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Freshwater Malacofauna and Distribution of Trabzon, Türkiye

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ABSTRACT
In this study, freshwater molluscs and their zoogeographical distributions in Trabzon were investigated. During the period of June-December 2021, samples were collected from 38 freshwater river localities. From the study area, *Ancylus fluviatilis* from Gastropoda class, Planorbidae family, non-native species *Physella acuta* from Physidae family, and *Dreissena polymorpha* from Bivalvia class and Dreissenidae family were identified. While *A. fluviatilis* specimens were found from all freshwater systems in Trabzon region, the non native *P. acuta* could be identified from Fol Stream, Yıldızlı Stream, Sera Lake and Manahoz River. Empty shells belonging to the *D. polymorpha* species were identified from the area where Çatalzeytin Stream joins the sea. *P. acuta* and *D. polymorpha* are new records for the freshwater streams of Trabzon region.

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Anahtar Kelimeler
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Trabzon'un Tatlı Su Malakofaunası ve Dağılımı, Türkiye

ÖZET
Bu çalışmada, Trabzon yöresinde yer alan tatlısu mollusklarının zoocoğrafik dağılışları incelenmiştir. Örnekler, 38 akarsu lokalitesinden Haziran-Aralık 2021 döneminde toplanmıştır. Araştırma bölgesinden, Gastropoda sınıfı Planorbidae familyasından *Ancylus fluviatilis* ve Physidae familyasından yabancı tür *Physella acuta* ile Bivalvia sınıfı Dreissenidae familyasından *Dreissena polymorpha* türleri tespit edilmiştir. *A. fluviatilis* Trabzon bölgesindeki bütün akarsu sisteminde bulunurken, yabancı *P. acuta* türü ise Fol Deresi, Yıldızlı Deresi, Sera Gölü ve Manahoz Çayı'ndan tespit edilmiştir. *D. polymorpha* türüne ait boş kavkılar ise Çatalzeytin Deresi'nin denize karıştığı bölgede tespit edilmiştir. Söz konusu 3 yumuşakça türünden *P. acuta* ve *D. polymorpha* Trabzon bölgesindeki akarsular için yeni kayıttırlar.

Su Ürünleri

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Anahtar Kelimeler
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INTRODUCTION
Mollusca phylum is the richest phylum after Arthropods (Arthropoda) in terms of the number of individuals and is represented by an average of 135.000 species. It is known that about 35.000 species of the Mollusca phylum live in terrestrial, 6-7.000 species in freshwater, and 95.000 species in marine (Taylor & Lewis, 2005). However, it is estimated that the total number of mollusc species identified and waiting to be made so far is around 200.000 (Van Bruggen et al., 1995). Freshwater molluscs have become an important part of the ecosystem in aquatic environments, as they are the primary consumers of their habitats and a source of food for many living things in the food chain. They have high medicinal importance as they host many parasitic trematodes (Şeşen & Yıldırım, 1993; Demirsoy, 1999; De Mendoza et al., 2023). They live successfully in almost all aquatic habitats including streams, lakes, rivers, ponds, swamps and drainage channels in all continents except Antarctica (Strong et al., 2008). With their capacity to withstand difficult conditions, they stand out a little more among other animal branches. They live successfully in marine, terrestrial and freshwater biotopes. They withstand even the harshest climatic conditions, especially in terrestrial and freshwater environments. They have adapted to all kinds of environments, from deserts to Arctic Tundra from

