

Article

Ichthyofauna of the Turkish parts of Kura-Aras River Basin

Erdoğan ÇİÇEK*, Sevil SUNGUR BİRECİKLİGİL

Nevşehir Hacı Bektaş Veli Üniversitesi, Faculty of Art and Sciences, Department of Biology, 50300, Nevşehir, Turkey.

Corresponding author: E-mail: erdogancicek@yahoo.com

Abstract

The Kura and Aras rivers are largest rivers of the Caucasus rising from Turkey flowing through the Georgia, Armenia, Azerbaijan and Iran, draining to Caspian Sea. This study was carried out at 20 sampling sites along the entire basin between the years 2014 and 2015 in order to describe the diversity of the ichthyofauna of the Kura-Aras River Basin. Fish were collected with the use of an electrofishing device in streams and gill nets in lakes. A total of 19 fish species were observed in the study period. Based on previous studies and the sampled species during the study period, we document the presence of 32 fish species belonging to 11 families living in the Turkish part of the basin. Of these, 23 fish species are endemic to the Kura-Aras River and Caspian Sea basins, and are not found in any other river basins of Turkey.

Keywords: Aras River, Ichthyofauna, Kura River, Lake Çıldır, Lake Aktaş, Lake Balık, Lake Deniz, Lake, Lake Aygır.

Zoobank: urn:lsid:zoobank.org:pub:896EF833-9E56-44DC-BB84-9D025434A7CD

Introduction

In the latest years, Turkey has taken major steps in the management of its river basins, which is the basic principle of EU Water Framework Directive, and River Basin Protection Action Plans have been successfully completed (Anonymous 2015). Understanding the fish community structure in the river basin could be an important tool in the management of the fisheries and also river basin (Çiçek and Birecikligil 2015). Fish Index of Biotic Integrity using fish assemblages to assess the overall health of a stream ecosystem (Grabarkiewicz and Davis 2008). Fish are good indicators of long-term disturbances. Because; (1) fish are long-lived animals in water ecosystem, (2) fish assemblages generally consist of a number of trophic levels, (3) fish are at the top of the food chain in aquatic environments and are consumed by humans, and (4) fish are easy to collect and identify.

Turkey divided to 25 main river basins. The Kura-Aras River Basin, which is trans boundary basin, is located in the eastern Anatolia region of Turkey. The Kura has a length of 1,364 km and flows through Georgia and Azerbaijan into the Caspian Sea. Aras River is one of the largest rivers of the Caucasus rising south of Erzurum in the Bingöl Mountains, Turkey. It meets with the Arpa River southeast of Digor, flows along the Turkish-Armenian border, and then near a corridor that connects Turkey to Azerbaijan's Nakhchivan exclave. The Aras River has a length of 1,264 km and forms the boundary between Turkey and Iran to the south and Armenia and Azerbaijan to the north. Then, it flows north and joins the Kura short before its outlet into the Caspian Sea. Shortly after the confluence with the Aras, the Kura has flow into the Caspian Sea. Due to the diverse climatic conditions in the basin, a high variety of natural ecosystems can be found. Both rivers have been regulated by dams are used for hydropower and irrigation and contribute to regulate the river flow (Ewing 2003).

Turkey has a very rich freshwater fish fauna in terms of diversity and endemism and its ichthyofauna is characterized by unique elements of both European and Asian origin (Tarkan et al. 2015). According to recent checklist (Çiçek et al. 2015) and new species identification (Küçük et al. 2015), a total of 369 fish species inhabiting freshwater systems in Turkey. Of these 154 species (41.6%) are endemic in Turkish freshwater habitats and 28 species (7.6%) are introduced species (Çiçek et al. 2015).

Various studies which have been conducted on some bioecological properties of fish species living in the Kura-Aras River Basin (Aras 1976; Yanar 1984; Aras et al. 1986; Akyurt 1988a, 1988b; Erdoğan 1988; Temelli

1988; Yerli et al. 1993; Yerli and Zengin 1998; Yerli et al. 1999; Canbolat et al. 1999; Çalışkan et al. 1999; Turkmen et al. 2001; Ayaz and Baysal 2004; Yolaçan 2005; Aksu 2006; Nur 2006; Gül et al. 2007; Ural 2007; Aksu et al. 2008a, 2008b; Güven et al. 2008; Zengin et al. 2012; Dağtekin and Baştürk 2014; Karatepe 2014; Yayla 2014; Çakır 2015; Sığircı 2015). Berg (1948-1949) gives detail information about some species living in Kura-Aras River Basin. Kuru (1971, 1975a, b) worked on zoogeography of freshwater fish species of eastern Anatolia and Kura-Aras River Basin. The aim of this study was to describe the biodiversity and to provide updated information on the status of ichthyofauna in Turkish part of the Kura-Aras River Basin.

