A good word on topmouth gudgeon *Pseudorasbora parva in small impoundments in the Aral Sea watershed* (Central Asia, Kazakhstan)

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Abstract. Biological invasions are one of the most powerful negative factors threatening the natural biological diversity and well-being of continental water bodies. In the Aral Sea (Small Aral) basin, it has now been possible to stabilize the catastrophe that arose as a result of the irrational use of water resources. However, the diversity and impact of alien fish species on water ecosystems remains little known. For 10 years, we studied the distribution of one fish species, topmouth gudgeon *Pseudorasbora parva* (Temminck & Schlegel, 1846) in water bodies of the Aral Basin in the Republic of Kazakhstan. Now, this species is found everywhere in the Syrdarya River itself, floodplain lakes and most tributaries, but is not numerous. Using the example of two small local impoundments, the ratio of the abundance of topmouth gudgeon and other fish species was studied. There was no significant correlation between the presence of topmouth gudgeon and the presence/absence of other fish species. There is also no any significant correlation between the total number of fish (abundance) and topmouth gudgeon abundance, diversity indices and topmouth gudgeon abundance. The findings do not suggest that topmouth gudgeon has a negative impact on other fish species. More likely, this species is able to quickly expand new habitats, but under more stable conditions of water bodies it gives way to other fish species. At high water temperatures, topmouth gudgeon remains the only fish species that feeds on the larvae of blood-sucking *Culex* and *Anopheles* mosquitoes.

1 Introduction

Inland waters are the most vulnerable component of the Biosphere, since fresh water supplies are extremely limited, but its existence is necessary for most terrestrial organisms. People not only use fresh water in the greatest volume, but also affect natural bodies of water by changing the topography, soil erosion, hydrological regime, and pollution with

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various substances [1-3]. One of the most complex and powerful types of impact is the introduction of alien species [2, 4, 5].

The Aral Sea is a large lake located in the center of Central Asia. As a result of ill-conceived water resource management at the end of the last century, this lake ceased to exist as a single body of water, which led to an environmental disaster throughout the region [6-8]. The Government of the Republic of Kazakhstan, with great international support, managed to implement a number of measures aimed at stabilizing and somewhat mitigating environmental conditions [9,10]. Now changes in the hydrological regime and abiotic factors are under the supervision of specialists, but much less attention is paid to the diversity of flora and fauna.

More than 20 alien fish species were intentionally or accidentally introduced into the Aral Sea basin in the second half of the last century, including *Pseudorasbora parva* (Temminck & Schlegel, 1846) [11,12]. *Pseudorasbora parva* is a small fish belongs to the order Cypriniformes, which has spread widely beyond its natural range and is known in different countries under the names pseudorasbora, topmouth gudgeon, stone morko. Despite its small size, the topmouth gudgeon is considered one of the most dangerous and unwanted invaders [13]. In the Syrdarya basin within Kazakhstan, this species was discovered in 1966-1967 [11], however, its role in the water bodies of this basin still remains poorly studied.

In this article we present the results of a study of the current distribution of topmouth gudgeon in the Aral Sea basin and an assessment of the role of this species using the example of two small impoundments.

2 Materials and Methods

The study was conducted from 2014 to 2023 in various sections of the Syrdarya River within the Republic of Kazakhstan (Figure 1). A fry seine and hand nets were used to catch fish. Biological analysis of fish was carried out according to routine methods [14]. Water temperature was determined during fish capture. The following symbols are used to denote the indicators: L – total length, SL – standard length, Q – body weight of fish, Fulton – condition factor calculated by Fulton. The obtained data were processed by methods of variation statistics: min - minimum value, max - maximum value, M - average value, ±SD - standard deviation, CV - coefficient of variation, r - Spearman's correlation [15,16].

