Stations	Latitude	Longitude	Altitude (m)	WT (°C)	pH	EC (µS/cm)
S1	Adaklı-Karaçubuk	39° 11'27.38"N	40° 29'27.59"E	1436	24.1±2.0	7.6±1.6	203.8±74.52
S2	Sarıçiçek	38° 53'22.55"N	40° 34'15.74"E	1028	20.8±2.3	9.3±0.4	401.5±11.9
S3	Çobantaşı	39° 03'10.81"N	40° 47'40.56"E	1484	25.9±6.8	9.6±3.1	280.0±68.0
S4	Alatepe	39° 03'05.71"N	40° 46'22.78"E	1382	24.5±8.0	9.1±3.4	298.0±60.2
S5	Arıcılar Hamlet 1	39° 03'26.83"N	40° 17'28.22"E	1653	24.6±4.6	9.0±3.2	215.5±31.1
S6	Arıcılar Hamlet 2	39° 03'24.59"N	40° 17'27.70"E	1648	22.9±4.4	4.8±0.3	193.4±23.0
S7	Arıcılar Hamlet 3	39° 03'23.35"N	40° 17'28.10"E	1644	21.9±3.1	5.4±0.5	274.2±53.5
S8	Arıcılar Hamlet 4	39° 03'21.77"N	40° 17'28.18"E	1641	17.7±5.7	5.5±0.4	381.7±151.4
S9	Arıcılar Hamlet 5	39° 03'35.22"N	40° 17'21.75"E	1652	23.5±0.0	5.3±0.0	338.0±0.0
S10	Göynük stream	38° 58'26.41"N	40° 40'36.85"E	1131	-	-	-
S11	Yamaç	38° 47'36.07"N	40° 26'12.71"E	1669	-	-	-
S12	Garip	38° 46'38.86"N	40° 33'35.80"E	997	-	-	-
S13	Soğukçeşme	39° 03'20.50"N	40° 47'52.32"E	1499	21.1±0.0	5.1±0.0	273.0±0.0

WT: Water temperature, EC: Electrical conductivity

species belonging to 6 genera in 4 families were recorded. Identified species are *Hirudo verbana* (Carena, 1820) from Hirudinidae, *Glossiphonia complanata* (L. 1758), *Theromyzon tessulatum* (Müller, 1774), *Placobdella costata* (Müller, 1846) from Glossiphonidae, *Erpobdella octoculata* (L. 1758), *Erpobdella testacea* (Savigny, 1822) from Erpobdellidae, and *Piscicola geometra* (L., 1761) from the family Piscicolidae (Table 2).

H. verbana was found in 10 stations (minimum: 8 ind., maximum: 95 ind., mean: 33.8±25.5 ind.), and Adaklı-Karaçubuk (S1) is the richest among these localities in terms of the number of individuals belonging to *H. verbana* with a total of 95 individuals. In terms of biodiversity, Çobantaşı (S3) and Arıcılar Hamlet 1 (S5) are the richest, because 7 different leech species were recorded together in these locations. The station with the highest leech population is Çobantaşı (S3) with a total of 119 individuals. The poorest localities in terms of biodiversity are the 9th, 10th, 11th, 12th and 13th localities where only one species is found. The species identified in the study areas are given in Table 2 according to their localities.

The most common species was *H. verbana* collected from 10 locations and then *E. octoculata* from 7 stations. *E. testacea* and *P. costata* collected from 4 stations, *T. tessulatum* from 3 stations, *G. complanata* from 2 stations, *P. geometra* from 1 station, respectively. In addition, seven of the eight recorded leech species were found in Çobantaşı (S3) and Arıcılar Hamlet 1 (S5) stations, because these ponds never dried up and so these stations were visited regularly.

In the summer of 2018, one of the two small ponds in Alatepe Village was filled with soil by the landowner, and no sampling could be made from here after July, and this leech habitat was also completely destroyed. In Karaçubuk Pond, it has been observed that the leech fauna can survive with the small amount of water remaining in the deepest area of the lake towards the end of August every year.