temporary forest pools to steppes (Boss, 1974). Some species prefer oxygen-rich cold waters (Prosobranch), while others do not seek oxygen-rich waters (Pulmonate). Again, some Prosobranch species prefer cold waters (Cantrell, 1981; Aldridge, 1983; McMahon, 1983). These living groups, which have such different characteristics; it is important to determine the systematic and fauna information in order to reveal the medicinal, physiological, chemical and economic aspects. Considering the freshwater molluscs of Türkiye 164 species belonging to Gastropoda and 40 species belonging to Bivalvia were recorded as a result of the studies (Gürlek et al., 2019). Examining the studies carried out in the Eastern Black Sea Region, we determined that Trabzon and its surroundings were not surveyed in detail by means of freshwater malacofauna. While studies are carried out in the provinces of Sinop and Tokat, in the west of the Black Sea closest to Trabzon, there are also studies carried out in Samsun, Bolu, Zonguldak, and Çanakkale (Retowski, 1889; Croockewit, 1953; Boettger, 1957; Schütt & Şeşen, 1993; Bat et al., 2000; Öktener, 2004; Özbek et al., 2004; Duran, 2006; Duran & Suiçmez, 2007; Kazancı et al., 2008; Yardım et al., 2008; Akbulut et al., 2009; Gözler & Baytaşoğlu, 2020). In these studies, the existence of *Viviparus mamillatus*, *Ampullaceana balthica*, *Theodoxus fluviatilis, Belgrandiella cavernica*, *Planorbis planorbis, Planorbis corneus, Lymnaea stagnalis, Hydrobia ventrosa, Euglesa casertana*, *Euglesa milium*, *Unio pictorum, Sphaerium spp.*, *Viviparus acerosus*, *Bithynia tentaculta, Valvata cristata, Valvata piscinalis, Radix ovata, Radix auricularia, Radix peregra, Stagnicola palustris, Planorbis carinatus, Segmentina nitida, Gyraulus albus, P. acuta, Physa fontinalis, Anodonta cygnea and Dreissena polymorpha* species from different localities were mentioned.

The first research on freshwater molluscs in the Eastern Black Sea Region was carried out by Mousson (1876). The researcher reported the *Viviparus costae* species from Erzurum in his study. In the studies carried out in the region after this date, *Anisus spirorbis* and *Gyraulus ehrenbergi* species from Erzurum, *A. fluviatilis* species from Yanbolu and Falkoz streams of Trabzon Arsin district, *Radix sp.* from Giresun Keşap River, *Gyraulus elenae* from Rize Fındıklı Çağlayan River were defined in another study (Boettger, 1957; Kinzelbach, 1986; Girgin, 2010; Vinarski et al., 2013). Bolat (2012) made a large number of benthos sampling from stations close to the research area. He stated that there is only 1 Bivalvia from 1 station. This shows that the region needs to be studied in detail. These data, which are specified only as a class, show that the researchers did not work in the field of mollusc systematics and that field studies were not carried out according to malacological sampling techniques at these stations and that the region should be studied in detail. Ustaoğlu (2009) reported the presence of *Pisidium casertanum, Pisidium cf. obtusale, Pisidium cf. pseudosphaerium, Radix peregra, Radix auricularia* and *A. fluviatilis* in high-altitude lakes in the Eastern Black Sea mountains.

Trabzon region is also very rich in freshwater resources. The value of water is increasing day by day, so it is easier to create awareness of the importance and awareness of water and apply protection measures, by revealing the creatures living in it. Therefore, determining the current habitats and habitat characteristics of aquatic molluscs in the region is important in terms of developing conservation strategies with future studies.

