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Current Status Freshwater Fishes of Nilüfer Stream (North-western Turkey)

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Abstract

In this study, the freshwater fish diversity of the Nilufer stream basin is investigated. Nine families, 16 genera, and 19 fish species were recorded. The most representative families are Leuciscidae with five species (27.7 %), followed by Cyprinidae with five species (27.7 %). Overall, 17 sampling localities were studied among 2014–2015 to inventory fish species in the area. No fish was found at five stations representing the middle and downstream parts of the Nilufer stream. The most common species were detected, *Barbus niluferensis, Squalius cii, Oxynoemacheilus angorae,* and *Oxynoemacheilus simavicus,* respectively.

Keywords: biodiversity, Kernel density analysis, Susurluk basin, Nilüfer Stream, Bursa

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Nilüfer Çayı Tatlı Su Balıkları Güncel Durumu -(Kuzey-batı Türkiye)

Özet

Bu çalışmada Nilüfer çayı havzasının tatlı su balıkları çeşitliliği araştırılmıştır. Çalışma sonucunda 16 cinse ve 9 familyaya ait 19 balık türü tespit edilmiştir. Çalışma alanında, beş türle (% 27,7) Leuciscidae, beş türle (% 27,7) Cyprinidae en yoğun takson içeren failyalardır. Bölgedeki balık faunasını tespit etmek için 2014-2015 yılları arasında 17 örnekleme noktasından örnekleme yapılmıştır. Nilüfer Çayının orta ve mansap kısmına ait beş örnekleme noktasında balık türüne rastlanmamıştır. En yaygın bulunan türler sırasıyla *Barbus niluferensis, Squalius cii, Oxynoemacheilus angorae ve Oxynoemacheilus simavicus*'tur.

Anahtar kelimeler: biyoçeşitlilik, Kernel yoğunluk analizi, Susurluk havzası, Nilüfer Çayı, Bursa

1. Introduction

In Turkey, the research on freshwater fish goes back to the early 18th century[1]. Until today, many researchers have investigated freshwater fishes. In Turkey, new species have been reported by the different researchers, and distribution areas of these species are given [i.e. 2-3-4-5-6-7]. Researchers have determined the distribution areas of the species by doing fauna studies in different basins [1-8-9-10-12-11-11]. These studies continue to increase day by day. In Turkey, there are 409 freshwater fish species [12]. The number of species is increasing day by day with new studies, and some species are reported synonym [13].

Bursa province is an important industrial center in Turkey. Nilüfer Stream passing through the city center of Bursa province is affected by industrial, agricultural, and domestic waste pollution [14]. These increasing anthropogenic pressures will adversely affect the fish biodiversity of the stream. The data on the fishes of the Nilüfer Stream date back to the beginning of the century, and it was stated that the fish caught from the Nilüfer Stream were sold in the Istanbul fish market [15]. Many researchers conducted studies on the fish of the Nilüfer Stream at different times, and 14 species

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were reported in these studies [5-6-15-16-17-18-19-20-21]. There is no comprehensive faunistic study to cover the entire stream basin.

Uludağ served as a shelter for northern faunal elements from Thrace during the glacial and interglacial periods [21]. The stream passes through the city center of Bursa and joins the Susurluk Stream. The length of Nilufer Stream is 203 km and covers a 1540 km^2 watershed area. Basin is used for agricultural purpose (53.8%), forests (33.9%), meadows (5.0%) and settlements (6.4%) [22]. Almost 70% of the drinking water of the province of Bursa is being provided from the dams and ponds on the Nilufer Stream. There is eight organized industrial zone in the region [22]. Nilüfer Stream Basin was affected by agricultural, industrial, and domestic wastes [14-22]. The tributaries pass through the center of Bursa. Arrangements are made in the residential areas within the stream structure. These arrangements have cut off connections with the water source points.

This study is aimed to determine the current status of Nilüfer stream fish fauna in detail. The study's findings will help overcome the information gap in determining the diversity and distribution areas of fish fauna in inland waters.

2. Materials and methods

The Nilüfer Stream is located in north-western Anatolia and an essential source of potable water in Bursa. The primary origin of the water is the glacial lakes in Uludağ. The study was carried out at 17 sampling points to cover the entire stream, representing all zones, including Trout, Barbus, Abramis-Cyprinid, and Downstream (Figure 1, Table 1).