Spearman's rho correlation analysis was performed to test the direction and strength of the relationship between water quality values and the detected species. According to this, it was observed that there was a positive and strong correlation between pH values and biological diversity ($r=0.758$, $p<0.05$), a positive and strong correlation between water temperature and the total number of leeches ($r=0.673$, $p<0.05$). In other words, it has been observed that as the pH value increases, the biological diversity increases, and as the water temperature increases, the amount of leech collected increases.

Furthermore, it was found to be a positive and strong relationship between *H. verbana* ($r=0.721$, $p<0.05$), *E. octoculata* ($r=0.857$, $p<0.05$), biodiversity ($r=0.879$, $p<0.01$) and total leech count. In other words, as *H. verbana*, *E. octoculata* and biodiversity in the station increase, the total number of leeches increases as expected (Table 2).

Table 2. Leech species for stations

Species/stations	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	Total
H. verbana	95	18	39	35	17	40	49	27	8		10			338
G. complanata			40		23									63
T. tessulatum	1		6		1									8
P. costata			14		9							1	1	25
E. octoculata	12	2	17	8	21	11	10							81
E. testacea		1	3		1			4						9
P. geometra										1				1
Total	108	21	119	43	72	51	59	31	8	1	10	1	1	525

DISCUSSION

There are many studies on Turkish freshwater leeches and the studies with similar results with the species obtained in our study are listed in the table below (Table 3).

Until recently, *H. verbana* was known as a variation of *H. medicinalis* belonging to the same genus *Hirudo*, which had different colors and patterns. These two *Hirudo* species have been confused with each other for years, but in recent years, detailed studies have

Table 3. Similar studies on leeches from freshwaters in Turkiye

Author	Location	Results
Geldiay and Tareen (13)	Gölcük Lake	*H. stagnalis, P. geometra, H. medicinalis, E. octoculata* and *E. testacea*
Sağlam (14)	Elazığ	*P. geometra, Actinobdella* sp.
Ustaoğlu et al. (15)	Izmir Tahtali Dam Basin	*H. costata, H. marginata, H. stagnalis, G. complanata, H. sanguisuga* and *E. octoculata*
Balık et al. (16)	North Aegean	*H. stagnalis* and *E. octoculata*
Neubert and Nesemann (11)	Turkiye, Anatolia	*G. nebulosa, P. costata, B. euxina, A. heteroclita, C. respirans, P. geometra, H. sanguisuga, H. verbana, L. paluda, E. octoculata, T. vigni, Trocheta* sp., *D. lineata lineata, D. lineata concolor, D. stschegolewi*
Sağlam (17)	Discharge channels in Elazığ	*P. costata*
Ustaoğlu et al. (18)	Gediz Basin	*H. stagnalis, G. complanata, H. medicinalis, H. sanguisuga, D. lineata, E. octoculata*
Balık et al. (19)	Bozalan Lake (İzmir)	*H. verbana, D. lineata*
Özbek and Sarı (20)	West Blacksea (Thirteen lakes)	*G. complanata, P. costata, H. marginata, H. stagnalis, T. tessulatum, H. medicinalis, H. verbana, E. octoculata, D. lineata*
Özbek et al. (21)	Western Taurus Mountains	*D. lineata, E. octoculata, T. bykowskii, G. complanata, H. stagnalis, T. tessulatum, H. medicinalis*
Odabaşı et al. (22)	Biga Peninsula	*H. medicinalis, D. lineata, P. costata, E. octoculata, G. complanata, H. stagnalis* and *P. geometra*
Arslan and Emiroğlu (23)	Lake Uluabat	*P. geometra*
Ceylan et al. (24)	Lake Uluabat	*P. geometra*
Koyun (25)	Murat River (Bingöl)	*P. geometra*
Sağlam (26)	Samsun (Nine Lakes)	*H. verbana, H. medicinalis*
Arslan and Öktener (27)	Turkiye (Checklist)	*P. geometra*/13 different species of freshwater fish in Turkiye
Ceylan et al. (28)	Experimental	The reproduction of the medicinal leech *H. verbana*
Kazancı et al. (29)	Yedigöller, Yeşilırmak, Büyük Menderes, Karadut, Karamuk	*H. stagnalis, E. octoculata, E. testacea, E. vilnensis, H. sanguisuga, H. verbena, D. stschegolewi, L. nilotic*a
Koyun et al. (30)	Dumlu and Göynük Stream	*P. geometra*
Saglam et al. (31)	Elazığ, Bursa, Samsun, Adıyaman, Gaziantep and Batman	*H. verbena, H. sulukii*/new species
Ceylan and Çetinkaya (32)	Lake Eğirdir	Ecology and population size of *H. verbana*
Özkan (33)	Tunca River	Colonization of *E. octoculata*
Saglam et al. (34)	Akpinar Marsh, Eastern Anatolia	Effect of Water Quality on *H. verbana*
Kaçmaz (35)	Edirne	*H. sanguisuga, H. verbana, L. nilotica, E. octoculata, Erpobdella* sp. *P. costata*
Saglam et al. (36)	Balıkesir	Detailed ultrastructure of the *H. verbana* salivary gland
Uğural and Serezli (37)	Lake Yay	Breeding patterns of *H. verbana*
Ayhan et al. (38)	Güdül, Ankara	Morphology of *H. verbana*
Ceylan and Çetinkaya (39)	Lake Eğirdir	Size and structure of *H. verbana* populations
Ceylan et al. (40)	Lake Eğirdir	*H. verbana, H. sanguisuga, T. tessulatum, P. costata, H. stagnalis, H. marginata, E. octoculata* and *Trocheta* sp.
Elaltunkara et al. 2022	Bingöl (Present study)	*H. verbana, G. complanata, T. tessulatum, P. costata, E. octoculata, E. testacea, P. geometra*

