

[Research]

## *Hemiculter leucisculus* (Basilewsky, 1855) and *Alburnus caeruleus* Heckel, 1843: new data on their distributions in Iran

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### ABSTRACT

This paper provides information on the geographic distributions of two cyprinid species: *Hemiculter leucisculus* (Basilewsky, 1855) and *Alburnus caeruleus* Heckel, 1843, in the world and the entire drainage systems in Iran. The new distribution records were taken from Maroon River (Jarrahi River system) and Chardaval River (Karkheh river system), both in Tigris River basin showing wide and narrow distribution ranges of these two cyprinid fishes, respectively. The main introduction sites and distribution range of *H. leucisculus* is the southern parts of the Caspian Sea basin in Iran from where it has probably been translocated to other Iranian basins along with exotic Chinese carps. Although *A. caeruleus* is native to Tigris River basin, it had been already recorded only from Gamasiab and Doab rivers in 2009 in Karkheh River system (Tigris) and thus the present study extends its distribution range. In case of alien species, human-mediated fish introductions may increase faunal similarity among primary drainages due to a strong tendency for taxonomic homogenization caused primarily by the widespread introduction of cyprinid fishes. Fish faunal homogenization might be highest in drainages (e.g. Caspian Sea and Tigris basins) subjected to the greatest degree of disturbance associated with human settlement, infrastructure and change in land use. The provided data might be used in conservation program of freshwater fishes of Iran.

**Keywords:** Freshwater fishes, species invasions, translocation, biogeography

### INTRODUCTION

Similar to the trends observed in other countries, by dissolving physical barriers to movement and connecting formerly isolated regions of Iran, human-mediated species introductions have dramatically changed and restructured the present-day biogeography of freshwater fishes. In the case of freshwater fishes, the number of reported alien and invasive ones has reached about 32 species in 10 orders and 12 families distributed in almost all the drainage basins in Iran which is about 14.7% of the freshwater ichthyofauna in Iran (Esmaeili *et al.*, 2014a). Recent reports of new introductions and range extensions of exotic and native fishes which has changed the distribution patterns of Iranian inland fishes have well been documented (see Esmaeili *et al.*, 2010a, b, 2011a, b, 2013, 2014a, b, c; Coad, 2014; Khaefi *et al.*, 2014). Fish behavior, minimal resource

competition, suitable water temperature, changes in water flow, suitable habitat for spawning, number of release events, species-level factors (such as diet, offspring per year, growth rate, body size, lifespan) and abundant food supply have been recorded to be the main factors promoting establishment of introduced fish species. Whether through accidental introductions or intentional releases, many species attain distributions beyond their natural ranges and form novel interactions with native counterparts (Pateron *et al.*, 2013; Esmaeili *et al.*, 2014a). In this study, we map and report the distributions of two cyprinid species: *Hemiculter leucisculus* (Basilewsky, 1855) and *Alburnus caeruleus* Heckel, 1843 in Iran. The sawbellies, genus *Hemiculter* Bleeker, 1859, belongs to the hemicultrine group (middle-sized cyprinids). Eight species of this genus occur in Asia