Species identification was carried out with the help of literature [4-5-17-21-23-24]. The valid scientific names of the species were obtained from the Catalog of fishes and Fishbase database [25-26]. Specimens collected using SAMUS 725MP electrofishing device and by hand nets and preserved in 4 % formaldehyde solution and then stored in 70% ethanol.

The distribution of the Nilüfer Stream fish species was analyzed. The presence and diversity of the species is mapped and an exploratory interpolation statistical method based on the Kernel Density Estimate (KDE) was used to establish a density based on the distribution points Bandwidth (influence radius) and K (Kernel) functions was predicted for each species at stations [27-28]. The KDE analyzes included types made in the same way at each station and whose coordinates were given, and samples were found. We included samples captured in the same method and at the same time in KDE analyzes.

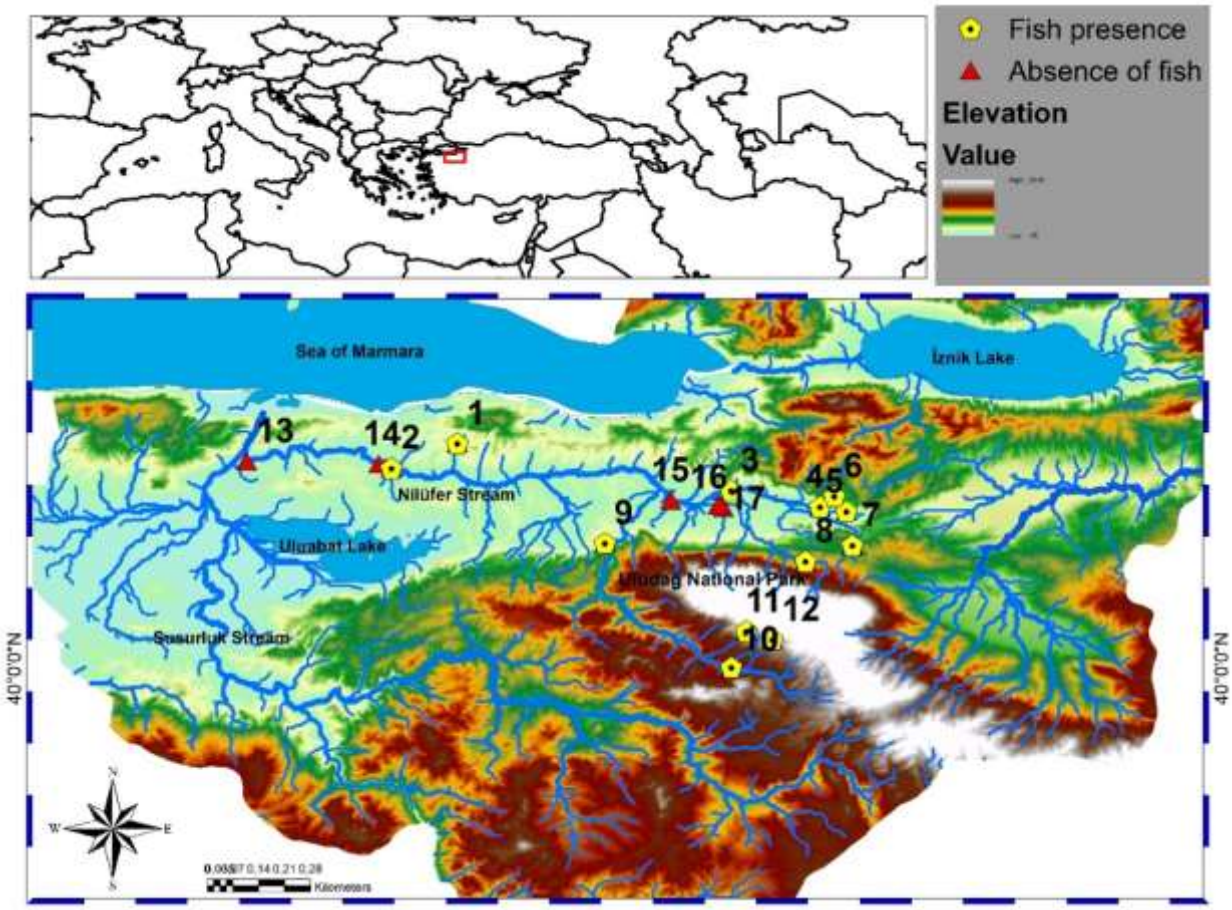

Figure 1. The map of the Nilufer stream basin, Bursa, Turkey

Table 1. Sampling locations

No	Stations	Longitude	Lattitude
1	Orhaniye Pond	28.759.690	40.321.568
2	Yörükyenicesi	28.665.585	40.286.296
3	Kazıklı village	29.150.059	40.254.424
4	Barakfakih	29.277.274	40.231.340
5	Gölbaşı pond	29.314.990	40.224.576
6	Narlıdere	29.297.480	40.246.244
7	Aksu creek	29.323.456	40.176.374
8	Deliçay creek	29.256.632	40.153.444
9	Misi village	28.970.266	40.179.108
10	Upper Nilufer dam	29.150.838	40.001.959
11	Arasdere	29.172.297	40.053.748
12	Ericek creek	29.209.271	40.041.448
13	Downstream	28.458.813	40.296.172
14	Hürriyet village	28.647.388	40.292.092
15	Buttim(Bursa International Textile and Trade Center) Köprü altı	29.064.396	40.240.319
16	Samanlı neighbourhood	29.139.357	40.230.164
17	Samanlı neighbourhood	29.132.342	40.233.664

3. Results

As a result of the study, 19 species of fishes belonging to 9 families were identified. Leuciscidae and Cyprinidae are the dominant families in the region (Table 2). As a consequence of the literature review, 14 species of fish were reported from the Nilüfer Stream [5-6-15-16-17-18-19-20-21] (Table 3). In the study area, the Leuciscidae family (46.51%), Cyprinidae (33.2 %) have the highest number of individuals, and Siluridae, Esocidae (0.22%) have the lowest number of individuals (Table 2). The most species diversity is in Gölbaşı pond outlet (10) and Misi village (6), and the species with the highest distribution are *B. niluferensis, S. cii, R. amarus* and *O. angorae* (Figure 2). *B. nilüferensis A. manyasensis* and *S.cii* species have the highest number of individuals (Table 2).

