

ORIGINAL ARTICLE

Exotic fishes in the southern Caspian Sea basin; with four new records

Hamed MOUSAVI-SABET^{*1,2}, Ekaterina D. VASIL'EVA³, Soheil EAGDERI⁴, Victor P. VASIL'EV⁵,
Saber VATANDOUST⁶, Keyvan ABBASI⁷

¹Department of Fisheries, Faculty of Natural Resources, University of Guilan, Sowmeh Sara, Guilan, Iran.

²The Caspian Sea Basin Research Center, University of Guilan, Rasht, Iran.

³Zoological Museum, Moscow State University, Moscow, Russia.

⁴Department of Fisheries, Faculty of Natural Resources, University of Tehran, Karaj, Iran.

⁵Severtsov Institute of Ecology and Evolution, Russian Academy of Sciences, Leninskii prospect 33, Moscow, 119071 Russia.

⁶Department of Fisheries, Babol Branch, Islamic Azad University, Mazandaran, Iran.

⁷Iranian Fisheries Sciences Research, Inland Waters Aquaculture Research Center, Agricultural Research Education and Extension Organization (AREEO), Bandar Anzali, Iran.

Abstract

We listed 28 exotic fish species belonging to 22 genera, 15 families and 12 orders for Iranian part of the southern Caspian Sea basin, based on published records and specimens collected between 2000 and 2023. Their native distribution ranges, as well as occurrences in the Iranian waters are given, and the presence of four species is recorded for the first time from the region. Two species are new records for the whole country. The family containing the highest number of exotic species is Xenocyprididae (5 species) followed by Cyprinidae (4 species), Mugilidae and Poeciliidae (3 species each), and Salmonidae and Loricariidae (2 species each). Five species were determined to be invasive due to their wide distribution, established populations, and fast dispersal through the region (*Gambusia holbrooki*, *Carassius gibelio*, *Hemiculter leucisculus*, *Pseudorasbora parva*, and *Rhinogobius chen*). Alien fishes have been introduced for a variety of reasons in the region, including ornament, sport, aquaculture, biological control, and by accident.

Keywords: Aquarium trade, Anzali Wetland, Alien Species, Iran.

Correspondence: mosavii.h@gmail.com

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INTRODUCTION

Fishes are one of the aquatic taxa that have been widely introduced and translocated. The introduction of a non-native species to an ecosystem likely presents an ecological risk if the species is able to integrate itself successfully into the ecosystem (Gozlan & Newton 2009), resulting in possible detrimental interactions with native species or even with the function of the ecosystem (Gozlan et al. 2010). The problem of exotic species, particularly when they become invasive, is more severe when these species are introduced in ecosystems with low species richness such as occur in springs and oases, displacing or eliminating native species that have evolved in isolation for thousands of years with little competition (Douglas et al. 1994). The introduction of nonnative fish species has increased considerably within recent decades (Jouladeh-Roudbar et al. 2015), reaching 29 confirmed species belonging to eleven families for Iran (Esmaeili et al. 2018; Eagderi et al. 2022). With 864 small and large rivers and a catchment of 193,161 km² (Zakeri 1997), the southern Caspian Sea basin is

a large basin in Iran, with diverse habitat and connection to a brackish environment which provides such high diversity. From a regional point of view, 17 exotic fish species have been reported for the southern Caspian Sea basin in Iran (Esmaeili et al. 2014).

The aquaculture purposes, aquarium trade, sport fishing, control of malaria, research and accidental introductions have been the main reasons for these introductions in the country (Coad 1996; Esmaeili et al. 2007; Radkhah et al. 2016; Mouludi-Saleh et al. 2022). The present checklist identifies exotic fishes found in the Iranian part of the southern Caspian Sea basin, documents their distribution, and suggests approaches for future research and management strategies.