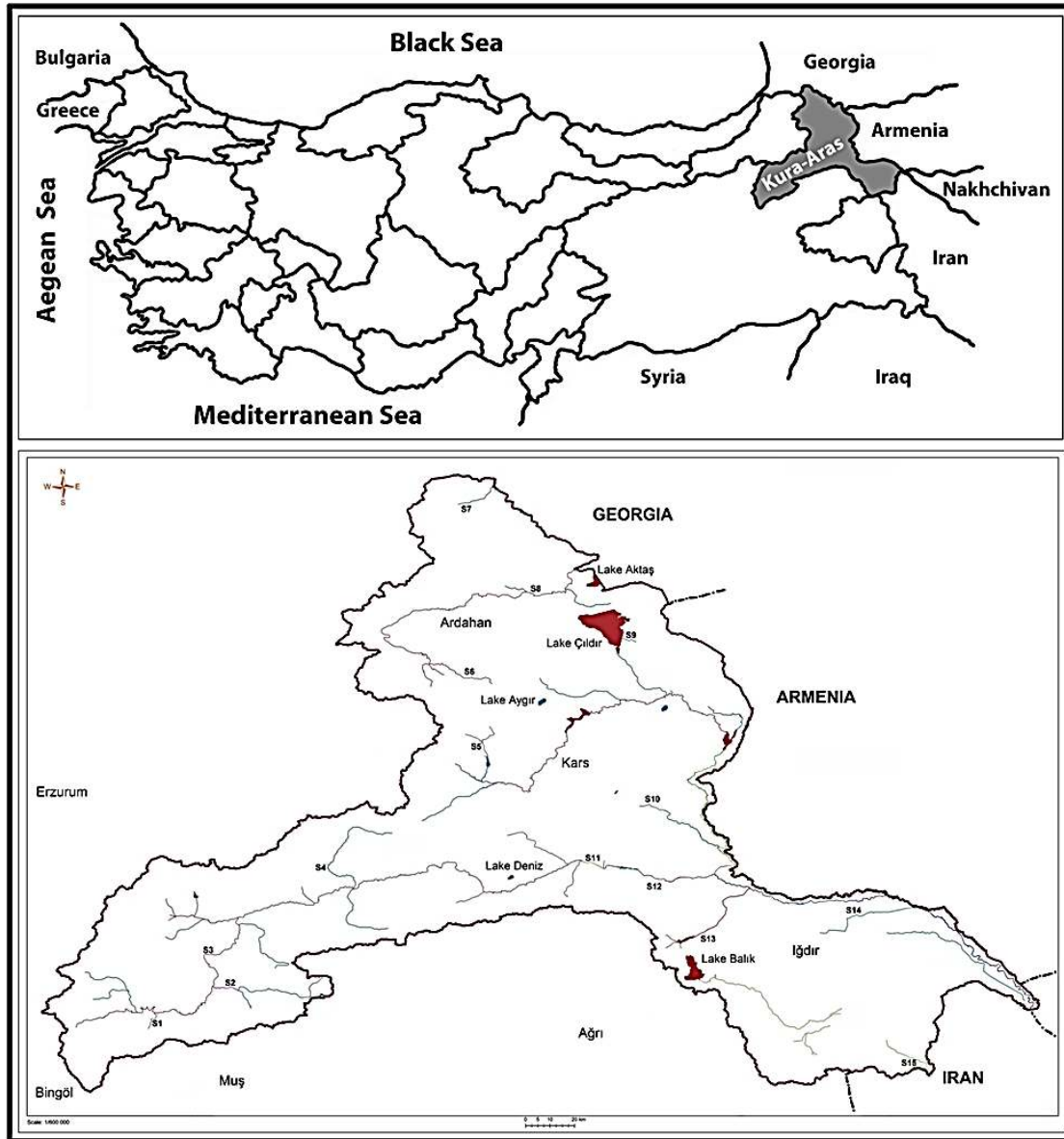


Figure 1. River Basins of Turkey and Sampling Location in Kura-Aras River Basin (S#: Station number).

Material and Methods

The Kura-Aras River Basin is an international river basin located in the South Caucasus with five separate countries contributing area to the watershed (Fig. 1). Both Kura and Aras rivers originate in the northeastern Turkey.

Fishes were collected using an electrofishing device in stream and gillnets of various mesh sizes (5, 6.25, 8,

12.5, 15, 19.5, 24, 29, 35, 43, 55 mm, knot to knot) in lake station for three times, in August and October 2014 and May 2015. Coordinates of the sampling stations are given in Table 1. The ichthyological material obtained in the samples was fixed in the field into 10% formalin solution. Specimens were photographed alive to obtain records of natural coloration. Sorting and identification of specimens were carried out at the Ichthyology Laboratory, Department of Biology, Nevşehir Hacı Bektaş Veli University. This ichthyological material was deposited into the Ichthyological Collection of the University (NHVIC 2015-05-1-100). The systematic list follows Van der Laan et al. (2015).

