

Article

Discovery of new sites of topmouth gudgeon *Pseudorasbora parva* (Temminck & Schlegel, 1846) in Algeria

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Abstract: The Topmouth gudgeon *Pseudorasbora parva* exhibits a remarkable capacity for expansion to spread outside of its current habitats and territories, across all continents, threatening the existence of native species. The species was recorded for the first time in 1992 in North-east Algeria; therefore, assessing its distribution in the country is necessary. This study is conducted in Algeria during the period from February 2023 to May 2024. The current study's objective is to explore historical sites and thus search for possible new localities of the species. Our study revealed the discovery of four new localities in Algeria for the species, in Oued Djendjen (Jijel), Aissi stream (Tizi Ouzou), Oued Z'hor (Skikda) and Chelif River (Mostaganem) which the latter is the most important hydrographic basin in Algeria. This is the first time this species has been reported in these regions, indicating a notable expansion of its range to the northwest. Consequently, further studies on its ecology in these newly colonized areas are urgently recommended in order to control the invasion of this species and its impact on Algerian indigenous species.

Keywords: *Pseudorasbora parva*; Invasion; Distribution area; Algeria; North Africa

1. Introduction

Accidental and intentional introductions of species into natural ecosystems have been known for centuries [1]. However, it wasn't until the 20th century that we fully realized the ecological, economic, and social repercussions of these introductions [2]. Partially, this is explained by the increasing movements of people and commercial activities, which have accelerated these introductions, as well as by our growing ecological awareness. Today, at the beginning of the 21st century, biological invasions caused by foreign invasive species that have been brought outside of their natural range, constitute the fifth threat to biodiversity [3] and the second threat to species extinction [4]. They alter ecosystem services and induce the disappearance of native species through various mechanisms such as hybridization, predation, food competition [5] and disease transmission [6,7]. Despite their small proportion of the Earth's surface, aquatic ecosystems are among the most vulnerable to species invasions, which are predominantly caused by various human activities [8]. Among the 100 invasive species identified, a significant proportion, namely 50 species, are associated with freshwater ecosystems and riparian zones. This abundance is notable considering the surface area occupied by these ecosystems [9]. In fact, Algeria possesses a wealth of natural rivers and various fish species, autochthonous and introduced freshwater fish species [10, 11]. The latter are still being introduced; according to [11], they account for over 50% of all ichthyologic diversity. A number of these species are invasive and have the potential to negatively affect the local ecology. The topmouth gudgeon, *Pseudorasbora parva*, is an invasive species of fish that is native to Asia. It has been introduced to many

Received: 13 November 2024

Accepted: 24 January 2025

Citation: Tababouchet M., Benaissa M. H., Karar M. and Bougaham A. F. Discovery of new sites of topmouth gudgeon *Pseudorasbora parva* (Temminck & Schlegel, 1846) in Algeria. *Journal Algérien des Régions Arides* 2025, 18 (1) : 48–56.

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regions worldwide, including Europe and North Africa, where it may have negative impacts on indigenous aquatic ecosystems [7]. Moreover, Welcomme [12] has categorized the topmouth gudgeon, listed since 2016 in the list of concerning invasive alien species for the European Union, as an international pest species, and it has been reported that it is the host of an infectious pathogens that causes increased mortality and prevents an endangered native fish from breeding.

Originating in East Asia, the topmouth gudgeonis is a species of freshwater fish belonging to the Cyprinid family. Japan, the Korean portion of the Amur River Basin, China (Yangtze and Hoanghe River Basins), and Taiwan comprise its natural distribution region [13]. Following its unintentional entrance to Romania in 1961 [14], a large number of the records originated in European, Asian, and even African nations [7]. In Algeria, [15] in the Kebir River, El-Kala, observed *Pseudorasbora parva* for the first time. This species was recently observed in the Sebaou River in Tizi Ouzou [16], contrasting with previous studies suggesting its localized presence in the region, but indicating a trend towards increased distribution area [11, 17].

This study is in line with [17] study of the distribution of all freshwater fish species in North Africa. In fact, our study completes and clarifies certain information and describes for the first time the ecology and mapping of the species' biogeographic distribution in Algeria, this led us to assume that its range has extended elsewhere in Algeria.

2. Materials and Methods

2.1. Study area

The fieldwork was conducted in various regions of Algeria susceptible to hosting this species, including northeastern areas such as Tizi Ouzou, Bejaia, Jijel, Skikda, Sétif, Constantine, and El-Kala, as well as northwestern regions including Chellif and Mostaganem (Figure 1). We also explored inland regions of the country, such as the city of M'Sila and Biskra. Northern Algeria is characterized by a variety of mountains traversed by significant hydrological networks formed by the association of mountain streams [18]. These coastal zones receive more precipitation, especially in eastern Algeria [19]. In contrast, the hydrological network of the highlands region in the interior of the country is particularly characterized by the presence of sebkha and chotts [20].