MATERIAL and METHOD

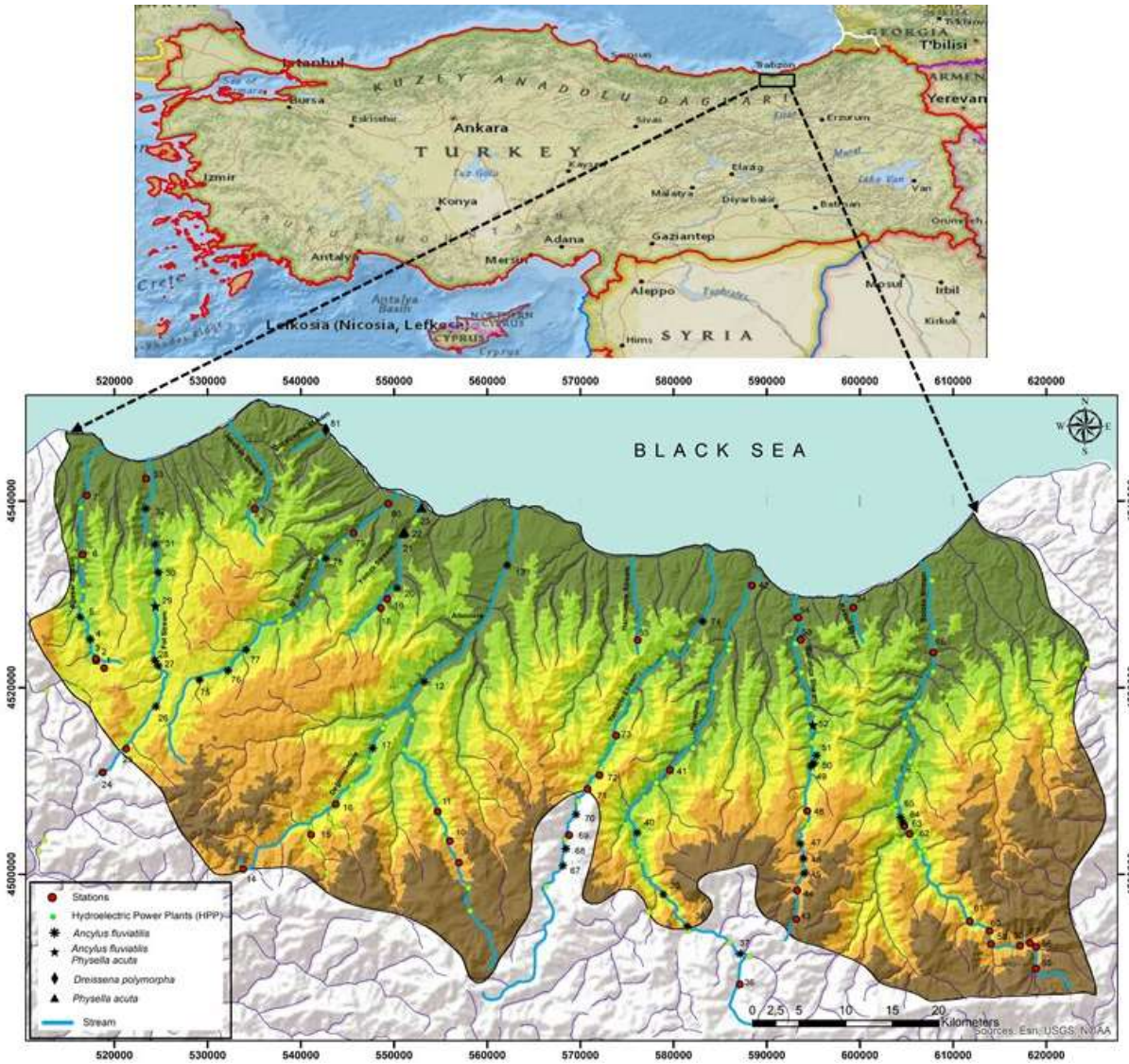
This study was carried out in 81 stations, including streams, and Sera Lake, between June 2021 and December 2021 in order to determine the freshwater mollusc fauna of the Trabzon (Figure 1).

Trabzon province is within the borders of the Eastern Black Sea region of the Black Sea region. It is surrounded by Giresun in the west, Gümüşhane and Bayburt in the south, and Rize in the east. The rivers, which take their sources from the mountains in the south of Trabzon, reach the Black Sea by deeply cutting the mountains and plateaus in the north. As Öztürk & Dengiz (2020) stated, rivers are fast-flowing due to high bed slopes (>50 %, Figure 2).

Most of the lands in the south of Trabzon province have a mountainous topography. On the other hand, the northern parts are slightly sloping or relatively flat. The aforementioned province of Trabzon has the Black Sea climate and the climate is mostly cool summers and mild winters except for the mountainous areas. All seasons, especially winter, are rainy (Öztürk & Dengiz, 2020). The altitude ranges from 0 to 3366 m above sea level (Figure 3).

As Öztürk & Dengiz (2020) stated, Trabzon province has a wide range of soils including alluvial soils, non-calcareous brown forest, brown forest soils, gray-brown and yellow-reddish podzolic soils, high mountain pasture soils, colluvial soils. The geological features of the study area mostly consist of igneous rocks including granitic and volcanic rocks. Some areas contain sedimentary materials such as alluvium, claystone, granite rock, lime-claystone and sand mudstone (Figure 4).

Descriptive geographic maps showing features such as elevation, slope and bedrock in the research area were produce using DEM raster data. In addition, the altitudes and coordinates of the sampling stations in the research area were determined in the field, and the maps were made using in the ArcGIS 10.5 program.



(●:Stations, ●:Hydroelectric Power Plants (HPP), **A. fluviatilis*, ♦:*D. polymorpha* ▲: *P. acuta*).
(●:İstasyon, ●:HES, *: *A. fluviatilis*, ♦:*D. polymorpha* ▲: *P. acuta*).