Addition to collected samples, reliable data from the literature were also considered for the compilation of the present list. Some questionable species appearing in previous checklists were evaluated, and either verified or excluded from the present list.

Table 1. Coordinates of the sampling sites in Kura-Aras River Basin.

Station #	Location	Stream Name	Coordinates	
			N	E
S1	Erzurum/Köprüküy	Aras River	41.839839	39.839904
S2	Erzurum/Tercan	Karasu Stream, Aras River	41.857149	39.707114
S3	Erzurum/Tercan	Ilığöze Stream, Aras River	41.585734	39.607575
S4	Erzurum/Horasan	Handere Creek, Aras River	42.248423	40.126866
S5	Kars	Bozkuş Stream, Aras River	42.785400	40.618924
S6	Kars	Ölçek Creek, Kura River	42.893254	40.979687
S7	Ardahan	Karaman Stream, Kura River	42.740486	41.49881
S8	Ardahan/Hanak	Çot Creek, Kura River	42.843873	41.197473
S9	Kars/Akçakale	Creek to Lake Çıldır, Aras River	43.357375	41.053078
S10	Kars/Digor	Digor Creek, Aras River	43.412261	40.376759
S11	Kars/Kağızman	Aras River	43.172046	40.169777
S12	Kars/Kağızman	Aras River	41.839839	39.839904
S13	Iğdır	Eğritaş Stream, Aras River	43.607087	39.914435
S14	Iğdır	Karakoyunlu Stream, Aras River	44.209111	39.980082
S15	Ağrı/Doğubeyazıt	Sarıs Stream, Aras River	44.387857	39.449141
L1	Ardahan/Kars/Çıldır	Lake Çıldır	43.298975	41.000356
L2	Iğdır	Lake Balık	43.552384	39.827967
L3	Ardahan/Çıldır	Lake Aktaş	43.168030	41.189460
L4	Kars/Susuz	Lake Aygır	43.022645	40.771313
L5	Kars/Kağızman	Lake Deniz	42.888882	40.106565

Results

Ichthyofauna of Turkish parts of Aras River Basin given below as following order.

Species name (Author) [Occurrence] (References) Remarks

List of abbreviations in term of occurrence of fish species are: [N]: Native species, [E]: Endemic to Kura-Aras River Basin and Caspian Sea Basin, [I]: Introduced, [ExT]: Extinct in Turkey

Class Petromyzonti

Order Petromyzontiformes

Family Petromyzontidae

Caspiomyzon wagneri (Kessler, 1870) [E-ExT] (Fricke et al. 2007; Çiçek et al. 2015)

Class Actinopteri

Order Acipenseriformes

Family Acipenseridae

Acipenser persicus Borodin, 1897 [E-ExT] (Fricke et al. 2007; Çiçek et al. 2015)

Order Clupeiformes**Family Clupeidae**

Alosa caspia (Eichwald, 1838) [E-ExT] (Kuru 2004, Fricke et al. 2007, Bilecenoğlu et al. 2014; Çiçek et al. 2015)

Order Cypriniformes**Family Cyprinidae**

Capoeta capoeta (Güldenstädt, 1773) [E] (Kuru 2004, Fricke et al. 2007; Çiçek et al. 2015)

Leucalburnus satunini (Berg, 1910) [E] (Kuru 2004, Fricke et al. 2007; Çiçek et al. 2015)

Subfamily Cyprininae

Barbus cyri De Filippi, 1865 [E] (Levin et al. 2012; Çiçek et al. 2015)

Carassius gibelio (Bloch, 1782) [I] (Kuru 2004, Fricke et al. 2007; Çiçek et al. 2015)

Cyprinus carpio Linnaeus, 1758 [N-I] (Kuru 2004, Fricke et al. 2007; Çiçek et al. 2015)

Luciobarbus capito (Güldenstädt, 1773) [E] (Kuru 2004, Fricke et al. 2007; Çiçek et al. 2015)

Luciobarbus caspius (Berg, 1914) [E] (Fricke et al. 2007; Çiçek et al. 2015)

Luciobarbus mursa (Güldenstädt, 1773) [E] (Kuru 2004, Fricke et al. 2007; Çiçek et al. 2015)

Subfamily Gobioninae

Pseudorasbora parva (Temminck & Schlegel, 1846) [I] (Kuru 2004, Fricke et al. 2007; Çiçek et al. 2015)

Romanogobio macropterus (Kamensky, 1901) [E] (Kuru 2004, Naseka and Freyhof 2004, Fricke et al. 2007; Çiçek et al. 2015)

Subfamily Leuciscinae

Acanthobrama microlepis (De Filippi, 1863) [E] (Kuru 2004, Fricke et al. 2007; Çiçek et al. 2015)

Alburnoides eichwaldii (De Filippi, 1863) [E] (Kuru 2004, Fricke et al. 2007; Çiçek et al. 2015)

Alburnus chalcoides (Güldenstädt, 1772) [N] (Kuru 2004, Fricke et al. 2007; Çiçek et al. 2015)

