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A Composition and Abundance of Alien Fish Species in Inland Waters, Southern Iraq

Abdul Hussein J. Abdullah[*1], Sajad A. Abdullah[1], Ali T. Yaseen[2]
[1]Department of Marine Vertebrate, Marine Science Centre, University of Basrah, Basrah, Iraq
[2]Department of Biology, College of Education-Qurna, University of Basrah, Basrah, Iraq

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Abstract

Alien fish species have negative effects on the abundance, diversity and richness of native fish species in southern Iraq. The numbers of alien fish species are constantly increasing due to the entry of invasive species. This has resulted in shifts in the historical composition of fish community structure and scarcity of some native species which represent the keystone in the building of fish populations.

Fish samples were monthly collected from three sites in southern Iraq (Al-Chibyaish marsh, the lower parts of Euphrates River, and the northern part of Shatt Al-Arab River) from April 2017 to June 2018. A total of 14,853 individuals of fish were sampled, which represented 26 species, 24 genera and 13 families of bony fishes. Ten alien fish species were recorded, affiliated to nine genera and five families, namely Cichlidae, Cyprinidae, Heteropneustidae, Poeciliidae and Xenocyprididae. Three alien fish species dominated the abundance in the three sites; the Prussian carp *Carassuis gibelio* comprised 12.58%, 26.19%, and 13.84%, the Blue tilapia *Oreochromis aureus* formed 16.78%, 13.66%, and 18.79%, , and the Redbelly tilapia *Coptodon zillii* comprised 7.37%, 7.71%, and 14.66% of the total number of species in three study sites respectively. (….)

These alien fish species created serious shifting in fish composition, diversity, richness, and abundance of native fish populations in comparison to the results of the historical survey in southern Iraq.

Keywords: Composition, Abundance, Diversity, Alien fish species, Southern Iraq.

تركيبة ووفرة انواع الأسماك الدخيلة في المياه الداخلية، جنوب العراق

عبد الحسين جعفر عبد الله [1*], سجاد عبد الغني عبد الله [1] , علي طه ياسين[2]
[1]قسم الفقريات البحرية، مركز علوم البحار، جامعة البصرة، العراق
[2]قسم علوم الحياة، كلية التربية , جامعة البصرة، البصرة العراق

الخلاصة

للأنواع الدخيلة تأثير سلبي على وفرة وتنوع وغنى انواع الاسماك المحلية الاصيلة. يستمر عدد انواع الاسماك الدخيلة بالتزايد بسبب دخول انواع جديدة، مما ادى الى تغير تركيبة مجتمع الاسماك التاريخية، وأحدثت تغيرات في وفرة الانواع المقيمة، فضلاً عن ندرة بعض الانواع التي تمثل حجر الزاوية في بناء مجتمعات الاسماك.

جمعت عينات الاسماك شهرياً من مناطق الدراسة الثلاث (هور الجبايش و الاجزاء السفلى لنهر الفرات والجزء الشمالي لشط العرب) للفترة من نيسان 2017 الى حزيران 2018. جمع 14853 نموذج من الاسماك تمثل

*Email: abdalhussin112@yahoo.com

26 نوعاً و 24 جنساً و12 عائلة من الاسماك العظمية. كانت عشرة انواع منهم من الاسماك الدخيلة تنتمي الى تسعة اجناس خمس عوائل هي Cichlidae و Cyprinidae و Heteropneustidae و Poeciliidae. و Xenocyprididae. تصدرت ثلاثة انواع دخيلة مواقع الدراسة الحالية الكارب البروسي *Carassuis gibelio* وتضمنت 12.58% و 26.19% و 13.48% من المجموع الكلي للأنواع في هور الجبايش والاجزاء السفلى لنهر الفرات والجزء السفلي لشط العرب بالتعاقب. شكل البلطي الازرق *Oreochromis aureus* 16.78% و 13.66% و 18.79% من المجموع الكلي للصيد في المواقع الثلاث بالتعاقب، والبلطي احمر البطن *Coptodon zillii* 7.37% و 7.71% و 14.66 بمواقع الدراسة الثلاث بالتعاقب.

أحدثت الانواع الدخيلة تغيرات جدية في تركيبة وتنوع وغنى ووفرة تجمعات الانواع المحلية الاصيلة مقارنةً بالدراسات التاريخية في جنوب العراق.