MATERIAL AND METHODS

The current checklist is based on information collected from searches of databases, review the available reports and extensive field expeditions since 2000 from different river systems of the Iranian part of the southern Caspian Sea basin. The Caspian Sea

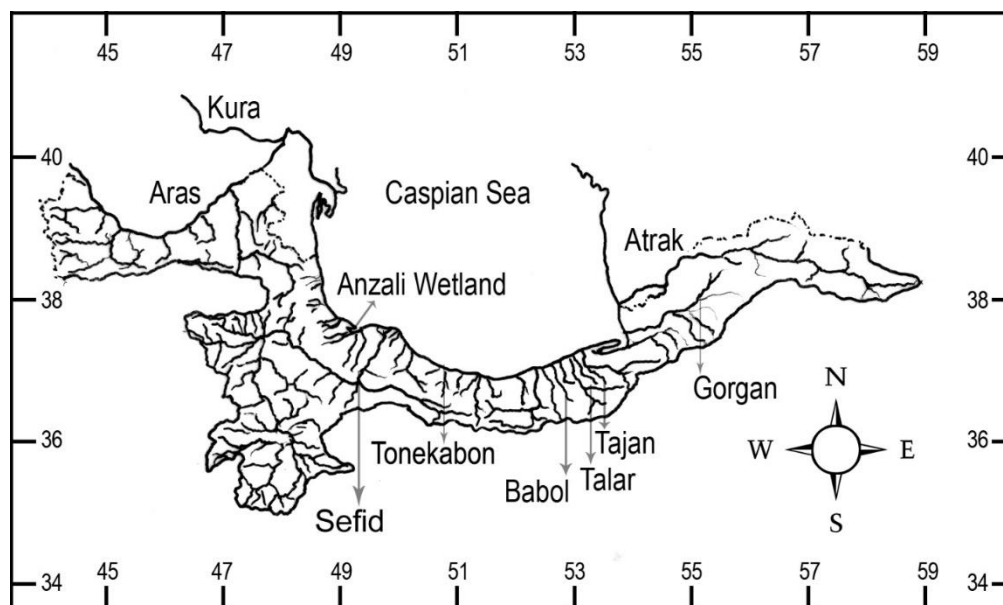


Fig.1. Map of Iranian portion of the southern Caspian Sea basin, showing some major rivers, including Atrak, Gorgan, Tajan, Talar, Babol, Tonekabon, Sefid, Aras and Kura rivers, and the Anzali Wetland.

basin is here taken to include both the rivers flowing into this Caspian Sea and the sea itself within Iranian territorial waters (Fig. 1).

RESULTS

Twenty-eight exotic fish species belonging to 22 genera, 15 families and 12 orders were documented for the southern Caspian Sea basin. The exotic fishes are listed below and their distributions are given. The family Xenocyprididae with five species (17.86% of the total exotic species in the southern Caspian Sea basin) is ranked first followed by the Cyprinidae (with 4 species, 14.28%), Mugilidae and Poeciliidae (each with 3 species, 10.71%), and Salmonidae and Loricariidae (each with 2 species, 7.14%), and nine families each with only one species or 3.57%. However, there are reports of some other exotic and transplanted species (Coad 1995), which have not been recently collected and cannot be confirmed to be present in Iran. Some species have been established, such as *Pseudorasbora parva*, *Hemiculter leucisculus*, *Chelon auratus*, *Chelon saliens*, *Gambusia holbrooki* and *Gasterosteus aculeatus*. Some species are questionably established but numerous in the basin due to stocking, such as *Hypophthalmichthys nobilis*, *Hypophthalmichthys molitrix*, and *Ctenopharyngodon idella*.

Order: Lepisosteiformes

Family: Lepisosteidae

Genus: *Atractosteus*

1. *Atractosteus spatula* (Lacepède, 1803)-Alligator gar

Native range: North America

Distribution in Iran: one specimen (Fig. 2), 420mm TL, 450g body weight, collected by local fisherman via beach seine from the Caspian Sea coast at Anzali (37°28'32.4"N, 49°29'31.8"E), in November 2015.

Comment: this species is reported for the first time from the southern Caspian Sea basin. It was formerly recorded from the Tigris River basin in Iran (see Esmaeili et al. 2017).