Figure 1. Map of the study area, sampling stations and identified species
Şekil 1. Çalışma alanı, istasyonlar ve tespit edilen türlerin haritası

The living snails were collected by 65x65 cm in size (200 µm mesh size) aquatic hand-scoop (kick-net) and sieve. In springs samples were collected on stones and aquatic plants by hand. The mollusc samples in question were taken into containers containing 96 % ethyl alcohol and the necessary notes were written on them. Later, they were brought to Karadeniz Technical University, Department of Biology, Hydrobiology Research Laboratory. The samples were identified according to Bilgin (1980), Şeşen (1997), Yıldırım et al. (2006) and Glöer (2002).

RESULT and DISCUSSION

In this study, which was carried out in the river basins of the Trabzon region, sampling was carried out in 81 localities and the presence of mollusc samples were determined in 38 localities.

The geographical locations of the research area and the identified species are given in Table 1. Ustaoğlu (2009) examined the high-altitude lakes in the Eastern Black sea mountains limnologically and reported the existence of *Pisidium casertanum*, *Radix peregra*, *Radix auricularia* and *A. fluviatilis*. In this study, except for *A. fluviatilis*, other species could not be determined. *P. acuta* and *D. polymorpha*, an invasive species in brackish and freshwaters, were recorded for the first time in Trabzon, except for *A. fluviatilis*, which is commonly found in stream localities throughout the province of Trabzon.

Ancylus fluviatilis, which is generally distributed in streams with, hard substrate. It is one of the characteristic mollusc of such kind of biotopes. They

show a wide distribution throughout Europe, the Caucasus and Türkiye (Glöer & MeierBrook, 1998; Yıldırım et al., 2006; Welter-Schultes, 2012). The shell of *A. fluviatilis* is in the shape of a Chinese hat and has a round oval structure with regular radial lines on its surface. The apex is vestigial and covers 3/4 of the lateral line of the crust and is slightly curved to the right. The size, shape, and condition of the apex may vary. It has been determined that there is variation between stations in terms of size and apex height in the research area and this issue has not been investigated in detail.