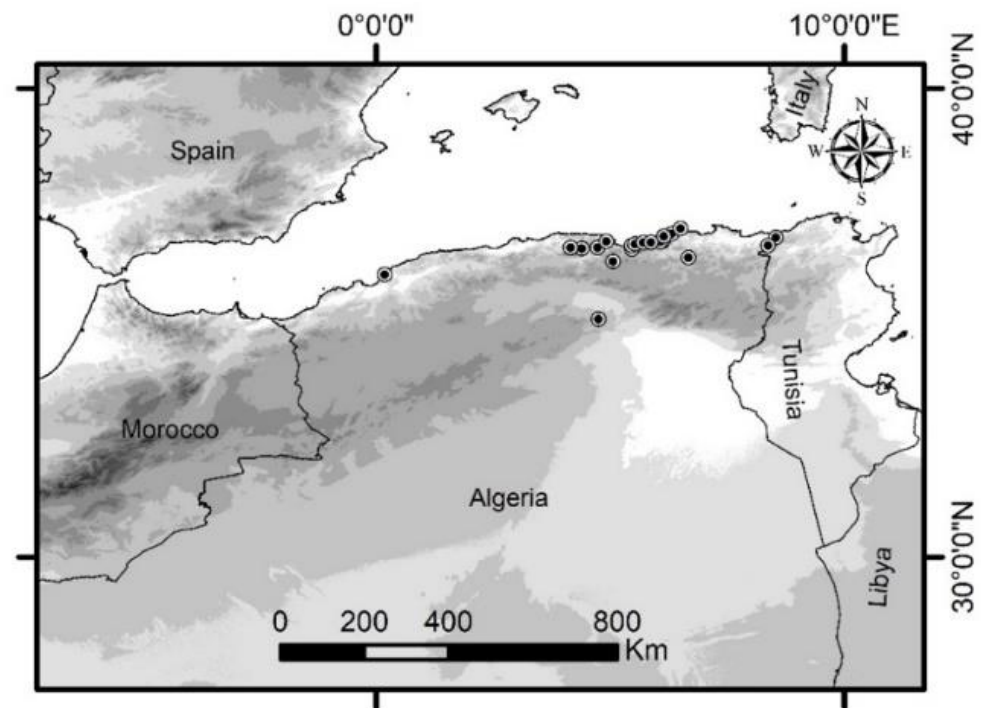


Figure 1. Geographical location of the study area and sampled sites

2.2. Sampling and data collection

The data collected were obtained through firsthand observations conducted between February 2023 and May 2024. These observations were part of monitoring the populations of the Maghreb Bleak, *Tropidophoxinellus callensis*, within its distribution area. Sampling sites cover all the main hydrographic basins. Twenty different sites belonging to nine hydrographic basins were visited (As shown in Figure 1). The species were captured using a scoop net. The specimens were immediately kept cold in a cooler before being transferred to the laboratory for further study. Additionally, some individuals of the captured species were photographed using Honor 50 cameras. Counts and measurements of specimens was carried out using a caliper. Complete lateral line scale counts were made using an Olympus binocular stereo zoom Z410 (0.8-4.7 x 10 magnification range). Sampled specimens are preserved in ethanol 70° in the Ecology and Environment Laboratory at the University of Bejaia. To the extent possible, we have tried to identify other fish species associated with the presence of the introduced *Pseudorasbora parva*.

2.3. Verification of species occurrence points

The main historical occurrences of the species concerning North Africa come from consulting recent literature dedicated to the study of freshwater fish inventories in this region (10, 11, 21, 22; 17, 16]. The portal of the GBIF (Global Biodiversity Information Facility) platform (<https://www.gbif.org/species/2362868>, *Pseudorasbora parva*) provided four occurrence points for the species *Pseudorasbora parva* in the North African region, three occurrences in Algeria and one occurrence in Morocco. Finally, an additional occurrence point from the El Kala region (El Taref, Algeria) [15] was added, as it is not listed on the GBIF platform portal.

2.4. Mapping and distribution of the species

To update the geographical distribution map of the topmouth gudgeon species, we downloaded all occurrence records from GBIF as separate files. Thereafter, we merged

these spatial data with our own field sampling records and georeferenced records from previously published literature [15] To ensure the reliability of our data, the different occurrence points were carefully verified. The geographic maps of the survey area were generated using Google Earth (version 2024). Imported and georeferenced with ArcGIS software version 2.2, they were used to create the base map. GPS points indicating the presence of the species were positioned throughout this area.

3. Results

3.1. Morphological parameters

The captured fish vary in size, with their measurements shown in Table 1. The total length of the topmouth gudgeon in Algeria range from 60.83 to 91.55 mm. Complete lateral line with 35 scales. We do not have comparison elements for some parameters measured.