Alburnus filippii Kessler, 1877 [E] (Kuru 2004, Fricke et al. 2007; Çiçek et al. 2015)

Chondrostoma cyri Kessler, 1877 [E] (Kuru 2004, Fricke et al. 2007; Çiçek et al. 2015)

Leuciscus aspius (Linnaeus, 1758) [N] (Kuru 2004, Fricke et al. 2007; Çiçek et al. 2015)

Squalius orientalis (Nordmann, 1840) [N] (Çiçek et al. 2015)

Squalius turcicus De Filippi, 1865 [E] (Doadrio and Carmona 2006; Çiçek et al. 2015)

Family Cobitidae**Subfamily Cobitinae**

Sabanejewia aurata (De Filippi, 1863) [E] (Çiçek et al. 2015)

Sabanejewia caspia (Eichwald, 1838) [E] (Fricke et al. 2007; Çiçek et al. 2015)

Family Nemacheilidae

Oxynoemacheilus araxensis (Banarescu & Nalbant, 1978) [E] (Kuru 2004, Fricke et al. 2007; Çiçek et al. 2015)

Oxynoemacheilus brandtii (Kessler, 1877) [E] (Kuru 2004, Fricke et al. 2007; Çiçek et al. 2015)

Oxynoemacheilus cyri (Berg, 1910) [E] (Fricke et al. 2007; Çiçek et al. 2015)

Family Siluridae

Silurus glanis Linnaeus, 1758 [N] (Kuru 2004, Fricke et al. 2007; Çiçek et al. 2015)

Order Salmoniformes**Family Salmonidae****Subfamily Coregoninae**

Stenodus leucichthys (Güldenstädt, 1772) [E-ExT] (Fricke et al. 2007; Çiçek et al. 2015)

Subfamily Salmoninae

Salmo caspius Kessler, 1877 [E] (Kuru 2004, Fricke et al. 2007; Çiçek et al. 2015)

Order Cyprinodontiformes

Family Poeciliidae**Subfamily Poeciliinae***Gambusia holbrooki* Girard, 1859 [I] (Kuru 2004, Fricke et al. 2007; Çiçek et al. 2015)**Order Perciformes****Family Percidae****Subfamily Luciopercinae***Sander lucioperca* (Linnaeus, 1758) [N] (Kuru 2004, Fricke et al. 2007; Çiçek et al. 2015)**Family Gobiidae****Subfamily Gobiinae***Ponticola cyrius* (Kessler, 1874) [E] (Fricke et al. 2007; Çiçek et al. 2015)**Table 2.** Species occurrence at stations in Kura-Aras River Basin (S#: Station number).

Species	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	L1	L2	L3	L4	L5
<i>Acanthobrama microlepis</i>			X													X				
<i>Alburnoides eichwaldii</i>		X	X	X	X	X		X		X		X				X	X			
<i>Alburnus filippii</i>		X	X	X				X			X	X		X	X	X				X
<i>Barbus cyri</i>		X	X	X						X		X	X							
<i>Capoeta capoeta</i>		X		X	X	X	X	X		X	X	X		X	X	X	X		X	X
<i>Carassius gibelio</i>															X	X		X		
<i>Chondrostoma cyri</i>																X				X
<i>Cyprinus carpio</i>																X	X		X	X
<i>Leucalburnus satunini</i>						X														
<i>Luciobarbus capito</i>							X				X				X	X	X			
<i>Luciobarbus mursa</i>				X												X				
<i>Oxynoemacheilus</i>										X										
<i>Oxynoemacheilus</i>		X	X	X	X					X	X				X	X				
<i>Oxynoemacheilus cyri</i>										X										
<i>Ponticola cyrius</i>								X												
<i>Pseudorasbora parva</i>																X		X		
<i>Romanogobio</i>			X																	
<i>Salmo caspius</i>	X								X							X	X			
<i>Squalius turcicus</i>		X	X	X	X	X				X						X				X

In this study the collection effort conducted in 20 sampling sites along the entire river basin a total of 19 fish species were observed in the study period (Table 2). While several species are widely distributed such as *C. capoeta*, *A. filippii*, *A. eichwaldii* and *O. brandtii*, some others inhabit in a restricted areas such as *R. macropterus*, *L. satunini* and *P. cyrius* (Fig. 2-14). Three invasive fish species which is named *C. carpio*, *C. gibelio* and *P. parva* were successfully established to Lake Çıldır and Lake Aktaş.

Based on encountered species in previous studies and the sampled species during the study period, we are documented the presence of a total of 32 fish species from Turkish parts of Aras River Basin. The confirmed ichthyofauna comprises of 32 species in 11 families, 7 orders and 2 classes. These 32 fish species represent 8.7% of the freshwater fishes of Turkey (Çiçek et al. 2015).