Introduction

The biological invasion is a serious challenge to the conservation of the biodiversity of natural resources. It is one of the most important threats that has adverse impacts, contributes to the loss of biodiversity, and creates pressure on the ecosystems in terms of the ecological and economical aspects [1]. Evolution of transportation equipment enhances the role of human activities in the relocation of the biota across long distances to new habitats, leading to an increase in the ratio of alien species that change the structure of communities to a new colonization [2]. The emergence of globalization and the growth of trade and tourism, with the focus on free trade, create more opportunities for the spread of new fish species, intentionally or unintentionally, to extensive regions in the world [3, 4]. Fish species are a keystone in freshwater ecosystems, where their presence and abundance are used as indicators of water quality and health of ecosystems. One of each five freshwater fish species are reported to facing extinction globally [5]. The results around the world showed the appearance of new problems with increasing the introduction of new alien fish species. These problems include increased environmental pressures caused by overcrowding, lack of growth, genetic hybridization, transmission of diseases, and competition on food and place, leading to the extinction of many native species [6].

Since the 1950s, many alien fish species were introduced to Iraqi inland waters for biological control (i.e. *Heteropneustes fossilis*, *Gambusia holbrooki*, *Ctenopharyngodon idella*) and for aquaculture. Some of these species entered incidentally from neighboring countries or introduced as ornamental fish which then escaped into inland water, representing most of the alien fish species **[**7-10].

Most of the studies that were executed on the alien fish species in the study area were related to taxonomy [11- 16], except one study which was implemented by Mohamed and Abood [9] on the structure and abundance of alien fish species in the Shatt Al-Arab River and recorded 13 alien fish species.

The objective of the present study is to verify the variations in composition and abundance of fish species after the entrance of several alien species that created changes in the natural structure of fish communities in southern Iraq.

Materials and Methods

The samples were monthly collected from the three sites in southern Iraq (Al-Chibyaish marsh, southern part of Euphrates Rivers and northern part of Shatt Al-Arab River) during the period from April 2017 to June 2018 (Figure-1). Several fishing methods were used to collect the samples, including seine nets, fixed gillnets, drift gillnets, and cast nets. The relative abundance of species was estimated according to Odum [17], while the occurrence was determined following Tyler [18]. Fish species were identified according to Coad [7], while the methods of Carpenter *et al*. [19] and Iwatsuki *et al*. [20] were used for marine fishes, and those of Freyhof *et al*. [21] and Frick *et al*. [22] were used for *Aphanius stoliczkanus*. The scientific names were assigned as updated by Froese and Pauly [23]. Several studies were surveyed to obtain suitable information about the freshwater alien fish species in southern Iraq [7, 11, 12, 13, 14, 15, 16, 24, 25, 26].

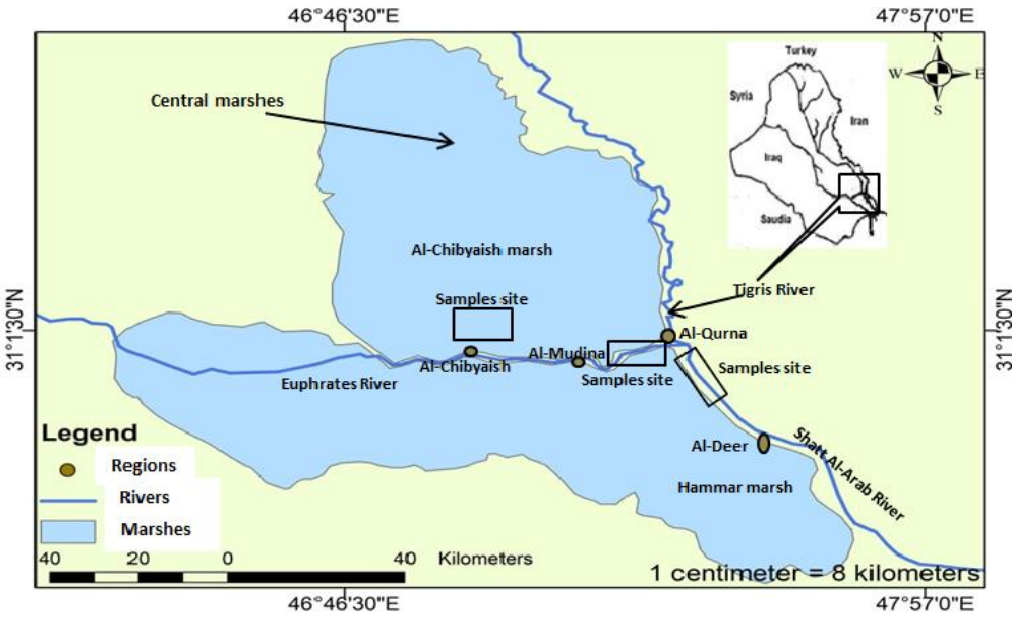

Figure 1- Map of study areas illustrating the sampling of fishing sites in the period from April 2017 to June 2018 to study the Alien fish species