Table 1. Different biometric measurements of the topmouth gudgeon in Algeria (lengths in millimeters, weight in grams)

Measures	Mean	Standard deviation	Range
Total length	71,93	9,73	60,83-91,55
Forked length	65,51	9,03	55,43-83,30
Standard length	57,98	8,05	48,38-73,41
Head length	14,32	1,95	11,88-17,65
Body depth	12,12	2,40	9,01-18,87
Eye diameter	3,78	0,61	2,18-5,16
Dorsal-fin height	13,06	1,54	10,8-17,65
Dorsal-fin base length	6,84	0,91	5,62-10,07
Pectoral-fin length	9,63	2,05	7,4-13,48
Pectoral fin height	4,83	0,55	3,88-5,99
Pectoral-fin base length	2,08	0,36	1,55-3,09
Pelvic-fin height	9,61	0,97	7,8-11,67
Pelvic-fin base length	2,21	0,39	1,77-3,12
Anal-fin height	9,00	0,71	7,61-10,93
Anal-fin base length	4,82	0,84	3,52-6,08
Caudal peduncle length	12,35	1,97	8,93-16,63
Caudal peduncle depth	6,65	1,05	5,08-8,93
Weight of fish	3,73	1,85	1,77-8,1

3.2. Distribution of topmouth gudgeon in Algeria

The topmouth gudgeon is distributed in all coastal areas of Algeria as well as inland regions, particularly in the El Hodna and Constantine regions (As shown in Figure 2). During our study, we discovered four new sites harbouring the *Pseudorasbora parva* species (As shown in Figure 2). The first site is located at Oued Djendjen (Azaouen), in the municipality of Emir Abdelkader (Jijel). The second is found in one of the tributaries of Oued Sebaou in Takhoukht (Tizi Ouzou), while the third is spotted at Oued Z'hor in the

wilaya of Skikda. Lastly, the fourth site of species' occurrence is located far at Oued Cheliff, specifically at lower Cheliff (Mostaganem) (As shown in Figure 2), approximately 700 kilometers from the nearest site (Oued Sebaou). We also rediscovered the species in the historical sites of its presence, namely El-Kala (El-Taref) and Jbel Ouahch (Constantine).

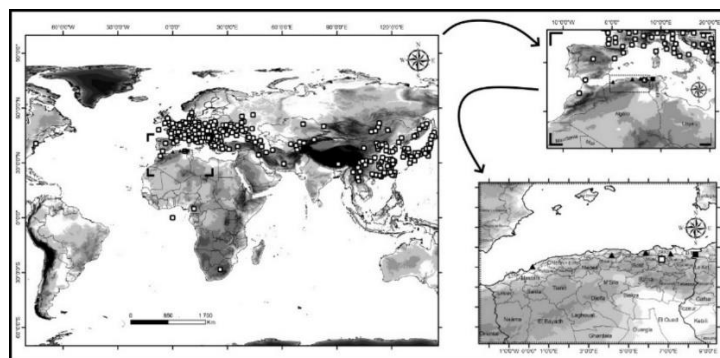


Figure 2. Topmouth gudgeon distribution Map. White squares represent occurrences from GBIF, dark squares represent occurrences from literature, and the dark triangles represent the new observation points in Algeria. <https://www.gbif.org/species/2362868> (31 May 2024)

3.3. Associated fish species

In total, we were able to identify eight fish species that share the same habitat with the *Pseudorasbora parva* species (As shown in Table 2). They are divided into five native species (62.50%) and three introduced species (37.50%). Among the native fish species, we recorded two endemic species, *Luciobarbus setivimensis* and *Tropidophoxinellus callensis*.

Table 2. Inventory of the ichthyofauna associated with the presence of topmouth gudgeon in Algeria. (+) Presence, (−) Absence, A: Autochthonous, I: Introduced

Species	El Taref	Skikda	Jijel	Constantine	Tizi Ouzou	Mostaganem	Status
<i>Luciobarbus setivimensis</i>	+	+	+	-	+	+	A
<i>Tropidophoxinellus callensis</i>	+	+	+	-	-	-	A
<i>Anguilla anguilla</i>	-	+	+	-	+	-	A
<i>Atherinaboyer</i>	-	+	+	-	-	-	A
<i>Rutilus rutilus</i>	-	-	-	-	+	-	I
<i>Gambusia holbrooki</i>	-	-	-	+	-	+	I
<i>Cyprinus carpio</i>	-	-	+	+	+	-	I
<i>Salaria fluviatilis</i>	-	+	+	-	-	-	A

4. Discussion

Topmouth gudgeon has been described as a small cyprinid with a maximum total length recorded 120 mm and maximum recorded fork length of 110 mm [23, 24]. In Algeria, the Topmouth gudgeon has reached sizes comparable to those observed in Asia and Europe. According to [7], there is a significant amount of variation in the external morphology of species populations, which is visible in both their native range and European populations. Although considerable morphological variety is expected in populations from various latitudes and/or environments, variations were also observed across populations within the same area [25].

