Acta Aquatica Turcica
E-ISSN: 2651-5474 16(2), 179-188 (2020) DOI: https://doi.org/10.22392/actaquatr.623207

Ichthyofauna of Düzce Province (Turkey): Population and Habitat Evaluation

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Research Article

Received 22 September 2019; Accepted 17 March 2020; Release date 01 June 2020.

How to Cite: Güçlü, S.S. (2020). Ichthyofauna of Düzce province (Turkey): Population and habitat evaluation. *Acta Aquatica Turcica, 16*(2), 179-188. https://doi.org/10.22392/actaquatr.623207

Abstract

This study aimed to analyze the distribution, endemism-conservation status, habitat features of inland water fish species and some threats in Düzce inland water systems. Fish samples were collected using electrofishing equipment, gill nets, fyke nets, and cast nets between April-October 2016. We have identified 17 fish taxa belonging to 9 families (Salmonidae (1 taxa), Acheilognothidae (1 taxa), Cyprinidae (2 taxa), Gobionidae (1 taxa), Leuciscidae (7 taxa), Tincidae (1 taxa), Cobitidae (1 taxa), Percidae (1 taxa), Gobiidae (2 taxa)). As a result of field observations conducted in Düzce province inland water, we determined 4 endemic (*Gobio baliki, Squalius pursakensis, Alburnoides coskuncelebii* and *Cobitis splendens*) and 2 invasive species (*Carassius gibelio, Oncorhynchus mykiss*). Endemic species were observed in narrow areas and small populations. Fish fauna and habitats were observed to be under the influence of drying, water and sand extraction, dam and pond building, pollution, mining and invasive species pressure.

Keywords: Anatolia, Düzce, fish fauna, anthropogenic effects

Düzce İli (Türkiye) İhtiyofaunası: Popülasyon ve Habitat Durumları

Özet

Bu çalışma Nisan-Ekim 2016 tarihleri arasında Düzce içsu sistemlerinde dağılım gösteren iç su balık türlerinin, endemizm-korunma durumu, habitat özellikleri ve bazı tehditlerini analiz etmeyi amaçlamıştır. Balık örnekleri, elektroşoker, solungaç ağları, ığrıp ve pinter ağları kullanılarak toplanmıştır. Çalışmada 9 familyaya ait 17 balık taksonu (Salmonidae (1 takson), Acheilognothidae (1 takson), Cyprinidae (2 takson), Gobionidae (1 takson), Leuciscidae (7 takson), Tincidae (1 takson), Cobitidae (1 takson), Percidae (1 takson), Gobiidae (2 takson)).tespit edilmiştir. Düzce ilindeki iç sularda yapılan saha gözlemleri sonucunda, 4 endemik (*Gobio baliki, Squalius pursakensis, Alburnoides coskuncelebii* ve *Cobitis splendens*) ve 2 istilacı tür (*Carassius gibelio, Oncorhynchus mykiss*) belirlenmiştir. Endemik türlerin, dar alanlarda ve küçük populasyonlar halinde bulundukları gözlenmiştir. Balık faunası ve habitatların; kuruma, su ve kum çekimi, baraj ve gölet yapımı, kirlilik, madencilik ve yabancı türlerin baskısının olumsuz etkisi altında olduğu gözlenmiştir.

Anahtar Kelimeler: Anadolu, Düzce, balık faunası, çevresel etkiler

INTRODUCTION

Turkey is one of the few terrestrial parts of geographically located between three continents with high biological diversity. Turkey's geography consists of the Anatolian and Thrace regions, but its ichthyofaunal richness originates from the Anatolian region (Görür et al., 1984). Though scientific studies in Anatolia began in the second half of the 1800s, the issue is still not fully clarified.

Anatolia has a geological structure that is consistently active, from the late Miocene period until today when it began to take shape. In addition to the lentic systems consisting of open and closed basins, the geographic isolation created by the lotic systems connected to the seas accelerated the speciation. In this way, nine different ecological regions formed (Görür et al., 1984).