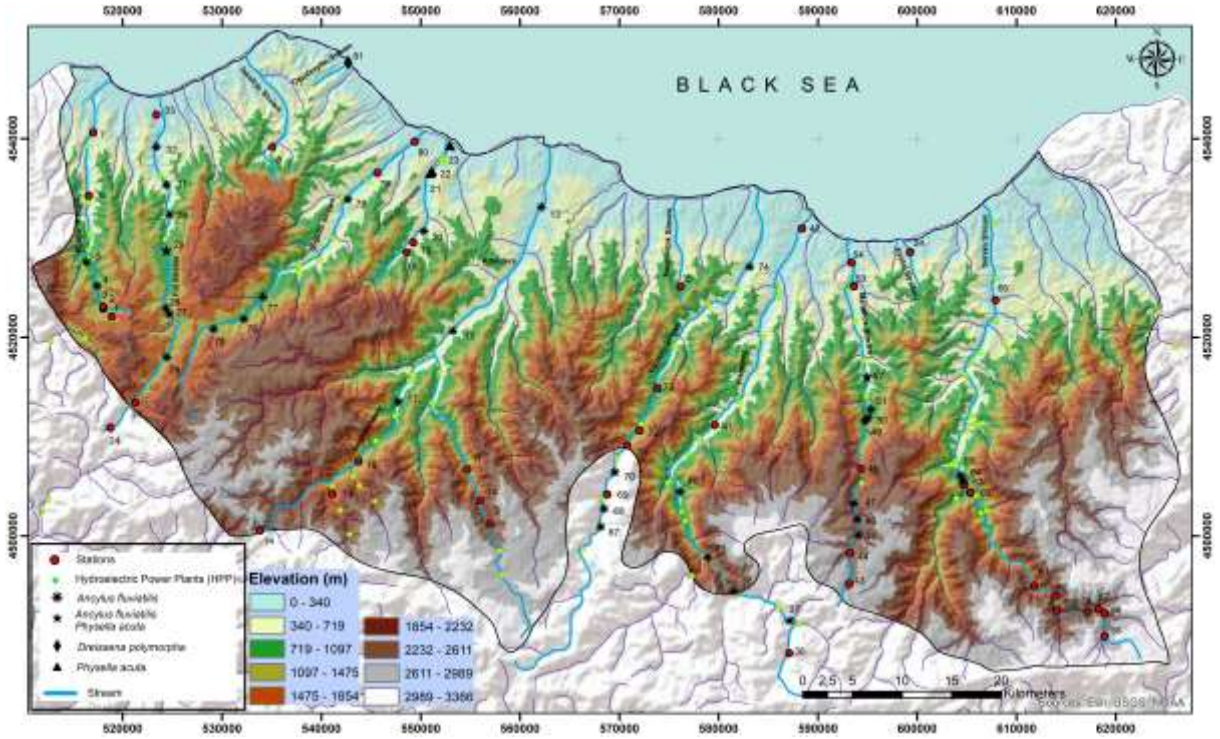


Figure 2. Slope map of the study area (slope %).
Şekil 2. Çalışma alanının eğim grupları haritası (% eğim)

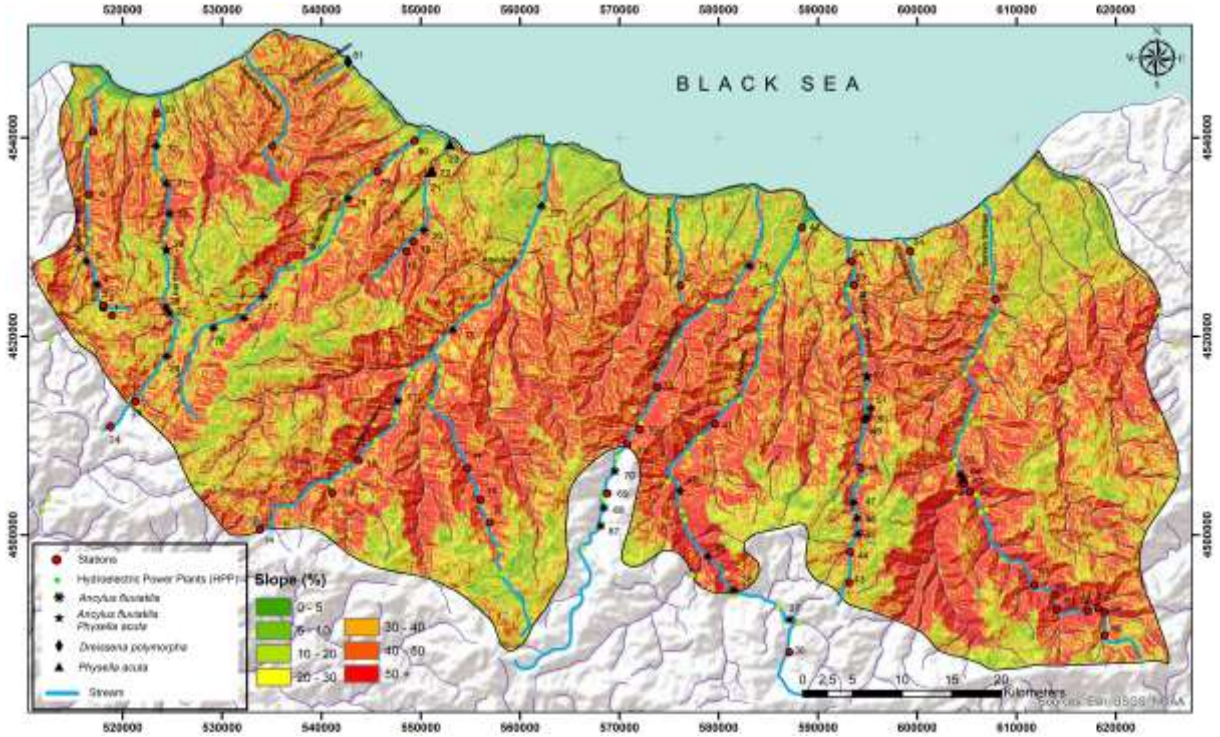


Figure 3. Elevation map of the research area (m).
Şekil 3. Çalışma alanının yükselti grupları haritası