Cyprinidae was the most dominant family with 18 species, representing 56.3% of the recorded species, followed by Nemacheilidae with three species, Cobitidae and Salmonidae with two species. The rest of the families were represented by a single species. Among the 32 species recorded in the basin, five are native species,

four are introduced species, and other 23 are endemic to Kura-Aras River and Caspian Sea basins.



Figure 2. *Acanthobrama microlepis* (Original).



Figure 3. *Alburnoides eichwaldii* (Original).



Figure 4. *Alburnus filippii* (Original).



Figure 5. *Barbus cyri* (Original).



Figure 6. *Capoeta capoeta* (Original).



Figure 7. *Chondrostoma cyri* (Original).



Figure 8. *Leucalburnus satunini* (Original).



Figure 9. *Luciobarbus capito* (Original).



Figure 10. *Luciobarbus mursa* (Original).



Figure 11. *Oxynoemacheilus brandtii* (Original).



Figure 12. *Ponticola cyrius* (Original).



Figure 13. *Romanogobio macropterus* (Original).



Figure 14. *Salmo caspius* (Original).

Discussion

Based on sampled species during the study period and listed species previous studies, we are documented the presence of a total of 32 fish species from Turkish parts of Aras River Basin. Some species, including *C. wagneri*, *A. persicus* and *A. caspia* are endemic in the Caspian Sea basins, and had been listed for the freshwater ichthyofauna of Turkey in previous studies. These species, as well as the Caspian Sea population of *S. leucichthys*, have seen a sharp decline after the construction of dams in the Caspian Sea watershed including the Kura and Aras rivers (Fricke et al. 2007; Freyhof and Kottelat 2008). These species are probably extinct in Turkey due to the construction of dams which have cut off the fish migration routes. Dam construction often prevents many migratory fish (an important food resource in many parts of the world) from reaching spawning and feeding grounds, changes the seasonal flow patterns afterward, and traps sediment in reservoirs to the detriment of downstream habitat, delta lands and nutrient regimes (Wong et al. 2007). There dam construction is one of the main threats to ichthyofauna of river basin (Coad 1980-1981).

Romanogobio persus sampled from Horasan (Erzurum) by Kuru (1975a, 1975b). However, this species is endemic species to Urumia basin (Iran) (Coad 2006). It is probable that *R. macropterus* was identified incorrectly as *R. persus*. *Squalius orientalis* described from Abkhazia, Georgia and *S. turcicus* described from Aras River at Erzurum, Turkey. Both species were given as subspecies of *S. cephalus* in previous studies (Kuru 1975a, 1975b; Zengin et al. 2012). Both of these have been listed as valid species by Turan et al. (2013). However, Coad (2015) put forward that *S. orientalis* and *S. turcicus* are synonym of *S. cephalus*. Therefore, this situation needs to be clarified by further studies. The entire of the Aras River Basin, trout found in areas has suitable habitats for trout. The species identified as *S. caspius*. However, given that detailed studies are lacking for trout, it is clear that there is need for detailed study on trout species.

In this study, some records were disregarded and excluded from ichthyofauna of Kura-Aras River Basin even listed in previous checklists (Kuru 1975a, 1975b; Kuru 2004; Fricke et al. 2007) as discussed below.

Barbus lacerta Heckel, 1843 was listed in the previous checklist (Kuru, 1971; 1975a, 1975b). However the distribution range of the species is now considered as restricted to Euphrates River Basin (Coad, 2015). Therefore *B. cyri* probably erroneously misidentified as *B. lacerta*.

Cobitis taenia distributed generally northern Europe, however reported from many parts of Turkey in the previous studies, including Aras River (Kuru 1975a). Kuru (1975a) caught many specimens belonging to genus *Cobitis* from different tributaries of Aras River. *Sabanejewia aurata* probably misidentified as *C. taenia* by the author.

There is a strong likelihood *P. cyrius* misidentified as *Gobius cephalarges constructor* in previous studies (Kuru 1975a, 1975b).

Scardinius erythrophthalmus was listed in the Lake Çıldır (Zengin et al. 2012). Because of natural distribution of the species does not contain Aras River Basin and the species erroneously given by the author.

Oxynoemacheilus tigris, *O. panthera* and *O. angorae* were reported from Kura and Aras rivers (Kuru 1975a, 1975b). However these species probably erroneously misidentified.

Some species given below are listed as questionable in this study, their presence in Turkish freshwaters needs confirmation.

Pseudophoxinus sojuchbulagi (Abdurakhmanov, 1950) was listed in the previous checklist as *Rutilus sojuchbulagi* (Fricke et al. 2007). The distribution range of the species is now considered as restricted to Azerbaijan (Bogustkaya et al. 2006).

Cyprinion tenuiradius is found in the Gulf and Lake Maharlu basins in Iran. The species has been listed from the Aras River system by Fricke et al. (2007), this record may be based on a confusion of the modern Aras or Araxes River with the classical Araxes or Kor River of Fars (Coad 2015).