(Coad, 2014), representing one of the six valid genera of the subfamily Cultrinae that are known only East Asia, including China, far-eastern region of Russia, Northern Korean peninsula, and Northern Vietnam (Dai and Yang, 2003; Nelson, 2006). *Hemiculter leucisculus* (Basilewsky, 1855), commonly called sawbelly, or *\_tizeh kuli\_* in Persian (=sharp or spiny fish, *\_kuli\_* being any small fish), is the only sawbelly that was accidentally introduced into Iran. The native range of this species is from maritime south Russia through China to Korea and Vietnam (Esmaili and Gholamifard, 2011). It has been probably introduced into Iran by accident along with commercial shipments of Chinese major carps from Central Asia in the former U.S.S.R. and/or Rumania in 1967 (Esmaili and Gholamifard, 2011; Coad, 2014). The Chinese major carps in Central Asia came from the Amur River basin in the Far East and sawbellies were accidentally transferred with them in the 1950s-1960s (Holčík and Razavi, 1992). *Hemiculter leucisculus* was reported for the first time in Iran from the Anzali Wetland by Holčík and Razavi (1992), and apparently was not uncommon there (Jolodar and Abdoli, 2004). Based on the works of Bogutskaya (1997), Bogutskaya and Naseka (2004) and Kottelat and Freyhof (2007), the *Alburnus* and *Chalcalburnus* genera were merged into single genus, *Alburnus* with about 38 species, among them, 7 species occur in Iran including *Alburnus atropatena* Berg, 1925; *Alburnus caeruleus* Heckel, 1843; *Alburnus chalcoides* Güldenstaedt, 1772; *Alburnus filippii* Kessler, 1877; *Alburnus hohenackeri* Kessler, 1870; *Alburnus mossulensis* Heckel, 1843 and *Alburnus zagrosensis* Coad, 2009 (Esmaili et al., 2010a; Coad, 2014). *Alburnus caeruleus* Heckel, 1843, the black spotted bleak, is found in the Tigris-Euphrates and Quwayq River systems (Freyhof, 2014). In Iran, it has been recorded by Abbasi (2009) from the Gamasiab and Doab rivers (34° 22' 16" N., 47° 54' 51" E., alt. 1412 m and 34° 27' 11" N., 47° 39' 34" E., alt. 1322 m) where he collected only 8 specimens and gave low fishing effort of 0.02% at fishing sites. The present study aimed at accessing the spatial distribution of *Hemiculter leucisculus* and *Alburnus caeruleus* and providing distribution map and new records for these species in their entire drainage basins in Iran.

## MATERIALS AND METHODS

In this study, the distributions of *Hemiculter leucisculus* and *Alburnus caeruleus* in the world and in the entire drainage basins in Iran were mapped. Materials for this study are resulted from (a) available data in fishbase (Fishbase, 2014); (b) available published data (Abdoli, 2000; Abbasi, 2009; Esmaili, 2011a; Coad, 2014); (c) extensive fieldworks that provided the geographic coordinate datasets for their distribution (mainly from ZM-CBSU data bank provided by H.R. Esmaili); (d) new samplings using electrofishing device, cast net, beach seine and hand net (scoop net). Distribution maps of the *Hemiculter leucisculus* and *Alburnus caeruleus* were constructed with DIVA-GIS (7.5.0) software (Hijmans et al., 2012) in which the new records for their southern distributions were shown. Newly collected specimens by the authors were preserved in 10% formalin in the field and were deposited in the Zoological Museum, Collection of Biology Department, Shiraz University (ZM-CBSU).

## RESULTS

Global (world) distribution maps of the *H. leucisculus* and *A. caeruleus* based on available data provided by Fishbase (2014) are shown in Figs. 1 and 2. *Hemiculter leucisculus* is native to Asia such as China, North and South Korea, Hong Kong, Japan and Amur River basin (Berg, 1964) to Red River drainages in Mongolia (Kottelat, 2006). It has been introduced to Iran, Afghanistan and Uzbekistan (Fig. 1). Fig. 3 shows distribution map of *H. leucisculus* in Iran based on prior data collections till 2012 and new collections made by the authors by electrofishing and by using hand net and hook, during field work on October 2012. Two specimens of *H. leucisculus* were collected in Maroon River, Behbahan (30° 40' 2.5"N., 50° 16' 17.8"E., alt. 320 m), Khuzestan Province (Fig. 3). Results revealed that at the present, *H. leucisculus* is found in three basins (e.g. Caspian, Urmia and Tigris) with doubtful record from Hari River basin (Fig. 3). Fig. 4 shows distribution map of *A. caeruleus* in Iran based on prior data collections till 2012 and new collections made by the authors during field work on October 2012. In this study one specimen of *A. caeruleus* was collected from Maroon River, Behbahan (30° 40' 2.5"N., 50° 16' 17.8"E., alt. 320 m), Khuzestan Province and four were captured from Chardaval River, Shir-

van (33° 41' 38.1" N., 46° 42' 57.4"E.), Ilam Province, Karkheh River system, Tigris basin (Fig. 4). At the present, *A. caeruleus* is found in Tigris River basin only (Fig. 4). Based on our field work *Alburnus mossulensis*, *Capoeta trutta*, *Chondrostoma regium*, *Carassobarbus luteus*, *Cyprinion macrostomum* and *Garra rufa* are species that co-exist with the two species above. Available data reveals that *H. leucis-*

*culus* was first reported from Anzali Wetland in 1992 and probably moved to western Caspian Sea basin in 1999-2004 and towards the southern east of the Caspian Sea basin during 2008. It seems that later, this fish has translocated from the Caspian Sea basin to two other basins including Urmia and upper Tigris basin and now it is recorded to be in the lower part of Tigris.