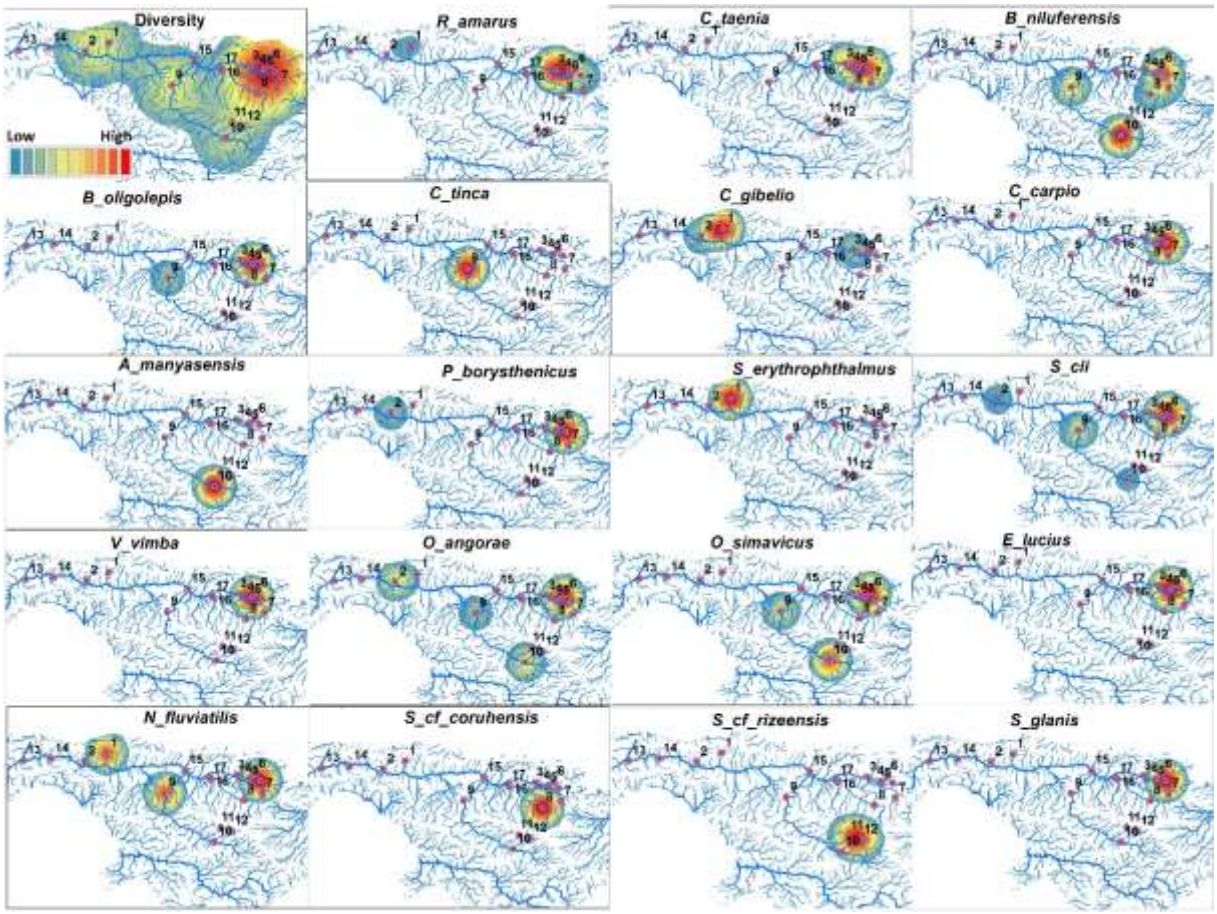

Figure 2. Kernel density analysis of Nilufer stream fish species

Table 2. Distribution, density and IUCN criteria of fishes identified from Nilüfer Stream in this study

Familia	**Species**	**IUCN**	**%**	**Sampling sites**												
				1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13,14, 15,16, 17**
Cobitidae	*Cobitis taenia*	LC	3,28			+	+	+								No fish
Acheilognathidae	*Rhodeus amarus,*	LC	8,52	+	+	+	+	+								
Cyprinidae	*Barbus niluferensis*	NT	17,4					+	+	+	+	+	+			
	Barbus oligolepis	LC	7,86				+	+				+				
	Capoeta tinca	LC	3,28									+				
	Carassius gibelio	NE	1,09	+	+	+										
	Cyprinus carpio	VU	0,22													
Leuciscidae	*Alburnoides manyasensis*	LC	15,2										+			
	Petroleuciscus borysthenicus	LC	4,15		+			+								
	Scardinus erythrophthalmus	LC	3,06	+												
	Squalius cii,	LC	14,6		+	+	+	+	+			+				
	Vimba vimba,	LC	0,87				+									
Nemacheilidae	*Oxynoemacheilus angorae*	NE	6,05	+	+	+	+	+	+			+				
	Oxynoemacheilus simavicus	CR	4,95			+	+	+	+			+				
Esocidae	*Esox lucius,*	LC	0,22				+									
Gobiidae	*Neogobius fluviatilis*	LC	2,84	+				+				+				
Salmonidae	*Salmo cf. coruhensis*	NE	2,18								+					
	Salmo cf. rizeensis	NE	4,80											+	+	
Siluridae	*Silirus glanis*	LC	0,22					+								