Results and discussion

Number and abundance of alien species

A total of 14,853 fish specimens were collected from the three sites in southern Iraq, represented by 26 species, 24 genera, and 13 families of bony fishes. The results indicated the occurrence of 11 native, 5 marine, and 10 alien fish species. The distribution of alien species according to the families was as follows: three Cichlidae species (*Coptodon zillii*, *Oreochromis aureus*, *O. niloticus*), three Xenocyprididae species (*Ctenopharyngodon idella*, *Hemiculter leucisculus* and *Hypophthalmichthys nobilis*), two Cyprinidae species (*Carassius gibelio* and *Cyprinus carpio*), and one species for each of Heteropneustidae (*Heteropneustes fossilis*) and Poeciliidae (*Gambusia holbrooki*). The distribution of alien species among the three sampling sites is demonstrated in Table-1.

Table 1- The distribution of alien species in the three sites of study areas (Absent (A), Resident (R), Seasonal (S) and Occasional (O) in the period from April 2017 to June 2018.

Family	Species	Al-Chibyaish marsh	The lower parts of the Euphrates River	Northern part of the Shatt Al-Arab River
Cyprinidae	*Carassius gibelio*	R	R	R
	Cyprinus carpio	R	R	S
Xenocyprididae	*Ctenopharyngodon idella*	A	A	A
	Hemiculter leucisculus	S	S	S
	Hypophthalmichthys nobilis	A	A	A
Heteropneustidae	*Heteropneustes fossilis*	A	A	A
Cichlidae	*Coptodon zillii*	R	R	R
	Oreochromis aureus	R	R	R
	Oreochromis niloticus	A	R	R
Poeciliidae	*Gambusia holbrooki*	A	A	A

Al-Faisal *et al*. [16] counted 12 alien fish species from the south of Iraq. One species of Pangasiidae (*Pangasianodon hypophthalmus*) was recorded by Khamees *et al*. [15], which increased the number to 13 fish species. Mohamed and Abood [9] collected 13 alien fish species from the Shatt Al-Arab River. One alien species (*Atractosteus spatula*) was recorded by Mutlak *et al*. [26], which is a native inhabitant species in North America that belongs to Lepisosteidae, increasing the number of alien fish species southern in Iraq to 14. The differences in the number of species are due to spatial-temporal variations and the use of different fishing methods [10] (Table-2).

Table 2- Alien fish species in southern Iraq recorded from the present and previous studies, with their common English names and families.

The species	Common English name	Family
Atractosteus spatula	**Alligator gar**	**Lepisosteidae**
Carassius gibelio	**Prussian carp**	**Cyprinidae**
Cyprinus carpio	**Common carp**	
Ctenopharyngodon idella	**Grass carp**	**Xenocyprididae**
Hypophthalmichthys molitrix	**Silver carp**	
Hemiculter leucisculus	**Sharpbelly**	
Hypophthalmichthys nobilis	**Bighead carp**	
Pangasianodon hypophthalmus	**Striped catfish**	**Pangasiidae**
Heteropneustes fossilis	**Stinging catfish**	**Heteropneustidae**
Coptodon zillii	**Redbelly tilapia**	**Cichlidae**
Oreochromis aureus	**Blue tilapia**	
Oreochromis niloticus	**Nile tilapia**	
Gambusia holbrooki	**Eastern mosquitofish**	**Poeciliidae**
Pangasianodon hypophthalmus	**Striped catfish**	**Pangasiidae**

Three fish species showed high abundance in Al-Chibyaish marsh, namely *Planiliza abu* (29.63%), *Alburnus sellal* (18.34%) and *O. aureus* (16.78%), which all together formed 64.75% of the total number of species in this site. Whereas in the lower parts of Euphrates River, the most abundant species were *C. gibelio* (26.19%), *P. abu* (23.28%) and *O. aureus* (13.66%), which constituted 66.13% of the total fish, catch in the Euphrates River. The species that topped the abundance of the north part of Shatt Al-Arab River were *O. aureus* (18.79%), *P. abu* (18.01%) and *C. zillii* (14.66%), forming 51.46% of the total specimens of fish in the Shatt Al-Arab River (Table-3).

These present results agree with several studies conducted that confirmed the dominance of some of the alien species in the south of Iraq [8, 10, 27, 28, 29].

Table 3- The relative abundance of fish species in the three study regions southern Iraq in the period from April 2017 to June 2018.