The latest status of Turkish inland water fishes and the endemism level of taxa have been discussed. According to Kuru et al. (2014) in Turkey, it is stated that 371 species and Eschmeyer et al. (2018), 377 species. According to the latest November 2018 data, the total number of 368 taxa (31 families) in Turkey has reached to 409 (including 29 exotic species) with the addition of 41 taxa from this date. The endemism rate in all species was 47.4% (194 species). It was determined that 4 species (2.1%) EX, 18 species (9.3%) CR, 38 species (19.6%) EN, 17 species (8.8%) VU from 194 endemic

species in Turkey's inland waters (Çiçek et al., 2015; Çiçek et al., 2018; Yoğurtçuoğlu and Freyhof, 2018). The regions where endemic species are highest in Anatolia; Central Anatolia and Lake District, Southwest Anatolia, Tigris, and the upper basins of the Euphrates, Ceyhan, and Seyhan basins.

Düzce placed in Western BlackSea Basin. The average altitude is 150 m. Düzce has a rich biological diversity due to its geographical location, variable habitat, and ecosystem diversity. The majority of the waters in the Düzce region are the creeks in the Melen Stream Basin (Efteni Lake Basin) (Melen Stream, Asarsu, Uğursuyu, Aksu Creek, Karadere, Aydınpınar). In the Akçakoca region, separated from the plain of Düzce with Kaplandede and Orhan mountains, there are small streams that are generally perpendicular to the shore, which are not connected to the Melen Basin (Sarmadere, Değirmendere, Çayağzı and Çakbelit creeks). There is also 1 natural lake (Efteni Lake) and 1 reservoir lake (Hasanlar Dam Lake) in Düzce. There are few studies on inland water fish in Düzce Province (İlhan and Balık, 2008; Keten, 2009). The present study aims to fill this gap by documenting the taxonomic features of the Düzce Province ichthyofauna.

MATERIALS and METHODS

Sampling was carried out in May, June, July, October and December 2016 with electrofishing equipment in a 50-meter transect in lotic systems (Küçük Melen Stream, Asarsu, Uğursuyu, Aydınpınar, Aksu, Sarmadere, Değirmendere, Çayağzı, and Çakbelit creeks), with gill nets (35x1.5 m and 35x3.5 m), castnet (trap) in diameter of 1.5-2 m. and seine net in the lentic system (Efteni Lake, Hasanlar Dam Lake) (Figure 1). The Küçük Melen Stream originates from the Yığılca Mountains and flows into Lake Efteni. There are Saklıkent Waterfalls and Hasanlar Dam Lake on it. The Asarsu Stream originates from the Bolu Mountains and passes through Kaynaşlı and joins the Küçük Melen Stream approximately 10 km west of Düzce. Uğursuyu and Aydınpınar creeks originate from the northeastern slopes of the Elmacık Mountains flow into Lake Efteni. It is 30 km long and has Samandere Waterfall on it. Aksu Creek is one of the streams that flow into Lake Efteni. It originates from the Elmacık Mountains. In the Akçakoca region, separated from the plain of Düzce with Kaplandede and Orhan mountains, there are small streams that are generally perpendicular to the shore, which are not connected to the Melen Stream Basin. These creeks Sarmadere, Değirmendere, Çayağzı, and Çakbelit creeks. There is Efteni Lake as a natural lake in Düzce. Its altitude is 112 m and its deepest point is 6 m. Lake Efteni is used as a wetland by many bird species as a feeding, shelter, and breeding area. Due to nutritious streams and the output of the Great Melen Stream, its waters are constantly being renewed. The lake was registered as a wildlife conservation area in 1992 by the Ministry of Forestry (Tatar, 2003).