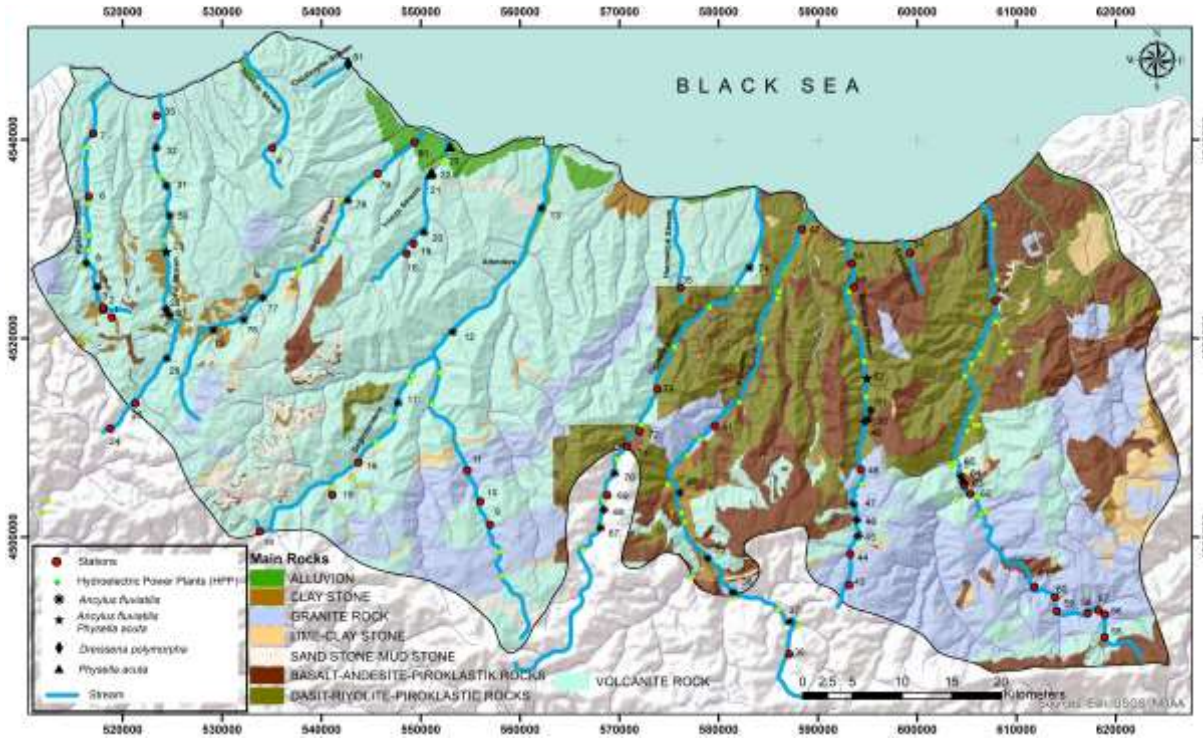


Figure 4. Main rock groups map of the study area.
Şekil 4. Çalışma alanının anakaya grupları haritası.

The presence of *A. fluviatilis* individuals was determined in all creeks and streams in the study area, except İskefiye Creek, Harmancık Creek and Kastel Creek, which are small creeks. However, it was determined that *A. fluviatilis* showed limited distribution in Ağasar Stream, Altındere Valley, Değirmendere, Solaklı Stream and Yıldızlı Creek. Apart from these, it was determined that *A. fluviatilis* individuals were found more widely distributed in Fol Stream, Karadere, Manahoz Stream, Yanbolu Stream and Söğütlü Stream. In addition, *A. fluviatilis* and *P. acuta* individuals were detected from in the same habitats in the Fol Stream (Station 29, altitude: 634 m) and Manahoz Stream (Station 52, altitude: 391 m; Figure 1, Table 1).

Ancylus fluviatilis found in the stream basins of the Trabzon region exhibits an exceptional situation for the Planorbidae family to which it belongs. Although this species is abundant in the middle parts of the streams and relatively rarely seen in the lower parts, it has not been detected from the source parts of any stream and from the habitats close to the sea (Figure 1). A few individuals of *A. fluviatilis* has also been detected from low-altitude habitats. It is estimated that the pollutants of *A. fluviatilis*, which occur in the environment as a result of human activity, limit the population of the species. However, it is a remarkable finding that the species was also detected in the stations where destruction was exposed. Like Değirmendere 14 stations (Figure 1).

Physella acuta from the Physidae family was detected for the first time in the study area. *P. acuta* has been detected in low-altitude localities where the water is relatively calm. In the research area, Yıldızlı Creek 6th station (altitude: 10 m), Sera Lake littoral zone (altitude: 89-100 m), Fol Stream, 29th station around Tonya Wastewater Treatment Plant (altitude: 634 m) and Manahoz Stream. It was determined from the 52'nd station of the Stream Manahoz (altitude: 391 m). *P. acuta* specimens were generally collected by hand from the stones on the stream banks (Table 1).