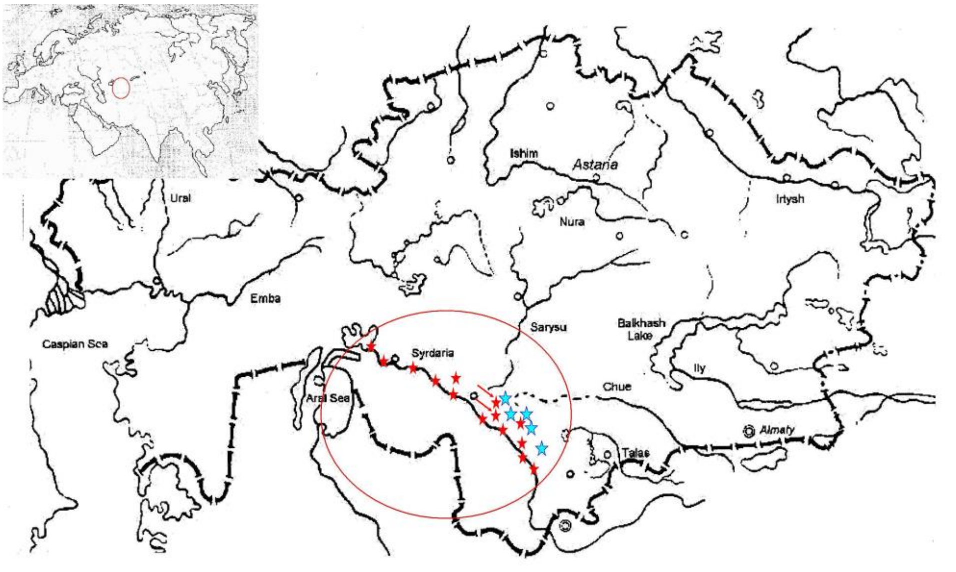

Fig. 1. Schematic map of the study area. Red asterisks indicate water bodies inhabited by *Pseudorasbora parva*, blue others water bodies without this species. The arrows show impoundments near the villages of Babaykorgan (BK) and Sert (S).

To characterize fish communities, the following indicators were used: N number of individuals, S richness (number of species), Ds Simpson's index, H Shannon's index, E – Simpson's evenness (logarithm base 2) [17].

3 Results and Discussion

For the ten years, topmouth gudgeon was consistently found in the shallow zone of the Syrdarya River in the area from the border with Uzbekistan to the mouth and in floodplain lakes (red stars in Figure 1). This species was never found in the mountainous sections of the Sarybas, Ikansu, Boraldai, and Arys rivers (blue stars in Figure 1), but inhabited similar sections of the Oyyk, Arystandy, and Shayan rivers. In reservoirs near the villages of Babaykorgan (BK) and Sert (S), topmouth gudgeon was the only fish species in 2014, 2015, 2018. Both reservoirs are used for irrigation and partly for domestic needs of local people. The summer water temperature in these reservoirs then reached 32.4-33.8 °C. In the summer of 2019-2021, both reservoirs were completely dry by the beginning of July.

In 2016, 2017, 2022, and 2023, topmouth gudgeon was part of multispecies fish assemblages (Table 1). In total, over the years of research, only 8 native and 4 alien fish species were discovered in these reservoirs.

Table 1. Proportion of different fish species in the small impoundments (dominant and sub-dominants are presented by bold)

Fish species	English name	Babaykorgan		Sert		
		2022	2023	2016	2017	2023
Alien						
Pseudorasbora parva	Topmouth gudgeon	**0.463**	0.029	**0.932**	0.138	0.008
Abbottina rivularis	Chinese false gudgeon	0.122	0.114	0	0.034	0
Micropercops sinctus	Eleotris	**0.333**	0	0	0	0
Triplophysa strauchii	Spotted thicklip loach	0	0.029	0.021	**0.379**	0
Indigenous						

Continuation of Table 1

Carassius gibelio	Prussian carp	0.171	**0.229**	0.021	**0.310**	**0.815**
Rutilus rutilus	Roach	0	0	0	0	0.118
Leusiscus lehmani	Zeravshan dace	0.171	**0.400**	0.027	0.138	0.050
Leuciscus aspius	Asp	0	0.029	0	0	0
Leuciscus idus	Ide	0	0.086	0	0	0
Gobio lepidolaemus	Gudgeon	0.167	0.029	0	0	0.008
Alburnus oblongus	Tashkent riffle bleak	0	0.029	0	0	0
Schizothorax intermedius (=Schizothorax curvifronts)	Sattar snowtrout	0	0.029	0	0	0

There was no significant correlation between the presence of topmouth gudgeon and the presence/absence of other fish species (r < 0.5). There is also no significant correlation between the total number of fish (abundance) and topmouth gudgeon abundance, diversity indices and topmouth gudgeon abundance (Table 2). Thus, data on fish diversity trends do not suggest that topmouth gudgeon is negatively impacting other fish species. More likely, this species is able to quickly colonize new habitats, but under more stable conditions of water bodies it gives way to other fish species [18].

