

Article

Ichthyofauna of the Turkish parts of Kura-Aras River Basin

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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.

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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.

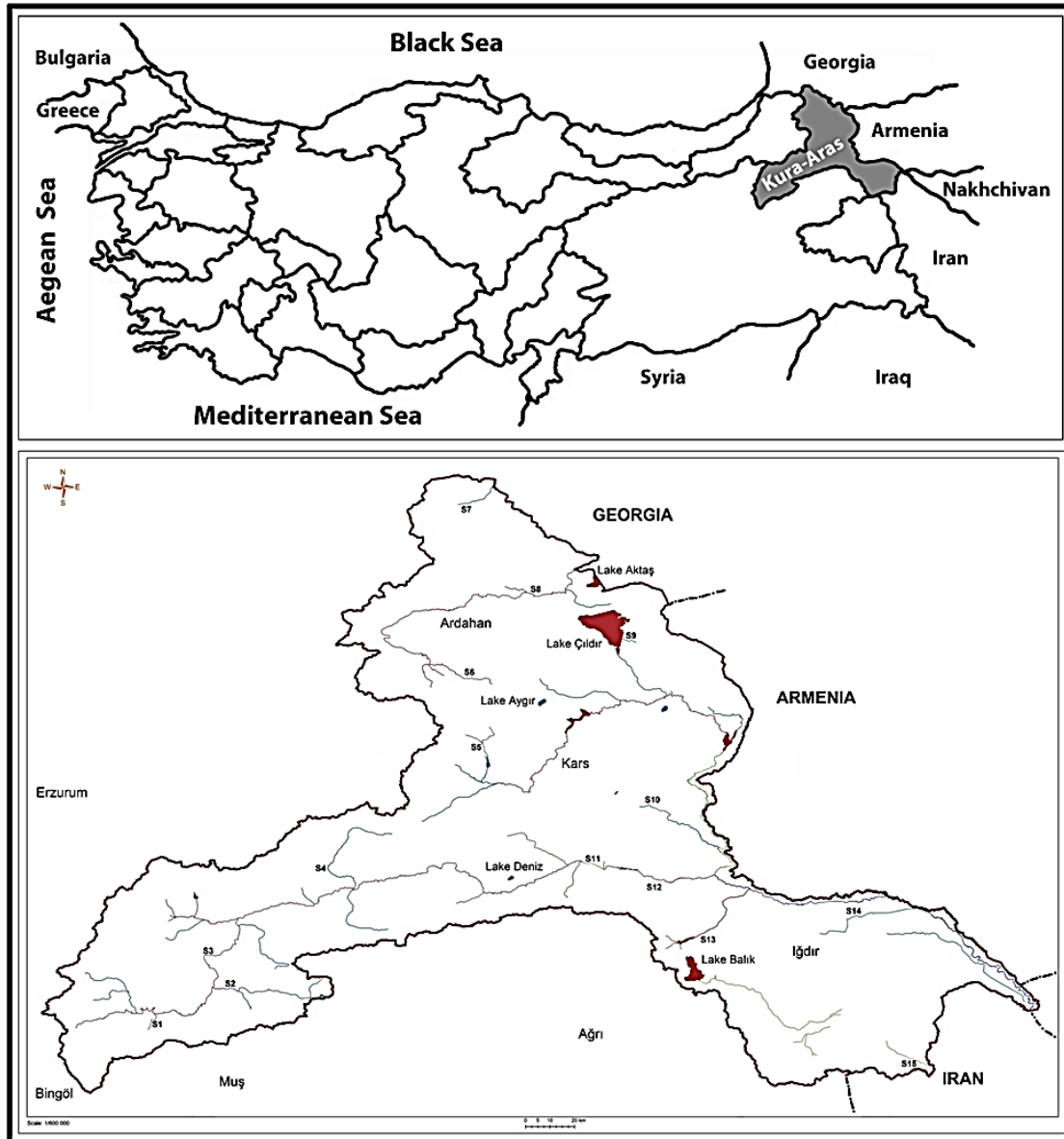


Figure 1. River Basins of Turkey and Sampling Location in Kura-Aras River Basin (S#: Station number).

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.

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