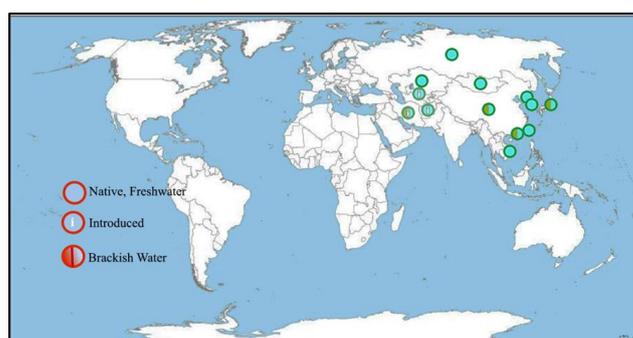


Fig. 1. Global distribution map of *Hemiculter leucisculus* (Modified from Fishbase, 2014).

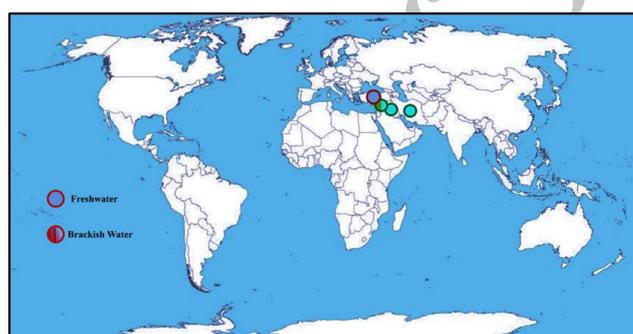


Fig. 2. Global distribution map of *Alburnus caeruleus* (Modified from Fishbase, 2014).



Fig. 3. Distribution map of *Hemiculter leucisculus* in Iran.

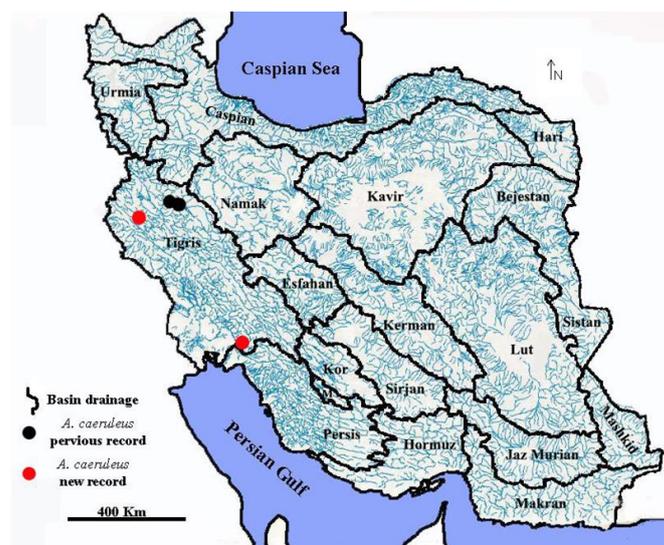


Fig. 4. Distribution map of *Alburnus caeruleus* in Iran.