Table 2. Diversity indicators of fish assemblages in different years

Metrics	Babaykorgan		Sert		
	2022	2023	2016	2017	2023
N	41	35	146	29	119
S	6	10	4	5	5
Ds	2.34	4.21	1.15	3.58	1.47
H	2.71	2.56	0.47	2.01	0.94
E	0.39	0.42	0.29	0.72	0.29

Data on the size, weight and fatness of topmouth gudgeon are presented in Table 3. All samples are represented by individuals of different sizes (and, accordingly, different ages). Within each sample, there is a large individual variability in body fatness, which indicates intrapopulation competition. The maximum size of only one individual from the Sert impoundment approaches the maximum known for this species [19]. In 2023, only one juvenile topmouth gudgeon was caught in each impoundment. Thus, the habitat conditions in both reservoirs allow the topmouth gudgeon to reproduce, but do not support longevity. It is known that reaching maximum sizes does not always indicate favorable living conditions [20]. However, in the case of the topmouth gudgeon populations we studied, it is the unstable hydrological regime that prevents the fish from reaching their maximum size and age.

Table 3. Characteristics of topmouth gudgeon samples

Year	Impoundment	Characteristic	Statistic Parameters				
			min	max	M	±SD	CV
2016	Sert, n=136	L, mm	19	46	28.8	6.16	21.4
		SL, mm	16	37	23.3	5.00	21.5
		Q, g	0.06	0.93	0.25	0.179	71.8
		Fulton	1.22	2.17	1.69	0.04	11.84
2017	Sert, n=4	L, mm	25	85	42.6	28.27	66.39
		SL, mm	22	79	36.3	21.99	60.57
		Q, g	0.12	5.13	1.40	2.46	169.77
		Fulton	0.94	1.82	1.40	0.39	27.88

Continuation of Table 3

2022	Babaykorgan, n=19	L, mm	21	57	32.0	10.39	32.46
		SL, mm	18	45	25.9	8.28	32.01
		Q, g	0.11	2.14	0.50	0.58	123.37
		Fulton	1.45	2.67	1.90	0.31	16.12

During years of high topmouth gudgeon abundance, an abundance of larvae of blood-sucking mosquitoes of the genera Anopheles and Culex were observed floating at the surface of the water. It was these larvae that formed the basis of the topmouth gudgeon's diet, even despite the high water temperature. Therefore, in the conditions of small reservoirs for irrigation purposes in Central Asia, this species of fish turns out to be one of the few capable of surviving at high water temperatures and exterminating the larvae of harmful insects.

4 Conclusion

Now, Pseudorasbora parva is found everywhere in the Syr Darya River itself, floodplain lakes and most tributaries, but is not numerous. Using the example of two small local reservoirs, the ratio of the abundance of topmouth gudgeon and other fish species was studied. There was no significant correlation between the presence of topmouth gudgeon and the presence/absence of other fish species. There is also no significant correlation between the total number of fish (abundance) and topmouth gudgeon abundance, diversity indices and topmouth gudgeon abundance. Thus, the results of our investigation do not suggest that topmouth gudgeon has a negative impact on other fish species. More likely, this species is able to quickly develop new habitats, but under more stable conditions of water bodies it gives way to other fish species. At high water temperatures, topmouth gudgeon remains the only fish species that feeds on the larvae of blood-sucking Culex and Anopheles mosquitoes.

Authors' contribution

Conceptualization, N.S.M. and G.S.I.; Methodology N.S.M., G.S.I. and E.B.K.; Software and Formal Analysis, G.Z.B..; Investigation, N.S.M., G.S.I., E.B.K.; Resources, G.S.I. and G.K.Z.; Writing – Original Draft Preparation, G.S.I., G.Z.B. and E.B.K.; Writing – Review & Editing, N.S.M.; Visualization, E.B.K. and G.K.Z.; Supervision, N.S.M.; Project Administration, G.S.I. and E.B.K.

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