Table 3. Fish species from Nilüfer Stream

[4].	[21].	[5-6-17].	[15].	[16-18-19-20].	This study
Salmo trutta labrax	*Alburnoides bipunctatus*	*A. manyasensis*	*Anguilla anguilla*	*Carassius carassius*	*C. taenia*
	B. tauricus escherichi	*B. niluferensis*	*Esox lucius*	*Esox lucius*	*A. manyasensis*
	Chalcalburnus chalcoides	*B. oligolepis*	*Leuciscus cephalus*	*S. erythrophthalmus*	*B. niluferensis*
	Capoeta tinca	*C. tinca*	*Tinca tinca*	*Vimba vimba*	*B. oligolepis*
	Nemacheilus angorae		*Silirus glanis*		*C. tinca*
	Leuciscus cephalus				*C. gibelio*
	S. trutta macrostigma				*C. carpio*
					P. borysthenicus
					R. amarus,
					S. erythrophthalmus
					S. cii
					V. vimba
					O.angorae.
					O.simavicus
					E. lucius,
					N. fluviatilis
					S. cf. coruhensis
					S. cf. rizeensis
					S. glanis

3.1 Fish fauna

Order: Cypriniformes
Family: Acheilognathidae
Rhodeus amarus (Bloch, 1782)
(Figure 3A, Table 2)
Material Examined: Gölbaşı pond (5), Yörükyenicesi (6), Kazıklı Village (3). 14 specimens, 15-50 mm SL

Meristic Characters: D: III 8-9½, P: I 8-10, V: I 6-7, A: III 8-9½, LL: 34-37, L.trans.: 5/4-5
Distribution: Central and Eastern Europe, Caspian Sea basin, Black Sea, on some streams and lakes in the Marmara and Aegean regions [23].