Species	Al-Chibyaish marsh%	The lower parts of Euphrates River%	The north part of Shatt Al-Arab %River
Carassius gibelio	**12.58**	**26.19**	**13.84**
Cyprinus carpio	**2.30**	**2.74**	**2.30**
Carasobarbus luteus	**3.25**	**3.60**	**1.28**
Leuciscus vorax	**2.33**	**2.51**	**1.08**
Alburnus sellal	**18.34**	**4.73**	**2.89**
Acanthobrama marmid	**1.56**	**1.95**	**0.98**
Hemiculter leucisculus	**0.91**	**1.39**	**0.69**
Garra rufa	**-**	**0.30**	**0.43**
Hypophthalmichthys nobilis	**-**	**0.07**	**0.05**
Ctenopharyngodon idella	**-**	**0.03**	**0.02**
Mesopotamichthys sharpeyi	**0.30**	**0.13**	**0.03**
Oreochromis aureus	**16.78**	**13.66**	**18.79**
Oreochromis niloticus	**-**	**2.22**	**10.88**
Coptodon zillii	**7.37**	**7.71**	**14.66**
Planiliza abu	**29.63**	**23.28**	**18.01**
Planiliza subviridis	**-**	**0.76**	**0.72**
Tenualosa ilisha	**-**	**0.79**	**7.20**
Nematalosa nasus	**-**	**-**	**0.18**
Acanthopagrus arabicus	**-**	**0.50**	**0.50**
Thryssa whiteheadi	**-**	**1.06**	**0.83**
Silurus triostegus	**3.48**	**4.56**	**3.35**
Gambusia holbrooki	**-**	**-**	**0.16**
Aphanius stoliczkanus	**-**	**-**	**0.05**
Heteropneustes fossilis	**0.27**	**0.56**	**0.15**
Mystus pelusius	**-**	**0.07**	**-**
Mastacembelus mastacembelus	**0.88**	**1.19**	**0.95**

The present study recorded high variations in the abundance of the alien species in the study sites (in relation to the native and marine species) (Table -4). Three alien species dominated the abundance in the studied areas. *O. aureus* recorded 41.72%, 25.03% and 30.54% in Al-Chibyaish marsh, the lower parts of Euphrates River and north part of Shatt Al-Arab River, respectively; *C. gibelio* represented 31.29%, 48.00% and 22.49%, respectively. *C. zillii* formed 18.33%, 14.12% and 23.83%, respectively. The three species formed 36.74%, 71.05, and 47.29% of the total number of species in the three sites, respectively. The present results are corresponding with previous studies implemented in southern Iraq, such as those of Mohamed *et al.* [28] on the Shatt Al-Arab River, Abdullah [8] in the lower parts of the Euphrates River, Mohamed and Abood [9] in the Shatt Al-Arab River, and Abdullah *et al.* [10] in the Al-Sweib River (Table-4).

Table 4- The relative abundance of alien species in the three sites in the present study area, southern Iraq in the period from April 2017 to June 2018.

Species	Al-Chibyaish marsh%	The lower parts of Euphrates River%	North part of Shatt Al-Arab River %
Carassius gibelio	**31.29**	**48.00**	**22.49**
Cyprinus carpio	**5.72**	**5.03**	**3.74**
Hemiculter leucisculus	**2.27**	**2.55**	**1.12**
Hypophthalmichthys nobilis	**-**	**0.12**	**0.07**
Ctenopharyngodon idella	**-**	**0.06**	**0.04**
Oreochromis aureus	**41.72**	**25.03**	**30.54**
Oreochromis niloticus	**-**	**4.06**	**17.68**
Coptodon zillii	**18.33**	**14.12**	**23.83**
Gambusia holbrooki	**-**	**-**	**0.26**
Heteropneustes fossilis	**0.67**	**1.03**	**0.24**
Number of species	**6**	**9**	**10**
Number of individuals	**1189**	**1650**	**5459**

***Atractosteus spatula* (Lacepede, 1803)**

Alligator garfish spread out in North America from Mississippi River in South-eastern Ohio and southern Illinois in the South of the United States of America to the South of Mexico Gulf and from Enconfina River in coastal of Mexico plain to Veracruz, Mexico [23]. Mutlak *et al*. [26] recorded one specimen in the Shatt Al-Arab River near Abu Al-Kaseeb town, it is likely that it was brought as an ornamental fish and either escaped or deliberately released into the rivers.

***Carassius gibelio* (Bloch, 1782**)

The first existence of Prussian carp in Iraq was recorded in the fish ponds at the farms [30]. The genus has the two species of *Carassius auratus* and *Carassius carassius*. *C. gibelio* was described by Jawad *et al.* [14] in Basrah province, southern Iraq, as a distinct species from *Carassius carassius*. The appearance of the species was reported to be associated with the increasing discharge of the Tigris Rivers and the reduction of salinity in the Shatt Al-Arab River [11]. The species is a durable fish that has a long reproductive season with high abundance in southern Iraq habitats [8].

