FishTaxa (2017) 2(3): 126-133
E-ISSN: 2458-942X
Journal homepage: www.fishtaxa.com

Invasion of the Neotropical and Nearctic fishes to Iran

Hamid Reza ESMAEILI[*1], Mojtaba MASOUDI[1], Mohammad AMINI CHERMAHINI[2], Amir Hossein ESMAEILI[3], Fatah ZAREI[4], Mehregan EBRAHIMI[1, 5]

[1]*Ichthyology and Molecular Research Laboratory, Zoology Section, Department of Biology, College of Sciences, Shiraz University, Shiraz, Iran.*
[2]*Department of Fisheries, College of Natural Sciences, Behbahan Khatam Alanbia University of Technology, Behbahan, Khuzestan, Iran.*
[3]*Islamic Azad University, Kazeron Branch, Kazeron, Iran.*
[4]*Zarivar Bird Records Group Bureau, Chya Green Association, Marivan 6671915640, Kurdistan, Iran.*
[5]*School of Biological Sciences, Flinders University, Adelaide, South Australia.*
*Corresponding author: *E-mail: hresmaeili@shirazu.ac.ir*

Abstract

Iran harbors a native and highly endemic inland ichthyofauna which is being threatened by an increasing number of exotic fishes receiving from different geographic realms including the Neotropical and Nearctic regions. Here, the Neotropical and Nearctic fish elements within the Iranian freshwater ecosystems, including 7 species belonging to 6 genera and 4 families, are listed, their distribution ranges are given, new records for *Poecilia latipinna* (Poeciliidae) are documented and approaches to future research and management strategies are suggested. Based on presented data, the eastern mosquitofish, *Gambusia holbrooki* has a wide distribution range while the alligator gar, *Atractosteus spatula* and red-bellied pacu, *Piaractus brachypomus* have been restricted to one locality in the Tigris River drainages. Till date, all introduced species, except *Atractosteus spatula* and *Piaractus brachypomus*, have established breeding populations and act as invasive species. Control of malaria and ornamental purposes, are the main reasons for these introductions.

Keywords: Freshwater fish, Middle East, Biodiversity, Alien Species.
Zoobank: urn:lsid:zoobank.org:pub:66D8B8E5-97EF-4A0F-B914-AE07E6695400

Introduction

Biological invasions are a major environmental issue of public and scientific community concern (Kolar and Lodge 2001; Lymbery et al. 2014; Esmaeili et al. 2015, 2017). Human population growth, development of the aquarium trade industry, increasing transport capacity and economic globalization have accelerated the rate of introductions of alien species throughout the world (Vitousek et al. 1997; Sakai et al. 2001; Lymbery et al. 2014; Esmaeili et al. 2015).

Similar to trends observed in other countries, the number of aquatic invasive species in Iran has increased considerably over recent decades. These invasive species have caused huge economic costs, loss of native fishes, reduction of genetic diversity, change in species diversity and faunistic structure, and biotic homogenization in Iranian water bodies (Coad 1980, 1999; Esmaeili et al. 2015, 2017). The Iranian Plateau is an important zoogeographical area (Fig. 1), as it comprises several major ecoregions of the world including the Palearctic, Ethiopian and Oriental Realms (Coad 1998; Nalbant and Bianco 1998). However, it harbors some exotic fish elements from the Neotropical and Nearctic Realms (Esmaeili et al. 2010a, b, 2013a, b; Esmaeili and Teimori 2016), receiving more species over time especially in recent years (Fig. 2).

In this paper, the Neotropical and Nearctic fish elements within the Iranian freshwater ecosystems are listed, their distributions are given, new records for *Poecilia latipinna* (Poeciliidae) are documented and approaches to the future research and management strategies are suggested.