Order: Osteoglossiformes

Family: Notopteridae

Genus: *Chitala*

2. *Chitala ornata* (Gray, 1831)-Clown featherback, Knife fish

Native range: Mekong basin in Laos, Thailand, Cambodia and Viet Nam; Chao Phraya and Mae Klong basins.

Distribution in Iran: one specimen (Fig. 3), 403mm TL, 448g body weight, collected by local fisherman via beach seine from the Caspian Sea coast at Anzali (37°28'32.4"N, 49°29'31.8"E), in September 2012.



Fig.2. *Atractosteus spatula*, 420mm TL, the Caspian Sea coast at Anzali (specimen not retained).



Fig.3. *Chitala ornata*, 403mm TL, the Caspian Sea coast at Anzali (specimen not retained).

Comment: this species is reported for the first time from the southern Caspian Sea basin. It is also a new record for Iran.

Order: Anguilliformes

Family: Anguillidae

Genus: *Anguilla*

3. *Anguilla anguilla* (Linnaeus, 1758)-European eel

Native range: Europe, Mediterranean Sea, Baltic Sea, northeastern Atlantic.

Distribution in Iran: introduced into the Caspian Sea (Fig. 4).

Order: Cypriniformes

Family: Cyprinidae

Genus: *Carassius*

4. *Carassius auratus* (Linnaeus, 1758)-Goldfish

Native range: *Cyprinus auratus* was originally described from China and Japanese rivers.

Distribution in Iran: introduced into several rivers and aquatic ecosystems throughout the southern Caspian Sea basin and other basins in the whole country.

5. *Carassius gibelio* (Bloch, 1782)-Prussian carp

Native range: Eurasia, including Eastern Europe, Russia to northeastern China.

Distribution in Iran: introduced into several rivers and aquatic ecosystems throughout the southern Caspian Sea basin and other basins in the whole country.

Genus: *Cyprinus*

6. *Cyprinus carpio* Linnaeus, 1758-Common carp

Native range: Black Sea, Caspian Sea and Aral Sea basins.

Distribution in Iran: a native population of *Cyprinus carpio* occurs in the southern Caspian Sea basin in Anzali Wetland and the Sea itself; introduced into several rivers, reservoirs, and other aquatic ecosystems throughout the southern Caspian Sea basin and other basins in the whole country.

7. *Cyprinus rubrofasciatus* Lacepède, 1803-Amur carp (ornamental form-Koi)

Native range: East Asia, Russia and China.



Fig.4. *Anguilla anguilla*, about 700mm TL, the Caspian Sea coast at Anzali (specimen not retained).



Fig.5. Ornamented form of *Cyprinus rubrofuscus*, 318mm TL, Siah-Darvishan River (specimen not retained).

Distribution in Iran: one specimen of Koi carp (Fig. 5), 318 mm TL, 350 g body weight, was collected by electrofishing from Siah-Darvishan River (37°18'40.5"N, 49°23'45.4"E), related to the Anzali Wetland, in April 2017.

Comment: presence of Koi (ornamented *Cyprinus rubrofuscus* used in aquarium trade) is the first record for the southern Caspian Sea basin, which was formerly recorded from Namak Lake basin (see Mousavi-Sabet 2019).

Family: Xenocyprididae

Genus: *Ctenopharyngodon*

8. *Ctenopharyngodon idella* (Valenciennes, 1844)-
Grass carp

Native range: East Asia, from Amur River south to Xi Jang.

Distribution in Iran: introduced into several rivers, reservoirs, and other aquatic ecosystems throughout the southern Caspian Sea basin and other basins in the whole country.

Genus: *Hemiculter*

9. *Hemiculter leucisculus* (Basilewsky, 1855)-Korean sharpbelly

Native range: East Asia, from Amur River basin in Mongolia, Russia and China south to Mekong estuary, Vietnam; Korea; recorded from rivers of Peter the Great Bay drainage, Primorsky Krai.