The historical studies recorded a low relative abundance of *C. gibelio*, as described by Mohamed *et al*. [31] who stated that the abundance of the species in the lower reaches of Tigris River is 11.02%. Then, the species enables the establishment of its occurrence leading to the increase of the abundance in the northern part of Shatt Al-Arab River to 31.55%, as reported by Al-Noor and Abdullah [32]. After the entrance of the new alien species of Cichlidae (*O. aureus*, *C. zillii* and *O. niloticus*) to the habitats, they became major competitors to *C. gibelio* in the aquatic environment in southern Iraq (Table-5).

As related to the previous studies of the 1980s and 1990s, Hussain *et al.* [33] recorded two alien species, Hussain *et al.* [34] collected three alien species and Hussain *et al*. [35] in Suaq Al-shyouk marsh-Al-Huwaiza marsh-East Al-Hammar marsh found the species abundance 25.48%,23.04%,29.65 % respectively. Hussain *et al*. 2009 [36] recorded 23.6% in Hammar marsh and Mohamed *et al*.[37] 23.7% in Shatt Al-Arab River. Since then, the entrance of several invasive species was reported. Al-Faisal *et al*. [16] found 12 alien fish species in the inland waters in southern Iraq.

Table 5- Comparison the relative abundance of *C. gibelio* species with the previous studies southern Iraq in the period from April 2017 to June 2018.

The study	Habitat	Relative abundance (%)
[33]	The lower part of Tigris River	11.02
[35]	Suq Al-Shyouk marsh, Al-Huwaiza marsh, East Al-Hammar marsh	25.48, 23.04, 29.65
[36]	Al-Hammar marsh	23.6
[37]	Shatt Al-Arab River from Al-Deer to Abu Al-Kaseeb	23.7
[34]	The north part of Shatt Al-Arab River	31.55
[8]	Lower parts of the Euphrates River	14.36
[10]	Al-Sweib River	17.51
The present study	Al-Chibyaish marsh, lower parts of Euphrates River, The north part of Shatt Al-Arab River	12.58, 26.19, 13.84

***Ctenopharyngodon idella* (Valenciennes in Cuvier and Valenciennes, 1844)**

The grass carp is prevalent in China, extending to the Amur River in the eastern part of Siberia. The species do not reproduce in nature, but rather artificially by hatcheries therefore the species constantly present in Europe through the storage for farmers [38]. The fish was introduced to Kozestan province in Iran in 1970 to control the aquatic plants in irrigation channels, as well as to the fish ponds in Iraq [39, 40]. This species does not reproduce spontaneously in the environment, but rather artificially in the hatcheries. Its abundance in the inland waters depends on the individuals that escape from the hatcheries and ponds and, therefore, it has the minimum abundance value [8]. Mohamed *et al*. [31] recorded an abundance of 0.24% of the total number of species in the lower part of the Tigris River, while Abdullah *et al.* [10] found an abundance of 0.03% in Al-Sweib River; Hussein *et al* [41] pointed abundance of *C. idella* 0.02% of the total number of species southern Iraq. Those results disagree with our finding (Table-6).

Table 6- Comparison the relative abundance of *C. idella* species with the previous studies southern Iraq in the period from April 2017 to June 2018.

The study	Habitat	(%)
[33]	The lower end of Tigris River	0.24
[35]	Suq Al-Shuak, Huwaiza marsh, East Al-Hammar marsh	0.30, 0.38, 0.18
[28]	Shatt Al-Arab River form Al- Deer to Abu Al-Kaseeb	0.01
[41]	The south part of Euphrates River	0.02
[9]	Shatt Al-Arab River	0.006
[10]	Al-Sweib River	0.03
The present study	Lower parts of Euphrates River, North part of Shatt Al-Arab River	0.03, 0.02

***Cyprinus carpio* Linnaeus, 1758**

The common carp is a successful alternative to local species that have become rare and considered as the main table fish in Iraq at the present time (Table-7). The wild individuals of the species are subjected to large fishing pressure in inland waters; hence its abundance is declining, with fluctuating values reported by the previous studies. *C. Carpio* was cultivated extensively in the Tigris and Euphrates basin, ponds, lakes, reservoirs, and irrigation canals. It was introduced to the Iraqi water bodies in 1955 and, since then, spread rapidly [42]. The species can reproduce in inland waters and widely in hatcheries. Al-Noor et al [43] found the abundance of *C. carpio* 3.81% in the southern thr Euphrates River. The breeding in tropic lands occurs throughout the year whereas that in temperate regions occurs only seasonally [23].