Material and Methods

This paper is based on our field work data since 2004, especially the collection of new fish materials. Fishes were collected from different water bodies, using different gears. After anaesthesia, fishes were fixed in 5% formaldehyde and stored in 70% ethanol or directly fixed in 99% ethanol. The collected specimens were

Accepted: 3 July 2017; Published: 10 August 2017

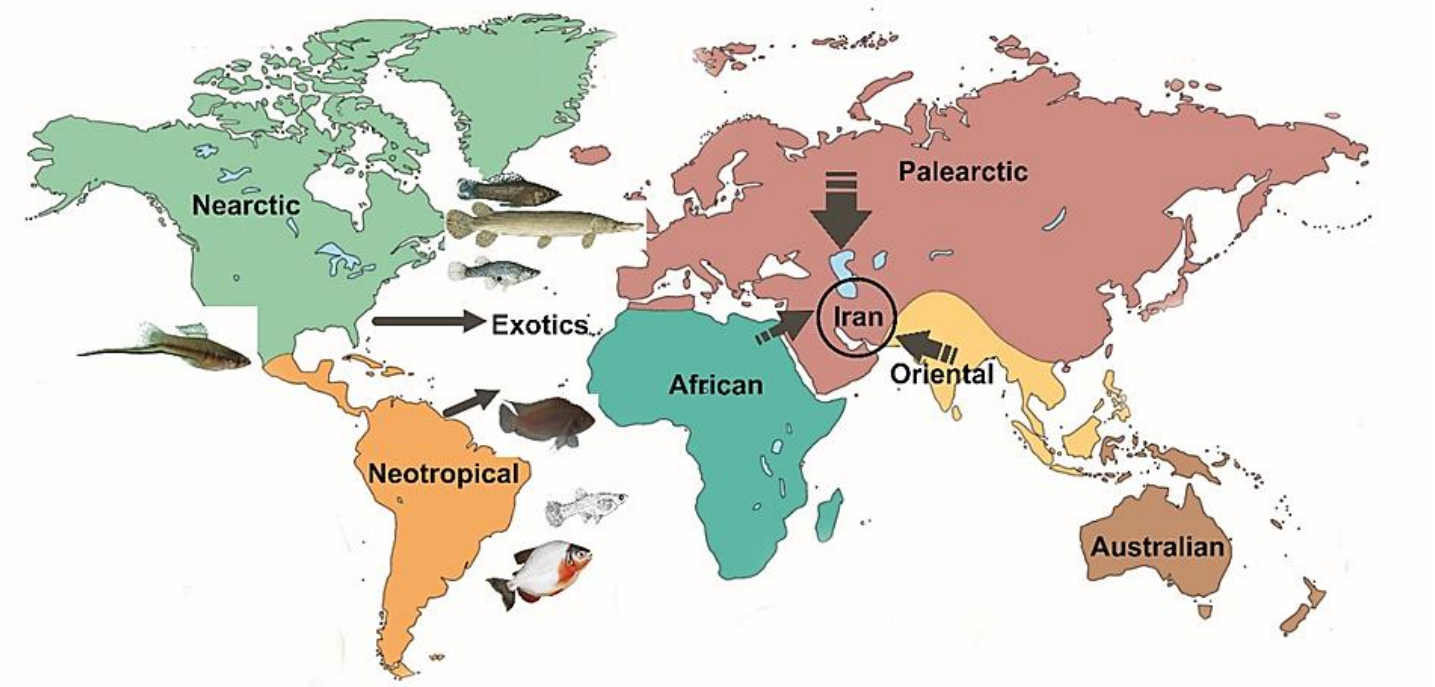

Figure 1. Map of the zoogeographic regions of the world showing Iranian ichthyofaunal elements (Palearctic, African, Oriental) and 7 exotics from the Neotropical and Nearctic realms.

deposited in the Zoological Museum of Shiraz University, Collection of Biology Department, Shiraz (ZM-CBSU).

Results

The Neotropical and Nearctic fish species introduced to the Iranian basins are detailed below and a distribution map is given in Figure 2. They comprise 7 species in 6 genera, 4 families, and 4 orders:

Order Lepisosteiformes

Family Lepisosteidae

Atractosteus spatula (Lacepède, 1803)

A single specimen of the Alligator gar, *Atractosteus spatula* (Fig. 3) was caught by local fishermen in March 2015 from Marivan (Zarivar) Lake, a Tigris River tributary of Iran (35°32'53.32"N, 46°7'19.08"E). Unfortunately, the fisherman was unable to preserve the specimen. The length of the specimen was about 65-70 cm. Only digital photographs and videos of fish were sent for identification. It might have been released by local people. It is known that these fishes are kept in aquaria all over the world including Iran, being sold in pet shops. It is also known that aquarists frequently get rid of unwanted fish by releasing them into open water bodies. The probability of natural reproduction of gars in the wetland is low mainly because they seem to get here episodically and in few numbers. At the same time, we cannot exclude the possibility that a gradual release of these long-living fishes may take place in Zarivar Wetland where they could find favorable conditions for spawning. According to a local fisherman, more specimens have been observed in the wetland in recent years. Monitoring of the wetland is highly recommended.