Distribution in Iran: introduced accidentally into



Fig.6. *Mylopharyngodon piceus*, 970mm TL, the Caspian Sea coast at Anzali (specimen not retained).

several rivers, reservoirs, and other aquatic ecosystems throughout the southern Caspian Sea basin and other basins in the whole country.

Genus: *Hypophthalmichthys*

10. *Hypophthalmichthys molitrix* (Valenciennes, 1844)-Silver carp

Native range: most Pacific drainages of East Asia, from Amur River to Xi Jiang.

Distribution in Iran: introduced into several rivers, reservoirs, and other aquatic ecosystems throughout the southern Caspian Sea basin and other basins in the whole country.

11. *Hypophthalmichthys nobilis* (Richardson, 1845)-Bighead carp

Native range: southern and central China.

Distribution in Iran: introduced into several rivers, reservoirs, and other aquatic ecosystems throughout the southern Caspian Sea basin and other basins in the whole country.

Genus: *Mylopharyngodon*

12. *Mylopharyngodon piceus* (Richardson, 1846)-Black carp

Native range: East Asia, from Amur River basin south to Xi Jiang, southern China, northern Vietnam, and Taiwan.

Distribution in Iran: introduced into the Caspian Sea basin (Fig. 6).

Family: Gobionidae

Genus: *Pseudorasbora*

13. *Pseudorasbora parva* (Temminck & Schlegel, 1846)-Stone moroko, Topmouth gudgeon

Native range: East Asia: southern and central Japan, Taiwan and Hainan, Korean Peninsula, northern Vietnam, China, Mongolia, and Russia.

Distribution in Iran: introduced into several rivers, reservoirs, and other aquatic ecosystems throughout the southern Caspian Sea basin and other basins in the whole country.

Order: Characiformes

Family: Serrasalminidae

Genus: *Piaractus*

14. *Piaractus brachipomus* (Cuvier, 1818)-Pirapitinga

Native range: South America, Amazon River basin.

Distribution in Iran: one specimen (Fig. 7), 272mm TL, 735g body weight, was collected by local fisherman via beach seine from the Caspian Sea coast at Anzali (37°28'32.4"N, 49°29'31.8"E), in February 2011.

Comment: it was formerly recorded from the Tigris River and Hari River basins in Iran (see Esmaeili et al. 2017; Mousavi-Sabet et al. 2018).

Order: Siluriformes

Family: Loricariidae

Genus: *Hypostomus*

15. *Hypostomus plecostomus* (Linnaeus, 1758)-the suckermouth catfish or the common pleco

Native range: South America, Orinoco River basin.

Distribution in Iran: reported from the Anzali Wetland (Abbasi et al. 2019).



Fig.7. *Piaractus brachypomus*, 272mm TL, the Caspian Sea coast at Anzali (specimen not retained).



Fig.8. *Pterygoplichthys joselimaianus*, 201mm TL, Sefid River (specimen not retained).

Genus: *Pterygoplichthys*

16. *Pterygoplichthys joselimaianus* (Weber, 1991)- Gold Spot Pleco

Native range: Tocantins River basin, Brazil.

Distribution in Iran: two specimens (Fig. 8), 201-225 mm TL, 96-130 g body weight, were collected by electrofishing from Sefid River (37°26'24.0"N, 49°55'33.0"E), and the Anzali Wetland (37°27'54.7"N, 49°26'19.1"E), in April 2014 and August 2015 respectively.

Comment: this species is reported for the first time from the southern Caspian Sea basin. It is also a new record for Iran.

Family: Pangasiidae

Genus: *Pangasius*

17. *Pangasius sanitwongsei* Smith, 1931-Giant pangasius

Native range: Southeast Asia: Mekong and Chao Phraya River basins, Thailand, Cambodia, Laos, Vietnam and Yunnan (China).