Family: Cobitidae

***Cobitis taenia* Karaman, 1928**

(Figure 3B, Table 2)
Material Examined: Barakfakih (10); Gölbaşı pond (3), Misi village (2). 15 specimens, 53-65 mm SL
Meristic Characters: D: 8½, P: 7-8, V: 5-6, A: 5½
Distribution: Marmara Region and Asian waters [31-32].
Remarks: *Cobitis vardarensis* was reported to distribute in the Susurluk Stream basin [8], but treated *C. vardarensis* in the Susurluk Stream basin as *C. taenia* [29-30].

Family: Cyprinidae

***Barbus niluferensis* Turan, Kottelat & Ekmekçi, 2009**

(Figure 3C, Table 2)
Material Examined: Misi Village;(15), Deliçay (8), Nilüfer Dam (30), Aksu Creek (6), Narlıdere (15), Gölbaşı pond (6) 80 specimens, 99-160 mm SL,
Meristic Characters: D: IV 7-8½, P: I 10-13, V: I 7-9, A: III 5½, LL: 65-69, L. trans.: 12-15/8-11
Distribution: Susurluk Stream basin [5].

***Barbus oligolepis* Battalgil, 1941**

(Figure 3D, Table 2)
Material Examined:Misi Village (10), Barakfakih (30), Gölbaşı pond (2) 36 specimens, 48-269 mm SL
Meristic Characters: D: IV 8½, P: I 13-14, V: I 8-9, A: III 5½, LL: 54-58, L.trans.: 12-14/8-9
Distribution: *Barbus oligolepis* is known from the drainages of streams Nilüfer, Koca (= Kocasu; entering Lake Ulubat), Kocachay (entering Lake Manyas, a tributary of Koca or Susurluk Stream), Hanchay (a tributary of Gönen) and Narlıca Stream in İznik (flowing to Lake Iznik), All are draining to the southern shore of the Marmara Sea [5].

***Capoeta tinca* (Heckel, 1843)**

(Figure 3E, Table 2,)
Material Examined: Misi Village (15), 15 specimens, 75-151 mm SL
Meristic Characters: D: III-IV 7-9½, P: I 16-17, V: I 8-9, A: III 15½, LL: 79-83, L.trans.: 15-16/10-11
Distribution: *Capoeta tinca* is known from the streams draining to the southern Marmara basin to the southwestern Black Sea [11-17-31]

***Carassius gibelio* (Bloch, 1782)**

(Figure 3F, Table 2)
Material Examined: Kazıklı village (1), Yörükyenicesi (1), Orhaniye pond (3), 5 specimens, 97-141 mm SL
Meristic Characters: D: III-IV 16-17½, P: I 15, V: I-II 9, A: III 5 ½, LL: 29-31, L.trans.: 6-7/5
Distribution: Widespread in Europe and Asia [25].