The intensities of the fish samples hunted in the systems were determined, were taken into 10% formaldehyde for examination in the laboratory and the photos were taken when the body tissues were hardened. Metric measurements were carried out with 0.01 mm sensitive calipers. Meristic characters such as several gill rakers, pharyngeal teeth, dorsal, and anal fin rays, total lateral line scales were counted under a stereomicroscope (Kottelay and Freyhof, 2007; Turan et al., 2017; Turan et al., 2018; Turan et al., 2019). Family names were given taxonomically according to Stout et al. (2016) and Van der Laan (2017). Conservation status of species provided from IUCN Red List (2019). Also, pollutants entering the systems were observed and biotic-abiotic factors that could threaten fish species were noted.

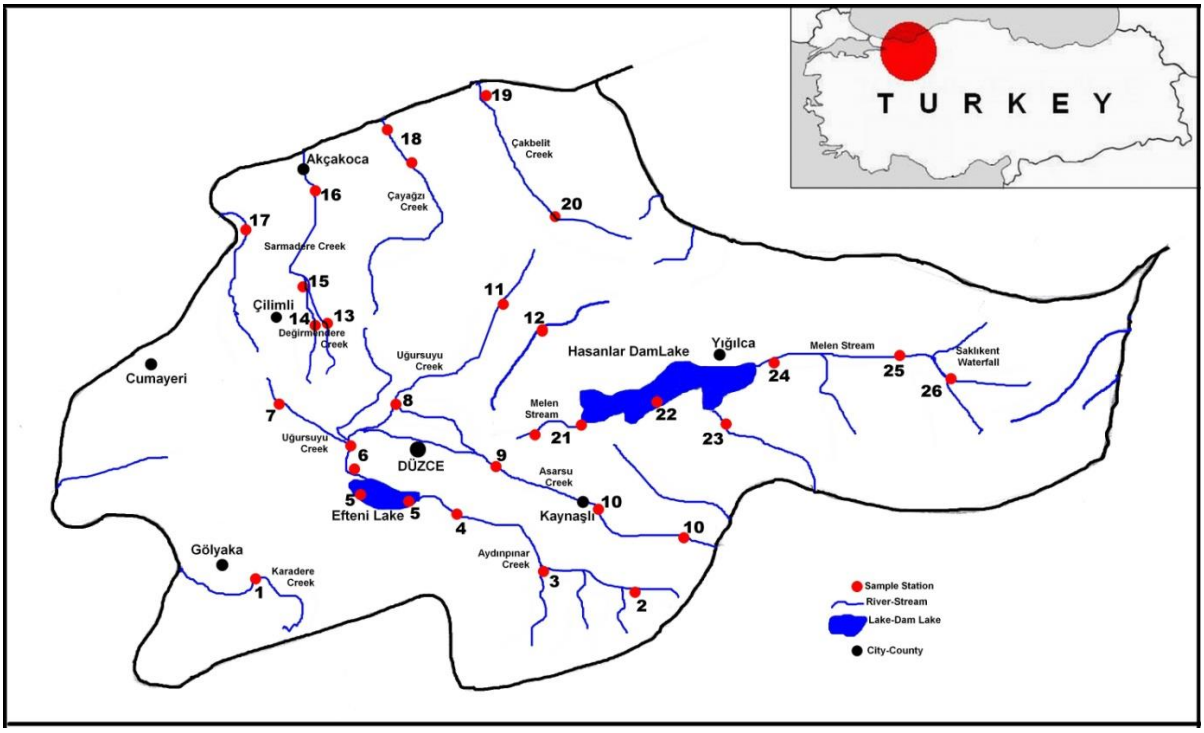

Figure 1. The map of Düzce Province sampling stations

RESULTS and DISCUSSION

17 species belonging to 9 families (Salmonidae (1 taxa), Acheilognothidae (1 taxa), Cyprinidae (2 taxa), Gobionidae (1 taxa), Leuciscidae (7 taxa), Tincidae (1 taxa), Cobitidae (1 taxa), Percidae (1 taxa), Gobiidae (2 taxa)) were identified from the Düzce Province (Table1, Figure 2-18).