Distribution in Iran: two specimens (Fig. 9), 392-

450mm TL, 658-1200g body weight, were collected by electrofishing in the Anzali Wetland (37°27'07.5"N, 49°28'08.4"E), and Sefid River (37°23'11.0"N, 49°54'19.0"E), in May 2015 and May 2014 respectively.

Order: Salmoniformes

Family: Salmonidae

Genus: *Oncorhynchus*

18. *Oncorhynchus keta* (Walbaum, 1792)-Chum salmon

Native range: North Pacific and Arctic.

Distribution in Iran: introduced into the Caspian Sea.

19. *Oncorhynchus mykiss* (Walbaum, 1792)-Rainbow trout

Native range: North Pacific and adjacent basins.

Distribution in Iran: introduced into several rivers, reservoirs, and other aquatic ecosystems throughout the southern Caspian Sea basin and the Sea itself for aquaculture purposes in cages. Also, introduced in most of the inland water basins in Iran.



Fig.9. *Pangasius sanitwongsei*, 392mm TL, the Anzali Wetland (specimen not retained).

Order: Gobiiformes

Family: Gobiidae

Genus: *Rhinogobius*

20. *Rhinogobius cheni* (Nichols, 1931)-Chinese goby

Native range: known from the lower reaches of the Yangtze River in China, from where, together with herbivorous cyprinids, it was introduced into the water bodies of Central Asia and Kazakhstan (Vasil'eva 2007).

Distribution in Iran: introduced accidentally along with Chinese carps into several rivers, reservoirs, and other aquatic ecosystems throughout the southern Caspian Sea basin.

Comment: in Iran it was formerly identified as *R. lindbergi* by several researchers. We have identified this species based on the species status of *Rhinogobius*, which has been widely introduced with carps (see Vasil'eva 2007), but special verification of the taxonomy of gobies introduced into Iranian waters is required.

Order: Mugiliformes

Family: Mugilidae

Genus: *Chelon*

21. *Chelon auratus* (Risso, 1810)-Golden grey mullet

Native range: Western Baltic Sea; North Sea; Mediterranean Sea; Sea of Marmara; Black Sea; Sea of Azov; eastern Atlantic.

Distribution in Iran: introduced into the Caspian Sea basin.

22. *Chelon saliens* (Risso, 1810)-Leaping mullet

Native range: Mediterranean Sea; Sea of Marmara;

Black Sea; Sea of Azov; eastern Atlantic.

Distribution in Iran: introduced into the Caspian Sea basin.

Genus: *Mugil*

23. *Mugil cephalus* Linnaeus, 1758-Flathead Mullet

Native range: Nearly circumglobal in temperate and tropical seas and estuaries.

Distribution in Iran: introduced into the Caspian Sea basin.

Order: Cyprinodontiformes

Family: Poeciliidae

Genus: *Gambusia*

24. *Gambusia holbrooki* Girard, 1859-Eastern mosquitofish

Native range: North America: Atlantic and Gulf Coast drainages, eastern U.S.A.

Distribution in Iran: introduced into the Caspian Sea basin and almost in whole country.

Genus: *Poecilia*

25. *Poecilia latipinna* (Lesueur, 1821)-Sailfin molly

Native range: North America: southeastern U.S.A. south to Tuxpan.

Distribution in Iran: introduced into the Caspian Sea basin (see Mousavi-Sabet et al. 2021).

26. *Poecilia reticulata* Peters, 1859-Guppy

Native range: Northern South America: coastal drainages between the Orinoco delta (Venezuela) and the Essequibo River delta, Guyana, Venezuelan Islands, the Netherlands Antilles and Trinidad and



Fig.10. *Channa micropeltes*, 530mm TL, Sefid River (specimen not retained).

Tobago.

Distribution in Iran: introduced into the Caspian Sea basin (see Abbasi et al. 2019), and Namak Lake basin.

Order: Anabantiformes

Family: Channidae

Genus: *Channa*

27. *Channa micropeltes* (Cuvier, 1831)-Indonesian snakehead or giant snakehead

Native range: Southeast Asia: Sundaland to Laos and Vietnam.