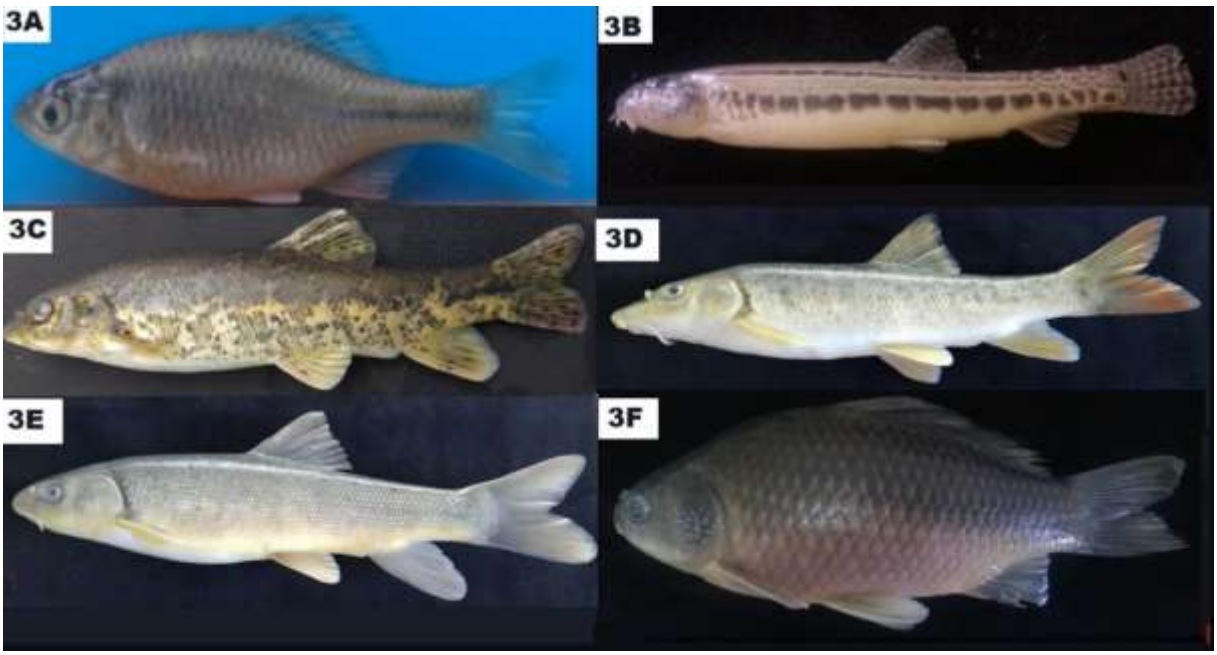

Figure 3. Freshwater Fishes of Nilufer Stream (A-F)

***Cyprinus carpio* Linnaeus, 1758**
(Figure 4A, Table 2)
Material Examined: Gölbaşı pond (1), 1 specimen, 130 mm SL
Meristic Characters: D: III 19½, P: I 14, V: I 7, A: III 5 ½, LL: 37, L.trans.: 6/5
Distribution: Asia and Europe [25].

Family: Leuciscidae

***Alburnoides manyasensis* Turan, Ekmekçi, Kaya & Güçlü, 2013**
(Figure 4B, Table 2)
Material Examined: Upper Nilufer Dam (70), 70 specimens, 50-90 mm SL
Meristic Characters: D: III 8-9½, P: 11-13, V: I 7-8, A: III 11-13½, LL: 47-53, L.trans.: 9-11/4
Distribution: *Alburnoides manyasensis* is widespread in the Simav/Koca Stream, drainage of Lake Manyas [6].

***Petroleuciscus borysthenicus* (Kessler, 1859)**
(Figure 4C, Table 2)
Material Examined: Gölbaşı pond (14), Yörükyenicesi (4), 18 specimens, 43-75 mm SL
Meristic Characters: D: III 8-9½, P: I 10-11, V: I 8, A: III 8-9 ½, LL: 35-37, L. trans.: 7/3
Distribution: Western, northern and eastern Black Sea and Sea of Azov basins, Bulgaria, northern-central Turkey, Aegean Sea basin, from Strma drainage eastward in Europe; north-western Turkey [24].

***Scardinius erythrophtalmus* (Linnaeus, 1758)**
(Figure 4D, Table 2)
Material Examined: Orhaniye pond (14), 14 specimens, 67-126 mm SL
Meristic Characters: D: III 8-9½, P: I 12-14, V: II 8-10, A: III 10-12½, LL: 40-42, L.trans.: 7-8/4-5
Distribution: It is widespread in Europe and around the basins of the Baltic, Black, Caspian, North and Aral seas in Asia [24].

***Squalius cii* (Richardson, 1857)**
(Figure 4E, Table 2)
Material Examined: Yörükyenicesi (8), Kazıklı village (3), Barakfakih (10), Gölbaşı pond (10), Misi Village (16), Narlıdere (20), 67 specimens, 77-242 mm SL
Meristic Characters: D: III 7-8½, P: 14-16, V: 8-9, A: III 8 ½, LL: 43-47, L.trans.: 8/4
Distribution: *Squalius cii* distributed in north-western Anatolia, and is known from Lake Iznik basin, Simav, Biga Peninsula and Lesbos Island (Greece) [32]

***Vimba vimba* (Linnaeus, 1758)**
(Figure 4F, Table 2)
Material Examined: Barakfakih (3), 3 specimens, 56-73 mm SL,
Meristic Characters: D: III 8½, P: I 13-14, V: II 9, A: III 14-15 ½, LL: 52-55, L.trans.: 3/5-6
Distribution: Caspian, Black, Marmara, and Baltic Sea basins [25].