Atractosteus spatula is native to North America. However, a few notable sightings of alligator gar have been reported outside North America including Turkmenistan (Salnikov 2010), Hong Kong, Singapore, and India. Iran is a new locality for this fish.

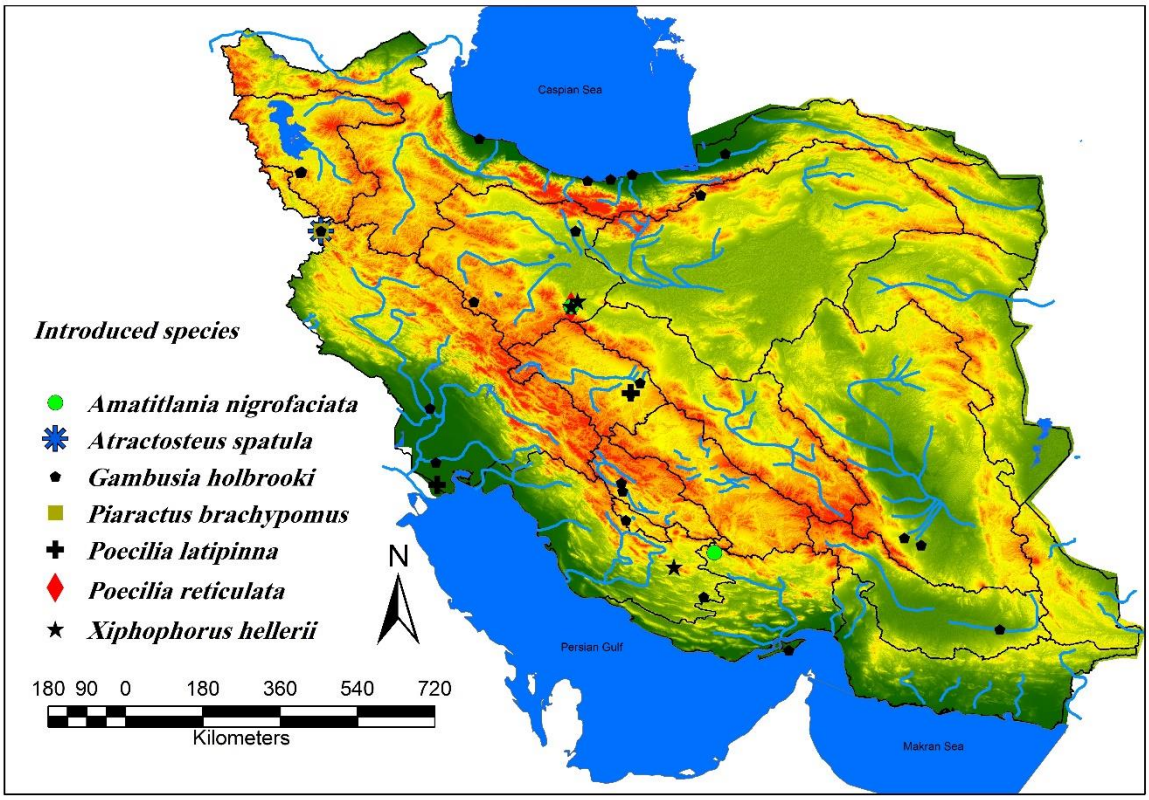

Figure 2. Map of Iran showing the distribution of 7 exotics with the Neotropical and Nearctic realms origin in different basins.

Figure 3. The Alligator gar, *Atractosteus spatula* caught by local fishermen in March 2015 from Marivan (Zarivar) Lake, Tigris River drainage, Iran (Photographed by Chya Green Association, Marivan).