Physella acuta is a thermophilic species with high adaptability to modified environments such as irrigation channels (Şeşen, 1997). The presence of this species in the research area can be associated with the recent increase in breeding activities. The intermittent distribution of the species, which was not recorded in the research area before, in natural and modified habitats supports this claim. It was determined that *P. acuta* species formed densely populated in the habitats from the area where Fol Stream, Manahoz Stream, Yıldızlı Creek joins the sea to Sera Lake, and its presence could not be detected in the other streams. It is not known exactly how and when the passive distribution of the species, which is known to expand its distribution through human activities such as aquarium trade (Ng et al., 2015), is realized in Türkiye and Trabzon province. However, according to the distribution information in the field, although the previous faunistic information is weak, there is a possibility of population formation in the research area in the near future.

Table 1. Sampling localities and identified species in the study area.
Çizelge 1. Örnekleme alanları konumları ve tespit edilen türler.

Station	X	Y	Altitude (m)	Location	Species
1	518917	4522091	1065	Ağasar Stream	
2	518044	4522887	896	Ağasar Stream	
3	518029	4523089	875	Ağasar Stream	
4	517427	4525177	767	Ağasar Stream	*A. fluviatilis*
5	516335	4527531	624	Ağasar Stream	*A. fluviatilis*
6	516593	4534245	267	Ağasar Stream	
7	517031	4540582	90	Ağasar Stream	
8	535082	4539130	289	İskefiye Creek	
9	556978	4501234	1589	Altındere	
10	556015	4503565	1340	Altındere	
11	554717	4506703	917	Altındere	
12	553246	4520631	260	Altındere	*A. fluviatilis*
13	562169	4533099	59	Altındere	*A. fluviatilis*
14	533830	4500535	1824	Değirmendere	
15	541119	4504245	1105	Değirmendere	
16	543756	4507496	864	Değirmendere	
17	547752	4513485	466	Değirmendere	*A.fluviatilis*
18	548600	4528524	397	Yıldızlı Creek	
19	549271	4529512	303	Yıldızlı Creek	
20	550352	4530663	275	Yıldızlı Creek	*A. fluviatilis*
21	550952	4536527	100	Sera Lake	*P. acuta*
22	551135	4536719	89	Sera Lake	*P. acuta*
23	552963	4539305	10	Yıldızlı Creek	*P.acuta*
24	518747	4510898	1458	Fol Stream	
25	521267	4513442	1139	Fol Stream	
26	524490	4517963	992	Fol Stream	*A. fluviatilis*
27	524720	4522304	881	Fol Stream	*A. fluviatilis*
28	524368	4522895	865	Fol Stream	*A. fluviatilis*
29	524407	4528716	634	Fol Stream	*A. fluviatilis , P. acuta*
30	524727	4532320	397	Fol Stream	*A. fluviatilis*
31	524420	4535340	208	Fol Stream	*A. fluviatilis*
32	523397	4539173	123	Fol Stream	*A. fluviatilis*
33	523401	4542403	21	Fol Stream	
34	599303	4528582	57	Kastel Creek	
35	576172	4525091	555	Harmancık Creek	
36	587122	4488188	1896	Karadere	
37	587188	4491445	1642	Karadere	*A. fluviatilis*
38	581509	4494416	1384	Karadere	*A. fluviatilis*
39	578911	4497836	992	Karadere	*A. fluviatilis*
40	576137	4504446	527	Karadere	*A. fluviatilis*
41	579615	4511164	306	Karadere	
42	588407	4530944	4	Karadere	
43	593159	4495168	2024	Limon Stream	
44	593269	4498260	1842	Manahoz Stream	
45	594075	4500083	1704	Manahoz Stream	*A. fluviatilis*
46	593976	4501689	1625	Manahoz Stream	*A. fluviatilis*
47	593610	4503269	1494	Manahoz Stream	*A. fluviatilis*
48	594346	4506775	1182	Manahoz Stream	
49	595069	4511873	673	Manahoz Stream	*A. fluviatilis*
50	594770	4511575	658	Manahoz Stream	*A. fluviatilis*
51	595360	4512729	633	Manahoz Stream	*A. fluviatilis*
52	594972	4515978	391	Manahoz Stream	*A.fluviatilis , P.acuta*
53	593653	4525130	72	Manahoz Stream	