shown that *H. verbana* is not different variation of *H. medicinalis* on the contrary it is a completely different species (31,41,42).

H. verbana is distributed in the Balkans, Greece, Bulgaria, Hungary, Austria, and Eastern Mediterranean Countries (11,43). It has been reported in different studies that *H. verbana* is found in different aquatic habitats in the North, West and Northwest of Anatolia such as Kızılırmak and Yeşilırmak Basin, Işıklı Lake (Denizli), Karamuk Marsh Lake (29), Eğirdir Lake (39), Bozalan Lake (İzmir) (19), Poyrazlar (Sakarya) (20), Çernek, Gıcı, Tatlı, Balık, Uzungöl, Ladik Lakes (Samsun) and Uzun Lake (Trabzon) (26,34) (Table 3).

It is seen that *H. verbana* can adapt to different water sources and has a wide ecological tolerance (11,44). It is reported that *H. verbana* can live on land as well as in water if there is sufficient moisture to don't dry out (41). The incidence of *H. verbana* in 10 of the 13 study areas is consistent with the data on its prevalence and density.

G. complanata is relatively common in much of Europe and parts of Eurasia, and as part of a historical misunderstanding, North America. This species is one of the most common leeches in freshwater and is usually rarely found on a muddy substrate and mainly on stones and macrophytes (45).

The distribution of *T. tessellatum* in the world is not clear, but it is reported as the Holoarctic region. It has been reported that *T. tessulatum* is found in stagnant wet areas on the migration routes of birds, especially attaches to wild ducks and geese, and it sucks blood from the cheek and nasal mucous membranes of these birds (8,11). In this way, it is reported that *T. tessulatum* is transported between water sources by means of water birds (7,8). Due to the lack of studies on the ecological characteristics of *T. tessulatum*, it is thought that some physico-chemical parameters measured in the field will partially help to overcome this deficiency.