## DISCUSSION

There is a long history in the introduction of non-indigenous fishes in freshwater ecosystems, the rate of which has accelerated greatly over time as methods of transportation have improved and trade barriers have relaxed (Copp *et al.*, 2005), the same is true in the case of freshwater ecosystems in Iran. Human-mediated movement of fish has a long history in Iran and probably has been started with the introduction of mosquito fish, *Gambusia holbrooki* (Poeciliidae) in 1920s (Esmaili *et al.*, 2010a; Coad, 2014). Since then, intentional, and accidental introduction, translocation and also range extensions or new records of freshwater fish species are being reported and discussed (see Esmaili *et al.*, 2010a,b, 2014a; Esmaili and Gholamifard, 2011; Coad, 2014) causing major ichthyofaunal changes in terms of number of species, distribution and biological impacts. While new records of native fishes (e.g. *A. caeruleus*) are good signs of biodiversity richness in the region; however, the movement of fish species beyond their natural range is potentially one of the most ecologically damaging of human activities and management of alien and translocated species may be one of the biggest challenges that conservation biologists face in coming decades. It seems that most of the translocated fish species are inadvertently moved with the Chinese carps as what happened in the case of *H. leucisculus*. Esmaili and Gholamifard (2011) reported that *Carassius gibelio* coexist with *H. leucisculus* in different locali-

ties and suggested that this species may have been introduced along with this exotic carps (Esmaili and Gholamifard 2011).

It seems that *H. leucisculus* is an ideal fish model in representing successful introduction, establishment and expansion of its distribution range. The natural distribution of this species is in East Asia, but it has been introduced outside this range (e.g. Iran, Iraq and Afghanistan), usually incidentally with Chinese major carps, which are important food fishes (Coad and Hussain, 2007). After successful introduction and establishment of *H. leucisculus* in Anzali Wetland (Holčík and Razavi, 1992), it became widely distributed in other bodies of water in the southern Caspian Sea basin. Abbasi *et al.* (1999), Kiabi *et al.* (1999), Abdoli (2000) and Gasmi and Mirzai (2004) recorded this species from the lower Sefidrud, Anzali Wetland and in the middle Aras River from the southern Caspian Sea basin. Patimar (2008) and Patimar *et al.* (2008) reported it from the International Wetlands of Alma-Gol, Adji-Gol and Ala-Gol and in Aab-Bandans (an artificial pool, in Golestan Province) in the south eastern Caspian Sea basin of Iran showing its movement to the eastern parts of this basin. It has also been reported to be in the Hari (=Tedzhen) River, Karakum Canal and Kopetdag Reservoir of Turkmenistan (as *H. eigenmanni*) (Aliev *et al.*, 1988; Shakirova and Sukhanova, 1994; Sal'nikov, 1995) and so may eventually be found in the Hari River basin of Iran expanding its populations in North Eastern part of Iran. Esmaili *et al.* (2011a) and

Esmaeili and Gholamifard (2011) also reported it in two new basins in the North Western of Iran including Zarivar Lake (Tigris basin) and Zarrineh River (Urmia basin). Coad and Hussain (2007) reported it from Hawizah Marsh (31°38'30"N., 47°35'21"E. and 31°36'02"N., 47°33'09"E.) in Iraq.

After its first record in the upper part of Tigris drainage in Iran (Esmaeili et al., 2011a), it was speculated that this might be the starting point of an invasion of the whole drainage system by this species. Based on the present study, it seems that sawbelly has invaded the other river system of Tigris basin (e.g. Maroon, Jarrahi river system); although, *H. leucisculus* seems to be still very rare in this body of water and only few individuals could be recorded.

The preferred habitat of this species are lakes, ponds, and backwaters of rivers; the lower reaches of slow flowing large and medium-sized rivers (Figs. 5 - 7); shallow water over sandy bottom rivers (Serov et al., 2006; Coad and Hossain, 2007; Think et al., 2012), which makes Mesopotamia area including Jarrahi river system ideal. It is a probable competitor with native species for food. Elsewhere, it is known to partially displace local species and shows more rapid growth and higher fecundity than under native conditions (Rosenthal in: Welcomme, 1988). Young fish feed on zooplankton and adults on plants, fish and insects. It is a predator on fish eggs and young and it can easily switch from a food to another as conditions warrant. It is an 'r' strategist forming dense, stunted populations in any new environment. This limits its utility as food, although

they are eaten in Iranian waters, and it becomes an environmental nuisance (Coad and Hossain, 2007). It is highly tolerant to water pollution (Think et al., 2012).