Table 7- Comparison the relative abundance of *C. carpio* with the previous studies southern Iraq in the period from April 2017 to June 2018.

The study	Habitat	Relative abundance (%)
[32]	Shatt Al-Arab River	0.59
[33]	The lower part of Tigris River	2.36
[35]	Suq Al-Shuak, Huwaiza marsh, East Al-Hammar marsh	2.65, 6.15, 0.92
[43]	The lower part of Euphrates River	3.81
[28]	Shatt Al-Arab River from Al-Deer to Abu Al-Kaseeb	3.10
[41]	The lower part of Euphrates River	0.15
[10]	Al-Sweib River	1.59
The present study	Al-Chibyaish marsh, lower parts of Euphrates River, The north part of Shatt Al-Arab River	2.30, 2.74, 2.30

(Basilewsky, 1855) *Hemiculter leucisculus*

The native range of this species is from Russia to China, Korea, and Vietnam. It is a small size fish with limited economic value in the south of Iraq. The first record in Iraq was reported in Al-Huwaiza marsh by Coad and Hussain [12]. The negative impacts of this species are represented by its competition with the native fish on food and the potential to predate on eggs and young fishes. The species occurs in a low abundance [7] (Table-8).

Table 8- Comparison the relative abundance of *H. leucisculus* with the previous studies southern Iraq in the period from April 2017 to June 2018.

The study	Habitat	Relative abundance (%)
[8]	The lower reaches of Tigris River	0.21
[10]	Al-Sweib River	0.35
[32]	The northern part of Shatt Al-Arab River	1.56
[37]	Shatt Al-Arab River from Al-Deer to Abu Al-Kaseeb	0.5
The present study	Chibyaish marsh, lower parts of Euphrates River, northern part of Shatt Al-Arab River	0.91, 1.39, 0.69

***Hypophthalmicchthys molitrix* (Valenciennes, 1844)**

The silver carp is native in most of the Pacific regions from Amur to Xi Jiang in China, as well as in eastern Siberia. It was introduced for aquaculture and blooms control in many regions in the world. The species resembles *Hypophthalmichthys nobilis* (bighead carp), but the head is smaller in size [38].

It was introduced into reservoirs and marshes in Iraq from the Khuzestan province in Iran. It was released by the government and private farms in northern Iraq and the species is cultivated abundantly in Iraq's ponds [40]. The species is spread relatively in a low abundance in the aquatic habitats in southern Iraq, because it cannot reproduce in this environment. However, it can reproduce in hatcheries through the process of artificial hatching. Its presence in the natural environment might be due to the escape from the ponds. The species do not have negative impacts on the local species, because of its feeding on the plankton in the water column [7].

***Hypophthamichthys nobilis* (Richardson, 1845)**

The bighead carp has originated from China and introduced to many countries where it has achieved a wide global spread [23]. The species is artificially reproduced in southern Iraq and Syrian reservoirs. It is the first to be mentioned in the fields and reservoirs of Khuzestan province in Iran [11]. The species is cultivated in fish farms in Iraq, being one of the important commercial species. It feeds on zooplankton and algae when it is mature. It can be distinguished from the silver carp by the large size of the head [16].

The abundance of the species is at the minimum in the inland waters, depending on the individuals that can escape from the fields and artificial hatcheries.

***Gambusia holbrooki* Girard, 1859**

The eastern mosquitofish have been widely introduced in different regions of the world, particularly in tropical and subtropical regions [23]. It was introduced to the Tigris and Euphrates basin (Iran, Iraq, Syria and Turkey) to combat mosquito larvae that cause malaria disease [11]. The species is widespread in high abundance in inland water in southern Iraq, but due to small size it cannot be caught in fishing nets. Therefore, we noticed that the species was reported to have low abundance by the scientific researches (Table-9). The males can easily be distinguished by the elongated anal fin that is modified as gonopodium for internal fertilization [16]. Al-Shamary et al. [44] recorded high abundance of *G. holbrooki* 25.11% of total caught.

Table 9- Comparison the relative abundance of *G. holbrooki* species with the previous studies southern Iraq in the period from April 2017 to June 2018.