P. costata is a common species in the Mediterranean, and is thought to be a vector of haemogregarine blood parasites in turtles. An ectoparasitic association with the turtle species was also noted in Tunisia, Algeria, Morocco, Iran, Spain (2).

Erpobdellid leeches are known as macrophagotic predators of aquatic invertebrates. *E. octoculata* is one of the most common leech species in fresh waters, and it is known as stone leech, which usually lives under stones in slow-flowing lotic habitats (8).

Most of the parasitic annelid species are associated with freshwater fish (53%). The remainder is associated with marine fish (39%), brackish water fish (4%) and aquarium fish (4%) (27). *P. geometra* is a member of the Piscicolidae and lives as an ectoparasite on freshwater fish. While it feeds by sucking the blood of its host, it is mostly seen in and around the gills where the skin is thin, at the bottom of the fins and around the mouth. It can be found solitarily under stones in the water floor and freely on aquatic macrophytes (46).

Almost all of the leech species need similar ecological conditions. Leeches living as ectoparasites prefer places where aquatic plants are abundant in the environment so that they can approach the host where they can feed unbeknownst. Places where aquatic plants are dense allow leeches to both hide and easily reach their hosts. Considering the physical conditions of the stations in the study, the summer pH average of Çobantaşı (S3) and Arıcılar Hamlet-1 (S5) locations, which have the highest number of species, was measured as 9.6±3.1 for Çobantaşı and 9.0±3.2 for Arıcılar Hamlet-1. Especially in Çobantaşı wetland, the continuous feeding of the pond with a source ensures that the water quality remains constant, and as it can be understood from these values, the water quality of the study area shows usable characteristics. It has been observed that the small pond in "Arıcılar Hamlet-1" is fed from the bottom, even a little. Because of both stations are fed from the source shows that the water is good in terms of both temperature and oxygen. The fact that almost all the leech species recorded in the study were found in these two stations proves that leech biodiversity is related to water quality.

While the water level was sufficient in the spring in all the locations where the sampling was taken, the wetland areas became muddy after the middle of summer, especially at Karaçubuk and Alatepe stations between May and July. It has been observed that these ponds increase with the snow waters coming from the mountains in the spring, but later on, the branches flowing into these lakes dry up. The preference of these ponds for agricultural irrigation, their use for water needs of animals, and excessive evaporation cause the water in the wetland to decrease earlier or partially dry out.

Most leech species appear most abundant at pH 7.0 because pH values in the 6.0-7.0 range likely have abundant prey. It will therefore have an indirect effect on the formation and abundance of leeches. Some species have been found at pH values as low as 4.0. In a study conducted at University of Port Harcourt, Abuja (Nigeria), *H. costata*, *H. sanguisuaga*, *H. medicinalis* and *E. octoculata* species were reported in fresh water with pH 4.40-4.58 (47). Like our study, it has been reported that *Hirudo* and *Erpobdella* species can survive even at very low pH levels.

Although leeches cannot be considered as the only parameter in water quality studies due to their wide ecological tolerance, it is seen that Hirudinea members are used in water quality evaluations (48). Thanks to these data, it can be said that the water resources in the locations where *H. verbana* was recorded are usable in terms of water quality parameters.

CONCLUSION

It was aimed to detect leech species in a total of 13 locations within the borders of the province of Bingöl, which is located in the Eastern Anatolia Region. The detected leech species are the first record for the given locations.