Despite wide distribution range of introduced *H. leucisculus* (Figs. 1 & 3), the native fish *A. caeruleus* has narrow distribution range in the world and in Iran (Figs. 2 & 4). It is distributed in Qweik, Euphrates and Tigris drainages from Southern Anatolia to Iraq (Freyhof, 2014). There are few records from Iranian sub drainage of Tigris. This paper reports for the first time, the occurrence of *A. caeruleus* in two new localities including Chardaval River (Figs. 8 & 9), Shirvan, (Karkheh River system, Tigris River basin) and Maroon River (Jarrahi River system). It was interesting that for a long time *A. caeruleus* was not reported from Iran. However, Abbasi (2009) recorded it from the Gamasiab and Doab rivers (Tigris River Basin). Similarity of this species to *Alburnus hohenackeri* and its low population may be the main reason for these late records. *Alburnus caeruleus* inhabits in the streams, rivers and lakes with moderate to slow current and reservoirs. Most likely sensitive to low temperatures as this species is, they are absent from the northern headwaters of Euphrates in Turkey (Freyhof, 2014). Human-mediated fish introductions may increase faunal similarity among primary drainages due to a strong tendency for taxonomic homogenization caused primarily by the widespread introduction of cyprinid fishes (e.g. *Cyprinus carpio*, *Hypophthalmichthys molitrix*, *H. nobilis*, *Pseudorasbora parva*, *Carassius auratus*), and poeciliid fish (*Gambusia holbrooki*).



Fig. 5. *Hemiculter leucisculus* from a canal that drains to Tajan River, Southern Caspian Sea basin.



Fig. 6. Habitat of *Hemiculter leucisculus*, a canal that drains to Tajan River, Southern Caspian Sea basin.



Fig. 7. Maroon River new locality record for *Hemiculter leucisculus*.



Fig. 8. *Alburnus caeruleus* from Chardaval, Karkheh, Tigris River basin, Iran.



Fig. 9. Chardaval River (Karkheh River system), new locality record for *Alburnus caeruleus*.

Fish faunal homogenization might be highest in drainages (e.g. The Caspian Sea and Tigris basins) subjected to the greatest degree

of disturbance associated with human settlement, infrastructure and change in land use (Fig. 10).



**Fig. 10.** Anthropogenic disturbance in freshwater ecosystem in Iran (Talar River, Southern Caspian Sea basin).

The scenario which significantly changes the present-day ichthyogeography in Iran. Understanding the role of invasive species and also new records of native fishes in defining patterns of present-day biogeography and preserving the antiquity of Iranian's freshwater biodiversity is highly recommended

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## داده های جدید از پراکنش دو گونه (*Hemiculter leucisculus* (Basilewsky, 1855) و *Alburnus caeruleus* Heckel, 1843 در ایران

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### چکیده

در این پژوهش اطلاعاتی از پراکنش جغرافیایی دو گونه از کپورماهیان (*Hemiculter leucisculus* (Basilewsky, 1855) و *Alburnus caeruleus* Heckel, 1843 در سطح جهانی و در تمام حوضه های آبریز ایران ارائه شده است. نمونه هایی از *H. leucisculus* و *A. caeruleus* به ترتیب از رودخانه های مارون در بهبهان و چرداول در سیروان هر دو از حوضه تیگریس جمع آوری گردید. دامنه پراکنش اصلی برای گونه *H. leucisculus* در ایران ناحیه جنوبی دریای خزر می باشد و بنظر می رسد از این حوضه به همراه گونه های غیربومی نظیر کپور چینی به دیگر حوضه ها منتقل شده است. اگرچه گونه *A. caeruleus* بومی حوضه تیگریس می باشد اما تنها از رودخانه های گاماسیاب و دوآب در سال ۲۰۰۹ گزارش شده است و این مطالعه گستره پراکنش آن را وسیع تر معرفی می کند. معرفی وسیع گونه ها به وسیله انسان از حوضه ای به حوضه دیگر ممکن است شباهت فونی بین حوضه ها را افزایش دهد. همسان شدن فون ماهیان در حوضه هایی که متحمل درجات زیادی از تخریب های مرتبط با فعالیت های انسانی نظیر فعالیت های زیر بنایی یا تغییر کاربری اراضی شده اند بیشتر باشد. این داده ها می تواند در برنامه ریزی های حفاظتی ماهی های آب شیرین ایران مفید باشد.

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