The study	Habitat	Relative abundance (%)
[33]	Lower part of Tigris River	0.01
[35]	Suq Al-Shuak, Huwaiza marsh, East Al-Hammar marsh	0.36, 0.14, 0.40
[44]	East Al-Hammar marsh	25.11
[37]	Garmat Ali River	1.87
[34]	North part of Shatt Al-Arab River	0.01
Present study	The north part of Shatt Al-Arab River	0.16

***Poecilia latipinna* (Lesueur, 1821)**

The sailfin molly is native in North America, North of Carolina to Veracruz, and Mexico [45]. Euryhaline species prefer warmer water temperature in brackish and seawater, while they also exist in shallow marshes. High tolerant species aquarium fish occurs in lakes, ponds, mostly vegetated regions, pools, backwaters pools and streams [23]. The abundance of the species is high in lentic waters, but due to small size, it is recorded in a low abundance in most studies in southern Iraq (Table-10).

Table 10- Comparison the relative abundance of *P. latipinna* with the previous studies southern Iraq in the period from April 2017 to June 2018.

The study	Habitat	Relative abundance (%)
[36]	Al-Hammar marsh	0.62
[27]	Shatt Al-Arab River from Al-Deer to Abu Al-Kaseeb	3.9
[37]	Shatt Al-Arab River from Al-Deer to Abu Al-Kaseeb	1.8
[41]	The southern parts of Euphrates River	3.13
The present study	The north part of Shatt Al-Arab River	0.16

***Coptodon zillii* (Gervais, 1848)** Africa and Eurasia: South Morocco, Sahara, Niger-Benue system, rivers Senegal, Sassandra, Bandama, Boubo, Mé, Comoé, Bia, Ogun and Oshun, Volta system, Chad-Shari system

The redbelly tilapia freshwater, brackish species distribution in Africa and Eurasia from southern Morocco, Niger to Benue, Senegal Rivers, Volta system and Chad system [46]. The species is established in the Syrian sector of the Euphrates River. The first record in Iraq was reported from Al-Musayib area [24, 47], then it was recorded in the southern part of the main outfall drain in the city of Basrah, south of Iraq [13].

The species feeds on aquatic plants and algae. It possesses strong teeth to crush the aquatic plants, which are also useful in causing devastation of the fishing nests. The eggs are usually attached to the aquatic plants and habitat of local species. The redbelly tilapia recorded high abundance since its first registration in southern Iraq habitats [32]. (Table-11).

Table 11- Comparison the relative abundance of *C. zillii* with the previous studies southern Iraq in the period from April 2017 to June 2018.

The study	Habitat	Relative abundance (%)
[27]	**Shatt Al-Arab River from Al-Deer to Al-Fao**	**0.2**
[37]	**Shatt Al-Arab River from Al-Deer to Abu Al-Kaseeb**	**9.8**
[41]	**The southern part of Euphrates River**	**22.72**
[10]	**Al-Sweib River**	**10.19**
Present study	**Al-Chibyaish marsh, The lower parts of Euphrates, The north part of Shatt Al-Arab River**	**7.37, 7.71, 14.66**

***Oreochromis aureus* (Steindacher, 1864)**

The blue tilapia is a freshwater brackish species distributed in Africa in the lower Nile basin, Chad basin, Senegal River, and valley of Jordan [47].

Coad [11] captured one specimen in Al-Kabour River in Syria and explained the existence of the species by the possibility of escape from fish bonds at the Euphrates River. It was first recorded in Iraq by Mutlak and Al-Faisal [13] in the southern part of the main outfall drain near the city of Basrah.

This is the most abundant species in the aquatic ecosystems in southern Iraq. The species abundance is increasing due to a distinctive breeding strategy and the protection of the offspring through mouth brooding. This is confirmed by the current study, which recorded abundance values of 16.78%, 13.66%, and 18.79% of the total number of all species in Al- Chibyaish marsh, lower parts of Euphrates Rivers and the northern part of Shatt Al-Arab River, respectively. While regarding the abundance among the alien species only, the study found values of 41.26%, 44.77% and 25.37%, respectively (Table-12).

Table 12- Comparison the relative abundance of *O. aureus* with the previous studies southern Iraq in the period from April 2017 to June 2018.

The study	Habitat	Relative abundance (%)
[10]	**Al-Sweib River**	**18.68**
[32]	**The north part of Shatt Al-Arab River**	**5.63**
[37]	**Shatt Al-Arab River from Al-Deer to Al-Fao**	**0.7**
[41]	**The southern part of Euphrates River**	**9.88**
Present study	**Al-Chibyaish marsh, The lower parts of Euphrates River, The north part of Shatt Al-Arab River**	**16.78, 13.66, 18.79**

***Oreochromis niloticus* (Linnaeus, 1758)**

The Nile tilapia lives in fresh and brackish water, with wide distribution in the Nile basin and other large areas of Africa Rivers and coastal rivers of Palestine [48]. The first record of the species in Iraq was reported by Al-Faisal and Mutlak [25] in the Shatt Al-Arab River. The clearest distinction of the species from *C. zillii* and *O. aureus* can be achieved by noticing the black stripes on the caudal fin.