Luciobarbus brachycephalus inhabits in the Caspian and Aral seas and their tributaries. The species reported from lower Kura and Aras rivers in Iran and Azerbaijan (Coad 2015). Its presence in Turkey needs confirmation by specimens.

Introduction and distribution of exotic and translocated species in freshwater habitats in Turkey is well-evaluated in the previous studies (Çetinkaya 2006; İnnal and Erk'akan 2006; İnnal 2012; Tarkan et al. 2014; 2015). The range extensions of some exotic species have been continuing into other parts of Anatolia and have been becoming invasive in the freshwater biomes of Turkey and cause some adverse effects on the native ichthyofauna. Invasive species intentionally or accidentally introduced or translocated fishes into this basin which has been changing the ichthyofaunal composition. Indeed, there have been dramatic changing and rise adverse effects after introduction of *C. gibelio* on native ichthyofauna of Lake Çıldır well documented (Zengin et al. 2012). By the way, habitat degradation, pollution and many other anthropological influences upon nature are other main threats to ichthyofauna of Aras River Basin.

This study provides recent status of the ichthyofauna of the Kura-Aras River basin. However, some gaps in the knowledge of this fish fauna still remain. Some questionable taxa (*Cobitis* sp. etc) need to be adequately surveyed from previously sampled location in order to confirmation by specimens. Additionally some taxa (genera *Squalius*) need to be revision in the light of recent knowledge.

Acknowledgements

In this study some of the fish samples were collected during the project which is named "Project on the Establishment of an Ecological Assessment System For Water Quality in Turkey" supported by Republic of Turkey, Ministry of Forestry and Water Affairs, General Directorate of Water Management. We are grateful to DOKAY Environmental Company to provide research facility during field sampling.

Literature cited

- Abdurakhmanov Y.A. 1950. New species of roach, *Rutilus sojuchbulagi* sp. nova. Doklady Akademii Nauk Azerbaidzhanskoi 6-3: 112-116.
- Aksu P. 2006. Genotoxic effects and LC₅₀ value of NAOCL on *Acanthalburnus microlepis* De-Filippi 1863. MSc Thesis, Kafkas University.
- Aksu P., Gül S., Baysal A., Özkan O., Nur G., Kaya Ö.T. 2008a. LC₅₀ value of NAOCL on *Acanthalburnus microlepis* De-Filippi 1863. 19. National Biology Congress. 23-27 June 2008, Trabzon.
- Aksu P., Gül S., Ozkan O., Nur G., Kaya O.T. 2008b. Evaluation of the acute toxicity and genotoxicity of NaOCl on *Acanthalburnus microlepis* De-Filippi 1863. Fresenius Environmental Bulletin 17: 298-302.