54	593403	4527499	27	Manahoz Stream	
55	618898	4489902	2036	Solaklı Stream	
56	618904	4492185	1781	Solaklı Stream	
57	618227	4492629	1700	Solaklı Stream	
58	617190	4492321	1604	Solaklı Stream	
59	614085	4492515	1342	Solaklı Stream	
60	613916	4493924	1335	Solaklı Stream	
61	611810	4494958	1189	Solaklı Stream	
62	605340	4504318	562	Solaklı Stream	
63	604770	4505153	501	Solaklı Stream	
64	604617	4505582	492	Solaklı Stream	*A. fluviatilis*
65	604379	4506100	461	Solaklı Stream	*A. fluviatilis*
66	607878	4523741	81	Solaklı Stream	
67	568145	4500905	1462	Yanbolu Stream	*A. fluviatilis*
68	568476	4502729	1325	Yanbolu Stream	*A. fluviatilis*
69	568805	4504185	1237	Yanbolu Stream	
70	569568	4506409	1104	Yanbolu Stream	*A. fluviatilis*
71	570778	4509122	876	Yanbolu Stream	
72	572071	4510603	705	Yanbolu Stream	
73	573835	4514856	568	Yanbolu Stream	
74	583142	4527079	75	Yanbolu Stream	*A. fluviatilis*
75	529168	4520837	996	Söğütlü Stream	*A. fluviatilis*
76	532213	4521826	768	Söğütlü Stream	*A. fluviatilis*
77	534150	4524047	657	Söğütlü Stream	*A. fluviatilis*
78	542702	4533847	156	Söğütlü Stream	*A. fluviatilis*
79	545659	4536553	86	Söğütlü Stream	
80	549409	4539689	18	Söğütlü Stream	
81	542714	4547643	10	Çatalzeytin Creek	*D. polymorpha*

x,y coordinate: WGS_1984_UTM_Zone_37N (6°)

Dreissena polymorpha, which spreads in brackish and freshwaters, is an invasive species that causes various ecological and economic problems (Bobat & Ertem, 2004; Gaygusuz et al., 2007). Its homeland is the Black Sea region (including Northwest Anatolia), but its distribution in the Central and Eastern Black Sea regions is unknown (Geldiay & Bilgin, 1973). Empty shells belonging to the *D. polymorpha* species were found around Akçakale (station: 81) in the area where Çatalzeytin Creek joins the sea. Its presence here is thought to be due to the activities of possible fishermen to clear their nets. However, it is difficult to predict where the individuals who were moved by sticking to the nets might have come from. *D. polymorpha*, which can live in brackish waters and survive on ship hulls for a long time, has not been found in population formations in the surrounding estuary.

The streams in the Eastern Black Sea region flow fast due to the high (>50 %) slope of their waterway (Figure 2). For this reason, stream floods occur in some years (Hocaoğlu, 1996; Gültekin et al., 2005). For example; it is stated that the Solaklı Stream overflowed in the flood disaster known as the "Seller Senesi" among the people in 1929 (Ayyıldız, 2016). The streams of the Eastern Black Sea region are not rich in aquatic insects due to flow regimes (Zengin et al., 2017).In this study, no mussel taxa were found, except for empty shells of *D. polymorpha*. This situation is thought to be caused by factors such as precipitation course, height, slope, and bedrock structure (Figure 2,3,4). Within the scope of stream improvement in the research area, there are embankments reinforced concrete canals in many streams basins. Again, in some stream basins, there is a hydroelectric power plant, sand and gravel pit and drinking water intake. For these reasons, it is possible that the ecological destruction was high and that it caused a decrease in the species diversity in the research area.

CONCLUSION and RECOMMENDATIONS

In this study, which was carried out to determine the freshwater molluscs in the streams of Trabzon region, *A. fluviatilis* showed a wide distribution in the stream localities. *P. acuta* individuals were identified in a small number of localities. Empty shells of *D. polymorpha* were recorded for the first time from the region where the Çatalzeytin Stream joins the sea, and no population formation was observed. In the streams in the Trabzon region, slope, elevation, precipitation regime, stream improvement, hydroelectric power plants, sand-gravel quarries, drinking water intake and domestic pollutants are considered as factors that cause the reduction of species diversity.

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Contribution Rate Statement Summary of Researchers

The authors declare that they have contributed equally to the article.

Conflict of Interest Statement

The authours report no conflict of interest.

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