Figure 4. Freshwater Fishes of Nilufer Stream (A-F)

Family: Nemacheilidae
Oxynoemacheilus angorae
(Figure 5A, Table 2)
Material Examined: Orhaniye pond (1), Yörük yenicesi (5), Nilüfer Dam (5), Misi Village (3), Narlıdere(5), Barakfakih (6), 25 specimens, 35-66 mm SL
Meristic Characters: D: 7- 8 ½, P: 8-9, V: 6, A: 5 ½
Oxynoemacheilus simavicus
(Figure 5B, Table 2)
Material Examined: Nilüfer Dam (8), Misi Village (4), Narlıdere(6), Barakfakih(4), 22 specimens, 57-67 mm SL
Meristic Characters: D: 7- 8 ½, P: 8-10, V: 6, A: 5 ½
Order Esociformes
Family: Esocidae
***Esox lucius* Linnaeus, 1758**
(Figure 5C, Table 2,)
Material Examined: Barakfakih (1), 1 specimen, 192 mm SL
Meristic Characters: D: III 8-9½, P: 11-13, V: I 7-8, A: III 11-13½, LL: 115, L.trans.18/15
Distribution: Black, Azov, North and Aral seas drainages, Europe, North and West Asia [25].

Order Gobiiformes
Family: Gobiidae
***Neogobius fluviatilis* (Pallas, 1814)**
(Figure 5D, Table 2)
Material Examined: Orhaniye pond (4), Gölbaşı pond (1), 5 specimens, 51-74 mm SL
Meristic Characters: D1: VI, D2: I 15-16½, P: I 17, V: I 5, A: I 13-14½, Sq: 57-59
Distribution: Azov and Black Sea basin streams [25].
Order Salmoniformes
Family: Salmonidae
Salmo* cf. *coruhensis
(Figure 5E, Table 2)
Material Examined: Derekızık village, Deliçay (6), 6 specimens, 148-200 mm SL
Meristic characters: D: III-IV 9-11½, P: I 12-13, V: I 9, A: III 8-9½, LL: 110-114, L.trans.: 26-30/19-21
Distribution: *Salmo coruhensis* is known from streams flowing to the south-eastern Black Sea coast in Turkey, from the Yeşilırmak drainage and Çoruh Stream drainage [4].
Salmo* cf. *rizeensis
(Figure 5F, Table 2)
Type Locality: Çoruh Stream
Material Examined: Aras creek (8), Ericek creek (14), 23 specimens, 75-182 mm SL
Meristic characters: D: III-IV 8-11½, P: I 11-12, V: I 8-9, A: III 7-9½, LL: 113-117, L.trans.: 26-30/17-21
Distribution: *Salmo rizeensis* is known from the headwaters and upper reaches of the streams, entering the Black Sea [4].
Order Siluriformes
Family: Siluridae
***Silurus glanis* Linnaeus, 1758**
(Figure 5G, Table 2)
Material Examined: Nilufer Stream, Gölbaşı pond (1), 1 specimen, Bursa
Meristic Characters: D: I 4, P: I 15, V: I 11, A: I 86
Distribution: Europe and Asia [25].