- Akyurt I. 1988a. A comparative study on the growth rate and various characteristics of sheatfish (*Silurus glanis* L.) and caner fish (*Barbus capito capito*) lived in the same habitat of Karasu Stream in Iğdır Plain. Atatürk University, Journal of the Faculty of Agriculture 19: 189-202.
- Akyurt I. 1988b. A Study on the bio-ecological and economical properties of the sheatfish (*Silurus glanis* L.) Lived in the Karasu Stream in Iğdır Plain. Atatürk University, Journal of the Faculty of Agriculture 19: 175-188.
- Anonymous 2015. River basin management. Republic of Turkey, Ministry of Forestry and Water Affairs, General Directorate of Water Management, Ankara. 40 p.
- Aras M.S. 1976. A bio-ecological study on trout in Aras and Çoruh Rivers Basins. Atatürk University, Journal of the Faculty of Agriculture 7: 1-16.
- Aras M.S., Karaca O., Yanar M. 1986. A bio-ecological study on trout in the bioecology of *Salmo trutta* L. species live in the Madrek Stream which is one of the spring branch of the Aras River. Atatürk University, Journal of the Faculty of Agriculture 17: 69-77.
- Ayaz M., Baysal A. 2004. A research on taxonomy of ichthyofauna of Kars River. Türk Sucul Yaşam Dergisi 19-26.
- Berg L.S. 1948-1949. Freshwater fishes of the USSR and adjacent countries. Vol. 1-3. Israel Program for Scientific Translations. Jerusalem, Reprinted translation. 1962-1965.
- Bilecenoğlu M., Kaya M., Cihangir B., Çiçek E. 2014. An updated checklist of the marine fishes of Turkey. Turkish Journal of Zoology 38: 901-929.
- Bogutskaya N.G., Küçük F., Atalay M.A. 2006. A description of three new species of the genus *Pseudophoxinus* from Turkey (Teleostei: Cyprinidae: Leuciscinae). Zoosystematica Rossica 15: 335-341.
- Çakır N. 2015. Determination of some population dynamical parameters of *Acanthobrama microlepis* (De Filippi, 1863) from Çıldır Lake. MSc Thesis, Nevşehir Hacı Bektaş Veli University, 36 p.
- Çalışkan M., Yerli V.S., Canbolat A.F. 1999. The growth parameters of *Barbus plebejus* Heckel, 1843 in Çıldır Lake-Ardahan. Turkish Journal of Zoology 23: 233-239.
- Canbolat A.F., Yerli V.S., Çalışkan M. 1999. The investigation of growth parameters of *Capoeta capoeta capoeta* (Guldenstant, 1773) in Çıldır Lake (Ardahan, Kars). Turkish Journal of Zoology 23: 225-232.
- Çetinkaya O. 2006. Exotic and native fish species that introduced or stocked into Turkish waters, their impacts on aquaculture, fisheries, wild populations and aquatic ecosystems: a preliminary study on constructing a database. Symposium on the stocking reservoir management. 07-09 February 2006, Antalya, Turkey.
- Çiçek E., Birecikligil S. 2015. Index of biotic integrity for evaluation and monitoring of water quality: using fish biotic integrity index. Nevşehir Journal of Science and Technology 4: 45-56.
- Çiçek E., Birecikligil S.S., Fricke R. 2015. Freshwater fishes of Turkey; a revised and updated annotated checklist. Biharean Biologists 9(2): 141-157.
- Coad B.W. 1980-81. Environmental Change and Its Impact on the Freshwater Fishes of Iran. Biological Conservation 19: 51-80.
- Coad B.W. 2006. Endemicity in the freshwater fishes of Iran. Iranian Journal of Animal Biosystematics 1: 1-13.
- Coad B.W. 2015. Freshwater fishes of Iran. Available from: www.briancoad.com. Retrieved 4/03/2015.
- Dağtekin B.B., Baştürk Ö. 2014. The determination of meat yield and biochemical composition of Prussian Carp, (*Carassius gibelio* Bloch, 1782) in the Çıldır Lake. Yunus Araştırma Bülteni 2: 15-22.
- Doadrio I., Carmona J.A. 2006. Phylogenetic overview of the genus *Squalius* (Actinopterygii, Cyprinidae) in the Iberian Peninsula, with description of two new species. Cybium 30: 199-214.
- Erdoğan O. 1988. Studies on the growth and reproduction peculiarities of *Capoeta capoeta capoeta* (Guldenstaedt, 1772) with physico-chemical properties of captured region waters in River Aras. PhD Thesis, Atatürk University, 93 p.
- Ewing A. 2003. Water quality and public health monitoring of surface waters in the Kura-Araks River Basin of Armenia, Azerbaijan, and Georgia. Water Resources Program, The University of New Mexico, Publication No. WRP-8, New Mexico, 55p.
- Freyhof J., Kottelat M. 2008. Caspiomyzon wagneri. The IUCN Red List of Threatened Species. Version 2014.3. Available from: www.iucnredlist.org. Retrieved 14/02/2015.