Distribution in Iran: two specimens (Fig. 10), 530-620mm TL, 1700-3100g body weight, were collected by electrofishing in the Sefid River (37°26'24.0"N, 49°55'33.0"E), and Anzali Wetland (37°26'54.8"N, 49°27'16.5"E) in November 2006 and December 2013, respectively.

Order: Scorpaeniformes

Family: Gasterosteidae

Genus: *Gasterosteus*

28. *Gasterosteus aculeatus* Linnaeus, 1758-Three spined stickleback

Native range: widespread in northern Europe, northern Asia and North America.

Distribution in Iran: introduced into the Caspian Sea.

DISCUSSION

The introduction of alien species has a negative impact on biodiversity. This is a global ecological problem, especially in inland water systems (Wellcomme 1992, Garcia-Berthou & Moreno-Amich 2000) and fisheries production (Sorensen & Hoye 2007). The

indiscriminate introduction of aquatic organisms from one habitat into another poses serious risks and represents a significant threat to aquatic biodiversity (Wellcomme 1988) since it can cause a decline in or even the extinction of endemic and native species (Lever 1996; Kumar 2000; Macneale et al. 2010). The introduced species could affect biodiversity through predation (Elvira et al. 1996; Nicola et al. 1996; McDowall 2006; Weyl & Lewis, 2006; Bampfylde & Lewis 2007; Yonekura et al. 2007), competition (Garcia-Berthou 1999; Caiola & Sostoa 2005; McDowall 2006; Zimmerman & Vondracek 2006; Blanchet et al. 2007; Alcaraz & Garcia-Berthou 2007), habitat modification/alteration and/or the disruption of ecological processes (Bruton 1995; Kitchell et al. 1997; Garcia-Berthou 2001; Tejerrina-Garro et al. 2005; McDowall 2006), disturbances in mate recognition (Seehausen et al. 1997), transmission of new pathogens or diseases (Daszak et al. 2000; Gaughan 2002; Gozlan et al., 2005 2006; Zenetos et al. 2009). These factors can have negative consequences on aquaculture and capture fisheries and/or other resources that impact the livelihoods of fisheries communities (FAO 2005), hybridization with native species (Elvira 1995; Allendorf et al. 2004; Costedoat et al. 2004, 2005; Hänfling et al. 2005; Almodovar et al. 2006; Nguyen & De Silva 2006; D'Amato et al. 2007; Peh 2010), and ecosystem modification (Zambrano et al. 2001; Peh 2010).

Iran has been considered as one of the freshwater fish biodiversity hotspots in the Middle East with more than 294 native (including 102 endemic) fish species (Eagderi et al. 2022). The number of exotic

fish species in Iran increasing in recent decades, reaching to 29 confirmed species comprising about 9.76% of the total confirmed freshwater fishes in this country (Esmaeili et al. 2018; Eagderi et al. 2022). Introductions of fish species into Iranian water bodies dates back a long time but were most prominent in the 1920s when the mosquitofish, *Gambusia holbrooki* has been introduced as an antimalarial agent (Esmaeili et al. 2010; Jouladeh-Roudbar et al. 2015). Later, five exotic species including *Oncorhynchus mykiss*, *Ctenopharyngodon idella*, *Hypophthalmichthys molitrix*, *H. nobilis* and *Cyprinus carpio* were introduced by Iranian Fisheries Organization (Shilat) for aquaculture purpose, but *Carassius gibelio*, *Hemiculter leucisculus*, *Pseudorasbora parva*, *Rhinogobius* sp., and *Gambusia holbrooki*, were accidentally transported with them into aquatic ecosystems. These five last unwanted introduced species were determined to be invasive due to their wide distribution, established populations, and fast dispersal through the region. In addition, our results confirmed that several exotic ornamental fish species are introduced into the region due to aquarium trade: *Atractosteus spatula*, *Chitala ornata*, *Carassius auratus*, *Piaractus brachipomus*, *Hypostomus plecostomus*, *Pterygoplichthys joselimaianus*, *Pangasius sanitwongsei*, *Poecilia latipinna*, *Poecilia reticulata*, *Channa micropeltes*, and Koi (*Cyprinus rubrofuscus*). It is well known that some aquarists frequently get rid of unwanted/oversized fishes by releasing them into natural water bodies. Therefore, one of the important pathways for introduction of non-indigenous species is the aquarium fish trade in Iran (see Mousavi-Sabet & Eagderi 2014, 2016; Esmaeili et al. 2017).