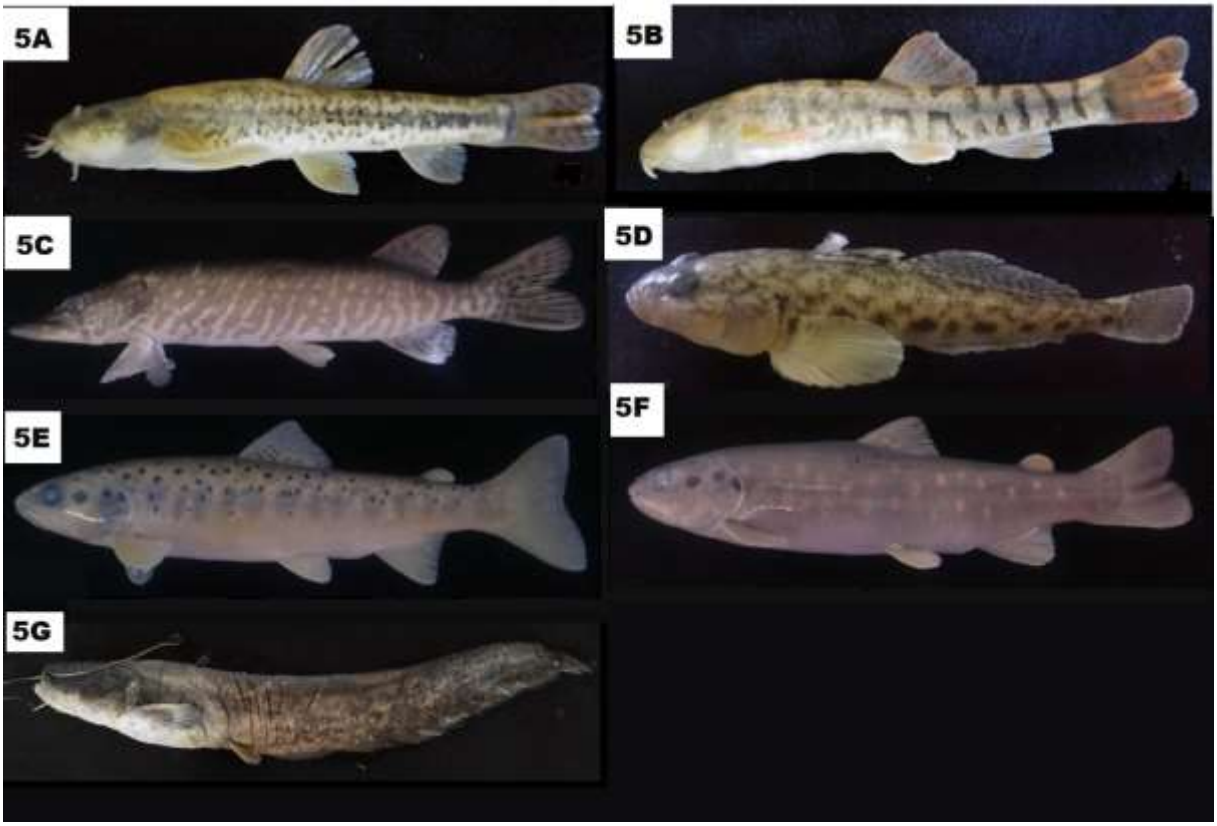

Figure 5. Freshwater Fishes of Nilufer Stream (A-G)

4. Conclusions and discussion

C. carassius [18], *A.anguilla*, and *T.tinca* [15] reported in Nilüfer Stream, but these species are not present in the Nilüfer Stream basin. There are trout populations on the northern and southern slopes of Uludağ. Arasdere and Ericek creek populations differ morphologically from the Deliçay creek population. Arasdere and Ericek creek populations do not share habitats with another species and show distribution alone. Deliçay population shares its habitat with B. nilüferensis in the lower part of the stream. Trout populations distributed in the Nilüfer River have been stuck in limited areas due to anthropogenic pressures (i.e., riverbed arrangements, agricultural irrigation, drinking water use, and housing). The IUCN red list category of *B. niluferensis* is NT [33]. In our study, *B. niluferensis* observed to be the most frequently distributed species in all stations (Table 2). Nilüfer Stream is under pressure by several anthropogenic factors such as pollution. Pollution has deteriorated water quality in the sub-basin of Nilufer Stream [14-22]. It reduces dissolved oxygen levels in the sub-basin to below 2 mg/L [14]. Dissolved oxygen levels experienced by Cyprinids are a minimum of 4 mg / L [34]. Low oxygen levels in the downstream region prevent fish migration to the Nilüfer Stream. In the early 1900s, the presence of (*T.tinca, L.cephalus* (*S.cii), A.anguilla, C.carpio, S. glanis, E. Lucius*) species from the Nilufer Stream was reported, and approximately 5000 kg of these fishes were sold in the Istanbul fish market annually [15]. In this study, we have not been able to found *T. tinca* and *A. anguilla* from the Nilufer Stream. *Alburnus alburnus, A. chalcaoides, Blicca bjorkna, Rutilus rutilus Alosa maeotica, and Mugil cephalus* are being caught commercially utilized in the Uluabat lake [35]; however, these fishes are not present in the Nilüfer Stream. *Anguilla anguilla* was reported from Uluabat Lake [35], however, this species is known to exist in the Nilüfer Stream at the beginning of the century. In our study, *A. anguilla* species were not found in the Nilüfer Stream. *Alosa maeotica, Alburnus carinatus, Blicca bjoerkna* species are distributed in Simav Stream and Uluabat lake [1-35], but these species do not exist in the Nilüfer Stream.

In this study, some inland fish species distributed in the Susurluk Stream basin, their distribution, and some morphological characteristics were investigated. The identified fish species were compared with the current literature. Conservation and sustainability of biodiversity are possible by monitoring this diversity. Accurate identification of species is essential for the accuracy of monitoring studies. These results will then provide necessary information to support all studies conducted with the relevant species.

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