Figure 2. *Rhodeus amarus*, IFC-ESUF 03-1406, 45.6 mm SL ♂- 42.4 mm SL ♀

Table 1. Fish taxons and sampling stations in Düzce Province (N: number of individuals, n: native, e: endemic, nn: non-native)

Species	Status	IUCN Status	N	Station
Salmonidae				
Oncorhyncus mykiss (Walbaum, 1792)	nn	LC	6	13,14
Acheilognothidae				
Rhodeus amarus (Bloch, 1782)	n	LC	75	5,6,21,22
Cyprinidae				
Barbus tauricus Kessler, 1877	n	VU	12	1,10,13,14,15,16,17,18,21,22,23
Carassius gibelio (Bloch, 1782)	nn	LC	2	5
Gobionidae				
Gobio baliki Turan,Kaya,Bayçelebi,Aksu & Bektaş,2017	e	LC	14	21,22,24,25
Leuciscidae				
Alburnoides coskuncelebii Turan,Kaya,Aksu,Bayçelebi & Bektaş,2019	e	LC	11	1,5,11,12,21
Alburnus derjugini Berg, 1923	n	LC	17	5,21,22,23,
Blicca bjoerkna (Linnaeus, 1758)	n	LC	21	5
Phoxinus strandjae Drensky, 1926	n	EN	432	9,10,13,14,15,18,19,26
Scardinius erythrophthalmus (Linnaeus, 1758)	n	LC	49	5
Squalius pursakensis (Hanko, 1925)	e	LC	236	2,3,4,5,6,7,8,10,11,12,13,16,17,18 ,19,20,21,22,23,24,25
Vimba vimba (Linnaeus, 1758)	n	LC	22	18,21
Tincidae				
Tinca tinca (Linnaeus, 1758)	n	LC	4	5
Cobitidae				
Cobitis splendens Erk'akan,Atalay-Ekmekçi & Nalbant, 1998	e	CR	56	5,16,18,19,20,21
Percidae				
Perca fluviatilis Linnaeus, 1758	n	LC	4	5
Gobiidae				
Neogobius fluviatilis (Pallas, 1814)	n	LC	24	1,18,5
Proterorhinus semilunaris (Heckel, 1839)	n	LC	1	5