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*Ethics

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***Authorship Contributions**

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REFERENCES

1. Moser WE, Govedich FR, Klemm D. Annelida, Euhirudinea (leeches). In: Encyclopedia of Inland Waters. Oxford, UK : G.E. Likens, editor. Elsevier Ltd. 2009.p.116-23.
2. Laghzaoui EM, Abbad A, El Mouden E. Host-parasite association of Placobdella costata (Glossiphoniidae: Hirudinea) and Mauremys leprosa (Geoemydidae: Testudinoidea) in aquatic ecosystems of Morocco. Parasitol Res 2020; 119: 3459-67.
3. Sket B, and Trontelj P. Global diversity of leeches (Hirudinea) in freshwater. In: Balian EV, Lévêque C, Segers H, Martens K, editors. Freshwater Animal Diversity Assessment. Developments in Hydrobiology; Springer: Dordrecht; 2007.
4. Sağlam N. Sülük biyolojisi ve yetiştirme teknikleri. Ticari Balık Türlerinin Biyolojisi ve Yetiştirme Teknikleri Hizmet İçi Eğitim Semineri. Ankara: Tarım ve Köy işleri Bakanlığı, Tarımsal Üretim ve Geliştirme Genel Müdürlüğü, Su Ürünleri Daire Başkanlığı 2000.p.51-6.
5. Wells S, Coombes W. The status of and trade in the medicinal leech. Traffic Bull 1987; 8: 64-9.
6. Kasparek M. Zum Handel und Populationsstatus des Medizinischen Blutegels (Hirudo medicinalis) in der Türkei. Germany : Unpubl. Report to Bundesamt für Naturschutz (German Scientific CITES Authority), 1994.
7. Sawyer RT. North American freshwater leeches, exclusive of the Piscicolidae, with a key to all species 46. Urbana: University of Illinois Press; 1972.
8. Elliott JM, Mann KH. A key to the British freshwater leeches with notes on their life cycles and ecology. Cumbria : Hyperion Books, Freshwater Biol. Assoc. Sci. Publ 1979; 40: 1-72.
9. Sládeček V, Košel V. Indicator value of freshwater leeches (Hirudinea) with a key to the determination of European Species. 5, s.l. : Acta Hydrochimica et Hydrobiologica 1984; 12: 451-61.
10. Davies RW. Annelida: Leeches, Polychaetes and Acanthobdellids. In: Ecology and Classification of North American Freshwater Invertabrates (Thorp JH, AP Covich AP, editors). New York: Academic Press; 1991.p.437-79.
11. Neubert E, Nesemann H. Annelida, Clitellata: Branchiobdellida, Acanthobdellea, Hirudinea. Berlin : 6/2.Spektrum Akademischer Verlag 1999.p.176.
12. Sağlam N. Tatlı su ve deniz sülükleri teşhis anahtarı. Elazığ: Fırat Üniversitesi Su Ürünleri Fakültesi, Fırat Üniversitesi Basım Evi; 2004.
13. Geldiay R, Tareen IU. Bottom fauna of Gölcük Lake. 1. Population Study of Chironomids, Chaoborusand Oligochaeta. İzmir : E.Ü.F.F. İlmi Raporlar Serisi 1972; 137: 15.
14. Sağlam N. Investigation of external parasites on fish caught in Lake Keban. Elazığ: Fırat University 1992.p.50.
15. Ustaoğlu MR, Balık S, Sarı HM, Özbek M. Tahtalı Baraj havzasının (Gümüldür-İzmir) Hirudinea faunası. E.Ü. Su Ürünleri Dergisi 1998; 15: 111-6.
16. Balık S, Ustaoğlu MR, Sarı HM. Kuzey Ege Bölgesi'ndeki akarsuların faunası üzerine ilk gözlemler. E.Ü. Su Ürünleri Dergisi 1999; 16: 289-99.
17. Sağlam N. First record of the leech *Placobdella costata* (Hirudinoidea: Glossiphonidae) in Turkey. Zoology in the Middle East 2001; 23: 113-8.
18. Ustaoglu MR, Balık S, Özbek M, Sarı HM. The freshwater leeches (Annelida-Hirudinea) of the Gediz catchment area (Izmir region). Zoology in the Middle East 2003; 29: 118-20.
19. Balık S, Ustaoğlu MR, Sarı HM, Özdemir Mis D, Aygen C, Taşdemir A, ve ark. Bozalan Gölü'nün (Menemen-İzmir) biyolojik çeşitliliği hakkında bir ön araştırma. E.Ü. Su Ürünleri Dergisi 2006; 23: 291-4.