Order Characiformes

Family Serrasalmidae

Piaractus brachypomus Cuvier, 1818

The presence of a South American fish, the red-bellied pacu, *Piaractus brachypomus* in Iran (Fig. 4) has been reported by Zarei and Rajabi-Maham (2017). They reported two specimens from Zarivar Lake in October 2015 and January 2016 (177 mm SL). Zarei and Rajabi-Maham (2017) could not determine how this exotic fish species reached the lake nor determine its actual abundance. However, the aquarium trade is a very small business in Marivan city and *P. brachypomus* is not very common in its aquarium stores. But, the incidental releases by aquarium hobbyists and aquarium trade has already been responsible for the introduction of *P. brachypomus* into the natural waters of Europe (Hensel 2004; Ćaleta et al. 2011) and India (Datta and Nandeesha 2006; Chatterjee and Mazumdar 2009; Dahanukar et al. 2011; Singh and Lakra 2011; Unmesh et al. 2012; Johnson 2014; Zeena and Beevi 2014).

Figure 4. Red-bellied pacu, *Piaractus brachypomus* collected from Marivan (Zarivar) Lake, Tigris River drainage, Iran (Photographed by Chya Green Association, Marivan).

The natural distribution of this species is South America. Predation, competition for trophic resources and habitat, behavioral interference, disease transmission and habitat and ecosystem alteration have been considered as potential impacts of introduced *P. brachypomus* on native fishes (Leunda 2010). The traders, aquarists and the general public must be made aware of the dangers of such carnivorous exotic species in the local natural ecosystems.

Order Cyprinodontiformes

Family Poeciliidae

Gambusia holbrooki (Girard, 1859)

The Iranian introductions of Eastern mosquitofish, *Gambusia holbrooki* were part of an active and successful program to control larval mosquitos, starting in 1922-1930 (Coad 2017). It has now been established in almost all the Iranian basins. The natural distribution of this species is North America, but it has been introduced to all continents except Antarctica.

Predation, competition for trophic resources and habitat, behavioral interference, disease transmission and habitat and ecosystem alteration have been considered as potential or demonstrated impacts of introduced *G. holbrooki* on native fishes (Leunda 2010).

Poecilia latipinna (Lesueur, 1821)

The first evidence of the sailfin molly, *P. latipinna* introduction in Iran comes from the study by Khalaji et al. (2016) who collected 30 specimens (55 mm TL) from Hasan Abad Qanat and Malvajerd, Esfahan Province, Zayandehrud Basin (32°8'17.02"N, 52°37'18.59"E, August 2013). Two ectoparasites *Ichthyophthirius multifiliis* Fouquet, 1876 and *Ichthyobodo* sp. were recorded from the collected specimens. An ichthyological survey in April 2017 from the same locality revealed that the population has been established and it co-exists with *Cyprinus carpio, Carassius auratus*, *G. holbrooki* and the endemic fish *Aphanius isfahanensis*. Out of 29 collected specimens of *P. latipinna* (13.1-55.7 mm SL) and 15 specimens of *A. isfahanensis* (14.9-23.4 mm SL), one specimen of *P. latipinna* (55.7 mm SL) and 8 specimens of *A. isfahanensis* were infected with *Lernaea* sp. showing the sensitivity of endemic tooth-carp fish to this copepod anchor worm.

Here, we report another established population of *P. latipinna* in the Tigris River tributary in Iran. We collected two male and female specimens of *P. latipinna* from Choibdeh canal, Arvand River (Fig. 5), Choibdeh

Figure 5. Male (above) and female (below) sailfin molly, *Poecilia latipinna* collected from Choibdeh canal (Arvand River), Choibdeh village, southeast Abadan, Khuzestan Province, Iran, August 27, 2014.

village, southeast Abadan, Khuzestan Province (30°12'25.8"N, 48°33'47.7"E, August 27, 2014). On April 6, 2017, a total of 23 specimens (13 males and 10 females, 26.3-51.2 mm SL) were collected from the same locality revealing establishment of this exotic fish.

Poecilia latipinna is native to the southeastern U.S.A. and south to Mexico but because of its wide environmental tolerances (Nunez et al. 2015) and popularity as an aquarium fish, *P. latipinna* has been introduced widely (Al-Faisal and Abdullah 2014) and has established breeding populations in most countries. Several countries have reported adverse ecological impacts of *P. latipinna* after its introduction (Smith 1997). Monitoring of this fish is highly recommended.