Figure 3. *Gobio baliki*, IFC-ESUF 03-1702, 98.4 mm SL

Figure 4. *Scardinius erythrophthalmus*, IFC-ESUF 03-1850, 190.2 mm SL

Figure 5. *Carassius gibelio*, IFC-ESUF 03-1612, 173.1 mm SL

Figure 6. *Phoxinus strandjae*, IFC-ESUF 03-1801, 71.6 mm SL

Figure 7. *Squalius pursakensis*, IFC-ESUF 03-0854, 13.4 mm SL

Figure 8. *Tinca tinca*, IFC-ESUF 03-1102, 261.1 mm SL

Figure 9. *Blicca bjoerkna,* IFC-ESUF 03-1825, 50.0 mm SL

Figure 10. *Vimba vimba,* IFC-ESUF 03-1133, 189.3 mm SL

Figure 11. *Barbus tauricus,* IFC-ESUF 03-0517, 172.5 mm SL

Figure 12. *Alburnus derjugini,* IFC-ESUF 03-0382, 128.1 mm SL

Figure 13. *Alburnoides coskuncelebii*, IFC-ESUF 03-1215, 78.2 mm SL

Figure 14. *Oncorhyncus mykiss*, IFC-ESUF 02-0020, 191.3 mm SL

Figure 15. *Perca fluviatilis*, IFC-ESUF 08-0006, 146.7 mm SL

Figure 16. *Cobitis splendens*, IFC-ESUF 18-0007, 85.6 mm SL

Figure 17. *Neogobius fluviatilis*, IFC-ESUF 20-0003, 110.5 mm SL

Figure 18. *Proterorhinus semilunaris,* IFC-ESUF 20-0004, 110.3 mm SL

There are few studies on inland water fishes in the borders of Düzce province. İlhan and Balık (2008) identified 32 taxa of inland water fishes in their study in the Western Black Sea region. When the study stations are examined, it is seen that 7 sampling points are remaining in the borders of Düzce province. A total of 10 species were obtained at these points along the northern line of Düzce province. These species; *Salmo labrax, Alburnoides bipunctatus*, *Barbus tauricus escherichi*, *Chalcalburnus chalcoides*, *Leuciscus cephalus*, *Phoxinus phoxinus*, *Cobitis splendens*, *Mugil cephalus*, *Neogobius fluviatilis,* and *Proterorhinus marmoratus*. In our study, *S.labrax* and *M. cephalus* species were not found. This difference may arise from station selection. In the study where the vertebrate diversity of the Efteni Lake was investigated (Keten, 2009), 10 fish species (*Abramis brama*, *Barbus escherichi*, *Cyprinus carpio*, *Rutilus rutilus*, *Squalius cephalus*, *Tinca tinca*, *Cobitis vardarensis*, *Esox lucius*, *Perca fluviatilis*, *Neogobius fluviatilis*) were identified by using the nets of local fishermen. In our study, although there were no *A.barama*, *B.escherichi*, *C.carpio*, *R.rutilus,* and *E.lucius* species identified by Keten (2009), 7 different fish species were identified (Table 1). Keten (2009) sampled with local fisheries and used local fishing gear according to the fish species. In our study, we used gill nets (35x1.5 m and 35x3.5 m), which are mostly used in scientific studies. Especially because the *E.lucius* species live in the deep and concealed locations of the Efteni Lake, short-term sampling was not sufficient to be caught. In particular, the dense reed areas of the lake made it difficult to use a gill and cast nets. Therefore, we think that the difference is due to the difference station selection and fishing tools.

According to the results of our study; 30% of Düzce Province fish fauna is endemic. *P.strandjae, R.amarus, A.derjugini,* and *S.pursakensis* are predominant, whereas *B.tauricus, V.vimba, G.baliki, N. fluviatilis,* and *P.semilunaris* species are represented by very few individuals. In the lentic systems, it was determined that *S.erythrophthalmus* and *C.splendens* species were dominant, while *P. fluviatilis* and *T.tinca* species were less individual. The populations of *S.pursakensis* (endemic and IUCN level LC), *B.tauricus,* and *G.baliki* (endemic and IUCN level LC) in habitats studied are intense while those in *A.derjugini* are infrequent. *Phoxinus strandjae* species (IUCN level EN) live in isolated areas in small ponds in the upper reaches of rivers (Saklıkent Waterfall). In the Değirmendere station, which is one of these areas, the rainbow trout farms that were found have a negative effect on population density. It is recommended that *A.coskuncelebii* be protected because the habitats create limited and small populations. *C.splendens* species (endemic and IUCN level CR) have formed large populations in Efteni Lake. However, due to the influence of the mining-quarry-sand extraction studies in the shallow areas of the lower sections of the rivers (Çakbelit Creek), a serious decrease in population density has been observed.

The base structure of the upper parts of the Küçük Melen Stream located at the exit of the Hasanlar Dam Lake consists of rocky and large stone-pebbles in places, while the lower parts consist of very small pebbles. While the intensity of the vegetation on the edges is noticeable in the upper parts of the stream, this vegetation disappears in the lower parts and the stream bed begins to expand and become shallow. The pouring of the Hasanlar Village into the upper area of the sewage has led to a slippery mucilage zone on the rocks and pebbles at the bottom. It is observed that there is an intense sand draft in the lower regions where the bed of the stream expands and shallows, and the bed of the stream is changed and played. These negative factors in these two areas of the stream may have serious negative effects on fish species and population densities. The lack of water in the Hasanlar Dam Lake in the autumn sampling and the lack of water in the Küçük Melen Stream (not even the Water of Life)

created a suitable environment for *C.splendens*. However, it was determined that other species fled in the environment and migrated to higher levels. Due to the low or no rains, Hasanlar Dam Lake has reached the drying point and a decrease of 8-10 m has been observed in its depth.