20. Özbek M, Sarı HM. Batı Karadeniz Bölgesi'ndeki bazı göllerin Hirudinea (Annelida) faunası. E.Ü. Su Ürünleri Dergisi 2007; 1-2: 83-8.
21. Özbek M, Balık S, Ustaoğlu MR. Batı Toros Dağları Üzerindeki Göllerin Hirudinea (Annelida) Faunası. E.Ü. Su Ürünleri Dergisi 2008; 25: 315-7.
22. Odabaşı DA, Sağır Odabaşı S, Akbulut M, Aşcıbaşı P, Bayrak GS, BAL D, Uluhan T. Biga Yarımadası Akarsularındaki Sülük Faunası (Hirudinea-Annelida) ve Dağılımı. Çanakkale : X. Ulusal Ekoloji ve Çevre Kongresi 2011.p.297.
23. Arslan N, Emiroğlu Ö. First record of parasitic annelida-hirudinea (*Piscicola geometra* Linnaeus, 1761) on *Carassius gibelio* (Bloch, 1782) in Lake Uluabat (Turkey). Kafkas Univ Vet Fak Derg 2011; 17: 131-3.
24. Ceylan M, Boyaci YÖ, Meke T, Inceoglu H, Kara A. A report of ectoparasite *Piscicola geometra* (Linnaeus, 1761)(Hirudinea: Rhynchobdellida) on roach (*Rutilus rutilus* (Linnaeus, 1758)) from Uluabat Lake. Turkiye Parazitol Derg 2011; 35: 207-9.
25. Koyun M. First report of Tracheliastes polycolpus (Copepoda: Lernaeopodidae) and Piscicola geometra L. 1761 (Annelida-Hirudinea) on Capoeta umbla at Murat River, Turkey. Asian J Anim Vet Adv 2011; 6: 966-70.
26. Sağlam N. Bazı tıbbi sülüklerin (Hirudo Medicinalis L., 1758 ve Hirudo Verbana Carena, 1820) ihracatı, korunması ve sürdürülebilirliği. Journal of Fisheries Sciences.com 2011; 5: 1-15.
27. Arslan N, Öktener A. A general review of parasitic Annelida (Hirudinea) recorded from different habitats and hosts in Turkey. Turk J Zool 2012; 36: 141-5.
28. Ceylan M, Çetinkaya O, Küçükkara R, Akçimen U. Reproduction efficiency of the medicinal leech Hirudo verbana Carena, 1820. Turkish Journal of Fisheries and Aquatic Sciences 2015; 15: 411-8.
29. Kazancı N, Ekingen P, Dügel M, Türkmen G. Hirudinea (Annelida) species and their ecological preferences in some running waters and lakes. Int. J. Environ. Sci. Technol 2015; 12: 1087-96.
30. Koyun M, Tepe Y, Mart A. First record of Piscicola geometra (Annelida, Hirudinea) on some species of Cyprinidae from Euphrates-Tigris basin in Turkey. Journal of Fisheries and Aquatic Science 2015; 10: 575-80.
31. Saglam N, Saunders R, Lang SA, Shain DH. A new species of Hirudo (Annelida: Hirudinidae): Historical Biogeography of Eurasian Medicinal Leeches. BMC Zoology 2016; 1.
32. Ceylan M, Çetinkaya O. Investigation on the Collection and Economy of Medicinal Leeches from Wetlands Around Lake Eğirdir, Turkey. Turkiye Parazitol Derg 2017; 41: 96-101.
33. Özkan N. Colonization of fresh water leech Erpobdella octoculata Linnaeus, 1758 (Annelida: Hirudinida) in different habitats in Tunca River, Edirne. Fresenius Environmental Bulletin 2018; 27: 4743-50.
34. Saglam N, Özbay Ö, Demir T, Balcı M, Pala A, Kılıç A. Effect of Water Quality on Monthly Density Variation of the Endangered Southern Medicinal Leech Hirudo verbana Carena, 1820 (Hirudinea: Arhynchobdellida: Hirudinidae). Acta Zoological Bulgarica 2018; 70: 433-41.
35. Kaçmaz D. Investigation of Hirudinea (Annelida) Fauna of inland waters in Edirne Province. Edirne : Trakya University Institute of Natural Sciences 2020.p.100. Available from: URL: https://acikbilim.yok.gov.tr/handle/20.500.12812/407665
36. Saglam N, Saunders R, Shain DH, Saidel WM. Detailed ultrastructure of the *Hirudo* (Annelida: Hirudinea) salivary gland. Micron 2020; 136: 102887.
37. Uğural B, Serezli R. Effects of various environments on number of cocoon and offspring in breeding of southern medicinal leech, *Hirudo verbana* Carena, 1820. Ege Journal of Fisheries and Aquatic Sciences 2020; 37: 207-11.