- Fricke R., Bilecenoğlu M., Sarı H.M. 2007. Annotated checklist of fish and lamprey species (Gnathostomata and Petromyzontomorpha) of Turkey, including a Red List of threatened and declining species. *Stuttgarter Beiträge zur Naturkunde* 706: 1-169.
- Grabarkiewicz J., Davis W. 2008. An introduction to freshwater fishes as biological indicators. EPA -260-R-08-016. U.S. Environmental Protection Agency, Office of Environmental Information, Washington DC.
- Gül S., Aksu P., Özkan O., Nur G., Kaya Ö.T. 2007. Genotoxic effects and LC₅₀ value of NAOCL on *Acanthalburnus microlepis* De Filippi 1863. Functional Genomics with Embryonic Stem Cells 24-26 November. EMBL Heidelberg, Germany.
- Güven A., Gül S., Kaya İ., Nur G., Deveci H.A., Kaya T.Ö. 2008. Antioxidant enzymes and lipid peroxidation in *Alburnus filippi* Kessler, 1877 and *Acanthalburnus microlepis* Filippi, 1863: a comparative study. *Kafkas Üniversitesi Veteriner Fakültesi Dergisi* 14: 13-18.
- Innal D. 2012. Alien fish species in reservoir systems in Turkey: a review. *Management of Biological Invasions* 3: 115-119.
- Innal D., Erk'akan F. 2006. Effects of exotic and translocated fish species in the inland waters of Turkey. *Reviews in Fish Biology and Fisheries* 16: 39-50.
- Karatepe M. 2014. An investigation on the growth and reproduction properties of *Capoeta capoeta capoeta* (Guldenstaedt, 1772) in Kars River. MSc Thesis, Atatürk University, 77p.
- Küçük F., Bayçelebi E., Güçlü S.S., Gülle I. 2015. Description of a new species of *Hemigrammocapoeta* (Teleostei: Cyprinidae) from Lake Işıklı, Turkey. *Zootaxa* 4052(3): 359-365.
- Kuru M. 1971. The fish fauna of the Eastern Anatolia Region. PhD Thesis, Atatürk University.
- Kuru M. 1975a. The systematical and zoogeographical assessment of freshwater fishes of the Euphrates-Tigris, Kura-Aras, Lake Van and the Black Sea Basins. Associate Professor Thesis, Ataturk University, 181 p.
- Kuru M. 1975b. The freshwater fish fauna of Eastern Anatolia. *İstanbul Üniversitesi Fen Fakültesi Mecmuası* 36: 137-147.
- Kuru M. 2004. Recent systematic status of inland water fishes of Turkey. *GÜ Gazi Eğitim Fakültesi Dergisi* 24: 1-21.
- Levin B.A., Freyhof J., Lajbner Z., Perea S., Abdoli A., Gaffaroğlu M., Özuluğ M., Rubenyan H.R., Salnikov V.B., Doadrio I. 2012. Phylogenetic relationships of the algae scraping cyprinid genus *Capoeta* (Teleostei: Cyprinidae). *Molecular Phylogenetics and Evolution* 62: 542-549.
- Nur G. 2006. Karyotype Analysis in *Acanthalburnus microlepis* (De Filippi, 1863) and *Alburnus Filippii* (Kessler, 1877) endemic to Kura-Aras River Basin. MSc Thesis, Kafkas University, 75 p.
- Sığırcı U. 2015. Determination of population parameters of south caspian spirin, *Alburnoides eichwaldii* (De Filippi, 1863), from Aras River basin. MSc Thesis, Nevşehir Hacı Bektaş Veli University, 43 p.
- Tarkan A.S., Ekmekçi F.G., Vilizzi L., Copp G.H. 2014. Risk screening of nonnative freshwater fishes at the frontier between Asia and Europe: first application in Turkey of the fish invasiveness screening kit. *Journal of Applied Ichthyology* 30: 392-398.
- Tarkan A.S., Marr S.M., Ekmekçi F.G. 2015. Non-native and translocated freshwater fish species in Turkey. *Fishmed Fishes in Mediterranean Environments* 003: 28 p.
- Temelli A. 1988. Bio-ecologic research of *Acanthalburnus microlepis* (Filippi, 1863) distribute in Aras River and its tributaries. MSc Thesis, Atatürk University, 70 p.
- Turan D., Kottelat M., Doğan E. 2013. Two new species of *Squalius*, *S. adanensis* and *S. seyhanensis* (Teleostei: Cyprinidae), from the Seyhan River in Turkey. *Zootaxa* 3637(3): 308-324.
- Turkmen M., Erdogan O., Haliloglu H.I., Yildirim A. 2001. Age, growth and reproduction of *Acanthalburnus microlepis*, Filippi 1863 from the Yağan Region of the Aras River, Turkey. *Turkish Journal of Zoology* 25: 127-133.
- Ural P. 2007. Growth properties of *Salmo trutta natio lacustris* (Slatenenko, 1955) caught from Lake Balık. MSc Thesis, Atatürk University, 52 p.
- Van der Laan R., Eschmeyer W.N. Fricke R. 2015. Family-group names of recent fishes. *Zootaxa Monograph* 3882: 1-230.
- Wong C.M., Williams C.E., Pittock J., Collier U., Schelle P. 2007. World's top 10 rivers at risk. WWF International. Gland, Switzerland, 52 p.

- Yanar M. 1984. Bio-ecological researches on *Leuciscus cephalus orientalis* (Nordman, 1840) and *Capoeta capoeta umbla* (Heckel, 1843) distribute in Karasu River and Creeks of Upstream. MSc Thesis, Atatürk University.
- Yayla D. 2014. Phenotypic features of *Cyprinus carpio* Linnaeus, 1758, *Capoeta capoeta* Gldenstadt, 1773 and *Squalius turcicus* De Filippi, 1865 from ıldır Lake. MSc Thesis Kafkas University, 54 p.
- Yerli S., Zengin M. 1998. An investigation on the reproduction of the common carp (*Cyprinus carpio* (Linnaeus, 1758)) from ıldır Lake-Turkey. Turkish Journal of Veterinary and Animal Sciences 22: 309-313.
- Yerli V.S., alıřkan M., Canbolat A.F. 1999. An investigation on the growth criterias of *Leuciscus cephalus* in ıldır Lake-Ardahan. Turkish Journal of Zoology 23: 271-278.
- Yerli V.S., Zengin M., Gnz E., alıřkan M., Canbolat A. F., Akbulut A., Emir N., Ata. 1993. The assessment of fish stocks in ıldır Lake. TBİTAK, DEBAG 079/G, 132 p.
- Yolaan E. 2005. Growth and reproduction of *Capoeta capoeta capoeta* (Gldenstaedt, 1772) living in Kars River. MSc Thesis, Kafkas University, 48 p.
- Zengin M., Yerli S.V., Dağtekin M., Akpınar İ.Ö. 2012. Changes in the fisheries of ıldır Lake (Turkey) in the last twenty years. Eğirdir Journal of Fisheries 8: 10-24.