The relative abundance of the species is lower than that of *C. zillii* and *O. aureus*. Therefore, the adverse ecological impact on this species could be lower than that of the other two species. Al-Noor and Abdullah [32] stated that the relative abundance of the species was 0.11% of the total number of species in the northern part of Shatt Al-Arab River, while Mohamed and Abood [9] found that the total abundance was 0.47% of the total number of species in Shatt Al-Arab River from Al-Deer to Al-Fao towns.

***Heteropneustes fossilis* (Bloch, 1794)**

The stinging catfish is a freshwater to brackish water species, with a distribution range from Pakistan and Sri Lanka to Myanmar [23]. The species was introduced to Tigris River basin, south of Iraq [49]. The fish is spread widely in all the rivers and marshes of southern Iraq. Hussain *et al*. [50] mentioned abundance of *H. fossilis* attained 28.91% north the port and 7.19 at the port area, while Yonis et al. [51] recorded species abundance 2.9%.

It was introduced to Iraq in order to feed on the snail *Bulinus truncatus*. *H. fossilis* causes damages to fishermen and swimmers. The relative abundance of the stinging catfish has been declining in recent decades, maybe due to the access of new alien species [16] (Table-13).

Table 13- Comparison the relative abundance of *H. fossilis* with the previous studies southern Iraq in the period from April 2017 to June 2018.

The study	Habitat	Relative abundance (%)
[8]	The lower parts of Euphrates River	0.02
[28]	Shatt Al-Arab River from Deer to Abu-Al-Kaseeb	0.001
[31]	The lower reaches of Tigris River	0.25
[32]	The lower part of Euphrates River	0.03
[50]	Kour Al-Zubiar north the port	28.91
	Kour Al-Zubiar at the port	7.19
[51]	Al-Huwaiza marsh, Aumm Al-Naaj	2.9
The present study	Al-Chibyaish marsh, The lower parts of Euphrates River, The north part of Shatt Al-Arab River	0.27, 0.56, 0.15

***Pangasianodon hypophthalmus* (Sauvage, 1878)**

The striped catfish is freshwater species, native in Asia: Mekong, Chao Phraya, and Maeklong basins. It was introduced into several rivers for aquaculture [23]. The species might have escaped from fish aquariums to Iraqi inland waters, with possible negative impacts on local fish community, since the species is a predator and grows to a large size. Two specimens were collected from Ibn Najim marsh, middle of Iraq, in 2009 and from Shatt AL-Basrah canal in 2011 by Khamees *et al*. [15] (Figure-15).

The abundance of alien fish species to the total number of species

The abundance of alien fish species to the total number of native species was increasing over time, due to entering of exotic fishes. The evolution of transportation and the prevalence of the acquisition of ornamental fish in domestic aquariums contributed to the spread of alien fish species. The number and abundance of alien species in the 1980s and 1990s appeared to be low, as shown by [33, 34, 52], whereas the subsequent studies, revealed an increase in the abundance of alien fish species to become 40.22%, 54.56%, and 61.52% of the total number of species in Al-Chibyaish marsh, lower parts of Euphrates River, and north part of Shatt Al-Arab River respectively. (Table-14)

Table 14- Comparison the relative abundance of alien fish species in the present study with the previous studies from April 2017 to June 2018 southern Iraq.

The study	Habitat	Relative abundance (%)
[8]	**The lower parts of Euphrates River**	**57.18**
[31]	**Lower reaches of Tigris River north of Qurna**	**13.88**
[33]	**Shatt Al-Arab River**	**9.9**
[34]	**Shatt Al-Arab River**	**0.88**
[35]	**Suq Al-Shuak, Huwaiza marsh, East Al-Hammar marsh**	**36.30, 41.6, 45.40**
[36]	**Al-Hammar marsh**	**28.072**
[41]	**The southern part of Euphrates River**	**40.83**
[51]	**Umm Al-Naaj marsh**	**30.21**
[52]	**Shatt Al-Arab River**	**7.5**
The present study	**Al-Chibyaish marsh, The lower parts of Euphrates River, The north part of Shatt Al-Arab River**	**40.22, 54.56, 61.52**

Conclusions

The results of the present study conclude that alien fish species created a serious shift in the composition and abundance of fish populations in comparison to the historical surveys of southern Iraq. The study revealed that native fish species, which comprised the keystone species of fish populations, were threatened to be very rare or absent in the future.

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