Saklıkent Waterfall has been observed as an environment that is far from human influence and has not deteriorated much. There is only *P.strandjae* species in the waterfall. Especially in regions where the waterfall forms small pools, the presence of the species is determined intensely. In addition to large individuals of reproductive maturity, very small individuals were also encountered. There is a rainbow trout farm about 1 km below the waterfall. However, individuals escaping from the rainbow trout farm are thought to pose a negative threat to the species.

Asarsu Stream maintains a high flow rate along a narrow bed. It was determined that the waste of the villages around the place were discharged to the stream. The Bolu Mountain Tunnel viaducts that pass over the stream seem to protect the stream in a way. However, conclusions about what the negative effects of viaducts during the construction phase will appear in the future.

The flow rate of Uğursuyu Creek, which is located in the west of Efteni Lake and forms the exit water of the lake, is quite high. The bottom part looks like sand and occasionally slime. In the autumn sampling, due to the density of the mine-quarry-sand extraction activities above the creek, the water looks quite muddy-mud. This will cause the fish to be negatively affected by biologically.

Aydınpınar Creek, which is located in the east of Efteni Lake and forms the inlet water of the lake, flows in a very narrow bed. It comes from the agricultural land around Efteni Lake and pours into the lake. The bottom part consists of sand and small pebbles in places. A large amount of cub *S.pursakensis* was found in the stream.

In Efteni Lake, which has an average depth of 1-2 meters, the excess of the reed areas attract attention. Also, *Nuphar lutea* (yellow water lily) and *Nymphaea alba* (white water lily) species also spread extensively in the lake. As a result of sampling in the lake; *S.erythrophthalmus, B.bjoerkna, T.tinca, C.splendens, P.fluviatilis, P.semilunaris, A.derjugini, C.gibelio,* and *R.amarus* species were identified. *S.erythrophthalmus* and *C.splendens* are dominant species in the lake.

Çayağzı Stream flows through a very large bed. It has a very small pebble floor, sandy part, and shallow creek. Sand was densely drawn from the stream, it was shallow and replaced with the bed of the stream. In the stream, *C.splendens* species is widely distributed especially in sandy and shallow regions. Also, *P.strandjae* and *S.pursakensis* species are also spreading, though a little.

Çakbelit Stream is a very small, narrow stream flowing in shallow but high flow. It is very close to the sea. There are hazelnut gardens and agricultural areas in the immediate vicinity. These areas are also capable of being negatively affected. Abundant *P.strandjae* species were found in the stream. Also, *S. pursakensis* species is also dominant. Although very rare, Gobiidae members have been identified.

Sarmadere is a stream that consists of small pebbles and stones flowing in a small stream bed and its water is clear and can be specified as a "trout zone". *P.strandjae* species have been frequently encountered in the regions where the water is pools. No factor will have any negative effects for the species. It is an ideal habitat for the species. Also, *B.escherichii* species is also rarely encountered. Değirmendere is very close to Sarmadere and after about 1 km it joins Sarmadere. There is a rainbow trout farm above the stream. *P.strandjae* species is frequently encountered in the regions where water flows in the stream. Rainbow trout escaping from here may have a negative interaction, especially with *P.strandjae.*

It is observed that there is an intense sand attraction in the lower regions where the stream is enlarged and shallow (Küçük Melen, Asarsu and Çayağzı creeks), that the direction of the stream is changed and played and that the quarries leave the wastes (Uğursuyu Creek). It is thought that individuals escaping from rainbow trout farms may pose a negative threat to natural species (Saklıkent Waterfall, Değirmendere and Sarmadere creeks).

Acknowledgements: This study was supported by the Ministry of Forestry and Water Affairs of Turkey within the scope of National Biodiversity Inventory and Monitoring Project-Düzce and ANADOKU firm (Ankara) for field survey.

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