It can be concluded that aquaculture purposes, aquarium trade, sport fishing, control of malaria, research activities, demonstration in national fairs and accidental introduction are the main reasons for these introductions in the region (Mousavi-Sabet & Eagderi 2014, 2016; Esmaeili et al. 2017; Mousavi-Sabet 2018). To control exotic fishes, eradication programs and a public awareness campaign are proposed to ensure that aquarium trade and hobbyists do not

release these pet fishes into natural habitats. In addition, further faunal and taxonomic studies are of great importance to detect new possible invaders and determine the taxonomic status of both new and known species. This is especially true for *Rhinogobius*, tentatively identified in this work as *R. cheni*.

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مقاله کامل

ماهیان غیر بومی در حوضه آبریز جنوبی دریای خزر، با چهار گزارش جدید

سید حامد موسوی ثابت^{۱،۲}، کاترینا واسیلوا^۳، سهیل ایگدری^۴، ویکتور واسیلو^۵، صابر وطن دوست^۶، کیوان عباسی^۷

^۱گروه شیلات، دانشکده منابع طبیعی، دانشگاه گیلان، صومعه سرا، ایران.

^۲پژوهشکده حوضه آبی دریای خزر، دانشگاه گیلان، رشت، ایران.

^۳موزه جانورشناسی، دانشگاه دولتی مسکو، مسکو، روسیه.

^۴گروه شیلات، دانشکده منابع طبیعی، دانشگاه تهران، کرج، ایران.

^۵موسسه بوم‌شناسی و تکامل سورتسوف، آکادمی علوم روسیه، مسکو، روسیه.

^۶گروه شیلات، واحد بابل، دانشگاه آزاد اسلامی، بابل، ایران.

^۷پژوهشکده آبی‌پروری آب‌های داخلی، موسسه تحقیقات علوم شیلاتی کشور، سازمان تحقیقات، آموزش و ترویج کشاورزی، بندرانزلی، ایران.

چکیده

ما ۲۸ گونه غیر بومی متعلق به ۲۲ جنس، ۱۵ خانواده و ۱۲ راسته را برای بخش ایرانی حوضه آبریز جنوبی دریای خزر براساس گزارش‌های منتشر شده و نمونه‌های جمع‌آوری شده بین سال‌های ۲۰۰۰ تا ۲۰۲۳ لیست کردیم. محدوده پراکنش بومی آن‌ها و همچنین محدوده حضور در آب‌های ایران ارائه شده، و حضور چهار گونه برای اولین بار از این منطقه گزارش شده است. دو گونه از چهار گونه مذکور، گزارش جدید برای کشور ایران هستند. خانواده‌های با بیشترین تعداد گونه‌های غیر بومی مربوط به Xenocyprinidae (۵ گونه) و سپس Cyprinidae (۴ گونه)، Mugilidae و Poeciliidae (هر کدام ۳ گونه) و Salmonidae و Loricariidae (هر کدام ۲ گونه) هستند. پنج گونه به دلیل پراکنش وسیع، جمعیت‌های تثبیت شده و گسترش پراکندگی سریع در منطقه به عنوان گونه‌های مهاجم شناخته شدند. ماهی‌های غیربومی به دلایل مختلفی از جمله اهداف زینتی، ورزشی، آبی‌پروری، کنترل زیستی و یا به صورت تصادفی در منطقه معرفی شده‌اند.

کلمات کلیدی: تجارت آکواریوم، تالاب انزلی، گونه‌های غیر بومی، ایران.