Poecilia reticulata Peters, 1859

Occurrence of the guppy, *P. reticulata* in Iran was first reported by Mousavi-Sabet and Eagderi (2014) who collected it from Soleiman Spring, Namak Lake basin on 31 October 2014 in sympatricity with *Capoeta aculeata* and *X. hellerii*. It seems that *P. reticulata* was introduced into Iran as an aquarium fish, but is now established in at least one natural habitat in Soleiman Spring (Mousavi-Sabet and Eagderi 2014). Disease transmission, predation, competition for trophic, competition for habitat and behavioral interference have been proposed to be major potential impacts of introduced *P. reticulata* on native fish fauna (Leunda 2010).

The natural distribution of *P. reticulata* is South America (Froese 2017). However, its distribution range has expanded dramatically and it is now established in at least 69 countries outside of its native range (Deacon 2011). Mosquito control, accidental introduction and intentional release of aquarium fish into natural water bodies are the main reasons of *P. reticulata* introduction. Due to its severe impacts on native fishes and other aquatic organisms and also being a carrier of certain exotic trematode parasites (Leberg and Vrijenhoek 1994), its monitoring is highly recommended.

Xiphophorus hellerii Heckel, 1848

The first record of green swordtail, *Xiphophorus hellerii* dates back to June 2008 (Esmaeili et al. 2010b). The

second introduction site was Soleiman Spring in central Iran (Esmaeili et al. 2010a). More specimens were collected from the same spring, in 2014-2015 (Mousavi-Sabet and Eagderi 2014) indicating the establishment of this exotic poeciliid fish.

The native distribution range of *X. hellerii* is North and Central America. However, it has been introduced into at least 33 countries and territories, as it is one of the most popular aquarium fish species (Esmaeili et al. 2010a). *Xiphophorus hellerii* may cause harm to native fishes because of its ability to reproduce rapidly. As the introduction of exotic fishes may affect populations of native fishes through predation, competition, habitat changes, genetic changes, and the introduction of parasites and diseases, special care should be taken to prevent such introductions.

Order Cichliformes

Family Cichlidae

Amatitlania nigrofasciata (Günther, 1867)

Esmaeili et al. (2013a) documented the first record of the convict cichlid, *Amatitlania nigrofasciata* specimens collected from the Golabi Spring, a fresh warm water site in the Kol River (Hormuzgan basin) in 2011 (Fig. 2). New collections in 2017 revealed that the population is still found in the same locality and it has been established. It has also been recorded from Soleiman Spring, Namak Lake basin by Mousavi-Sabet and Eagderi (2016). *Amatitlania nigrofasciata* is native to Central America but has been introduced to some other countries causing harm to native fishes due to its aggressive and territorial behavior (Bassleer 1997; Wisenden, 1994; Mrtinez 2002).

Discussion

Iran has been considered as one of the freshwater fish biodiversity hotspots within the Middle East harboring more than 262 native (including 88 endemic) fish species (Esmaeili et al. 2017). However, anthropogenic effects resulted in the introduction of 26 previously recorded exotic fish species (Esmaeili et al. 2017) and 3 recent records (*A. spatula*, *P. brachypomus* and *P. latipinna*). Out of these 29 exotic species, 7 species (24%) have Nearctic/Neotropical origins. The introductions have been attributed to mosquito control to prevent malaria (*G. holbrooki*) and mostly release of aquaria fishes (6 other species). Fortunately, two exotic fishes, *A. spatula,* and *P. brachypomus* have not established self-sustaining populations due to the low frequency of individual introduction. However, there is a great possibility that a gradual release of these long-living fishes provides favorable conditions for growth, spawning, and establishment. Based on the available documents, predation, competition for trophic resources and habitat, behavioral interference, disease transmission, habitat and ecosystem alteration, hybridization have been mainly considered as potential or demonstrated impacts of introduced fishes on native fishes (Leunda 2010). However, knowledge of the impact mechanisms and interactions of most exotic freshwater fish species in Iran is rare and inadequate. Improvement of fishery management, improvement of conservation strategies through gaining knowledge of the mechanisms by which non-native fish may degrade ecosystems and interact with native/endemic fishes, and gaining public awareness which could be effective in order to prevent or reduce future ornamental fish releases are highly recommended.

Acknowledgments

We would like to thank G.H. Burgess and M. Schartl for verification of *P. latipinna* and Chya Green Association (Marivan) for providing photos. The research work was funded by Shiraz University and was approved by the Ethics Committee of Biology Department (SU- 909830).

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