38. Ayhan H, Özyurt Koçakoğlu N, Candan S. Functional morphology of the suckers and teeth of the medicinal leech *Hirudo verbana* Carena, 1820 (Annelida; Clitellata; Hirudinida): A scanning electron microscope study. Microscopy Research and Technique 2021; 84: 2930-5.

39. Ceylan M, Çetinkaya O. Size and structure of the Mediterranean medicinal leech, *Hirudo verbana* populations inhabiting wetlands around Lake Eğirdir, Turkey. Ege Journal of Fisheries and Aquatic Sciences 2021; 38: 437-47.

40. Ceylan M, Çetinkaya O, Kvist S. Function of the waterfowl nests as reproduction and living areas for leeches (Annelida: Hirudinea). Animal Reproduction Science 2021; 232: 106816.

41. Kutschera U, Elliott JM. The European medicinal leech Hirudo medicinalis L.: Morphology and occurrence of an endangered species. Zoosystematics and Evolution 2014; 91: 271-80.

42. Siddall ME, Trontelj P, Utevsky SY, Nkamany M, Macdonald III KS. Diverse molecular data demonstrate that commercially available medicinal leeches are not Hirudo medicinalis. Proceedings of the Royal Society B: Biological Sciences 2007; 274: 1481.

43. Todorov M, Grozeva S, Hubenov Z, Kenderov L, Trichkova T. Taxonomic status and distribution of medicinal leeches of the genus *Hirudo* L. (Hirudinea) in Bulgaria. Acta zool bulg 2016; 68: 171-82.

44. Utevsky S, Zagmajster M, Atemasov A, Zinenko O, Utevska O, Utevsky A, et al. Distribution and status of medicinal leeches (genus Hirudo) in the Western Palaearctic: anthropogenic, ecological, or historical effects? Aquatic Conservation: Marine and Freshwater Ecosystems 2010; 20: 198-210.

45. Mack J, Kvist S. Improved geographic sampling provides further evidence for the separation of *Glossiphonia complanata* and *Glossiphonia elegans* (Annelida: Clitellata: Glossiphoniidae). Journal of Natural History 2019; 53: 335-50. https://doi.org/10.1080/00222933.2019.1590658

46. Demirtaş M, Şenel Ü. Terkos Gölü'ndeki bazı balıklarda (cyprinidae) *Piscicola geometra* L., 1761 enfestasyonun mevsimsel dağılımı. KSÜ Doğa Bil Derg 2012; 15: 52-8.

47. Woke GN, Eze NC. Effect of physico-chemical parameters of water containing leech in University of Port Harcourt community Abuja, Port Harcourt. Global Journal of Pure and Applied Sciences 2014; 20: 135-8.

48. Koperski O. Testing the suitability of leeches (Hirudinea, Clitellata) for biological assessment of lowland streams. 1, s.l. Polish Journal of Ecology 2005; 53: 65-80.