According to reports, the topmouth gudgeon was introduced to North Africa in the 1970s [21], although the precise dates of its introduction to Algeria remain unknown [11]. This species was documented as either isolated or rare in this region [11]. However, the extent of the species range in Algeria is probably exceeds what is currently documented in scientific literature [21]. Before this study, we mention two observations in Algeria [11] and one observation in Morocco [21]. In Algeria, this species was spotted in the Oued El Kebir, at the extreme east of the El-Kala region [15]. Another site where it is present is in the Constantine region, at Lake Jbel Ouahch (Algeria), listed on the Global Biodiversity Information Facility (GBIF) map. Our multiple field observations corroborate the findings of the study conducted by [22] in the Soummam River basin in Bejaia, demonstrating the absence of cyprinid fish in this hydrographic basin. This diverges from the data of the ichthyological inventory by [10], which had reported its presence as common. However, the rediscovery of this species in the Sebaou River basin in Tizi Ouzou aligns with the observations presented in the study by Welcomme [16], who have consistently recorded the presence of this species in the same hydrographic basin.

However, locating this species in the regions of Skikda, Jijel, and Mostaganem represents new discoveries of this cyprinid, undocumented in previous studies such as the one conducted by [26], notably in the Cheliff River to the west of Algeria. In less than 50 years since its introduction to Romania in the 1960s, this invasive species has spread to occupy the majority of Europe [7]. The species' opportunistic life-history traits such as omnivore status, short generation time, polyphilic spawner status, high reproductive effort, and parental care—can be used to explain why it is found in numerous other places and why its invasion spread well in Algeria [27].

Moreover, the topmouth gudgeon's wide physiological tolerance which allows it to endure harsh environmental circumstances like low water levels, high temperatures, low oxygen concentrations, and algal blooms [14, 28] explains why it lives in the Cheliff River (As shown in Figure 3). Indeed, research on Algerian climatology has established that precipitation is lower and temperatures are higher in western Algeria compared to the east [19]. The observation of this fish in the wettest areas of Algeria, in Skikda and Jijel, seems to strengthen the hypothesis that it has a superior ability to colonize watercourses compared to other introduced species such as *Cyprinus carpio* [21].



Figure 3. Photos showing topmouth gudgeon (a) sampled from the lower Cheliff River (b)

We do not know the reasons for the introduction of the topmouth gudgeon in Algeria. The voluntary or involuntary introduction of a new species always represents a risk, the consequences of which cannot be entirely predicted. There is notably a risk of food competition with endemic species [23]. The most widespread introduced species in the Oued Sebaou was *Pseudorasbora parva*, surpassing the distribution range of all native species except for *Luciobarbus setivimensis* [16]. We do not know precisely the conditions of the introduction of this species in Algeria [11]. The first individuals were seen in June 1992 in Oued Kebir, El-Kala. [15] suggest that the arrival of *Cyprinus carpio* is likely linked to the existence of *Pseudorasbora parva* in Algeria. However, there is no record of this later non-native fish in the Oued Z'hor (Skikda) in relation to the topmouth gudgeon. This could be explained by the lack of nearby water reservoirs, as the main points of introduction for this fish are dams and other types of reservoirs [29]. Negative effects on Asian and European fish species have been reported, despite the lack of information regarding *Pseudorasbora parva*'s interactions with native Algerian freshwater fish species. These effects include interspecific competition for food [30], predation on native species' eggs and larvae (Stein and Herl, 1986), and the introduction of exotic parasites [6]. Endemic fish species are the most vulnerable to introductions [31]. In this situation, the species *Pseudorasbora parva* could have an adverse impact on populations of *Tropidophoxinellus callensis* and *Luciobarbus setivimensis* by preying on their eggs.

With new sites discovered, the topmouth gudgeon is now widely distributed along the entire Algerian coastal strip as well as in the high plateaus' interior regions of the country. This expansion of its distribution range in Algeria reflects trends observed in other populations of this species in other biogeographic regions. The presence of the topmouth gudgeon in the natural lake of Jbel Ouahch in Constantine confirms the hypothesis that it may have been accidentally introduced during the introduction of *Cyprinus carpio*. To anticipate which fish groups in Algeria could be affected by future invasions by *Pseudorasbora parva*, an alien species, it is now necessary to conduct urgent study and

gather knowledge about the species' dispersing capabilities, preferred environment, and current invasion scale.

5. Conclusions

La découverte de quatre nouvelles localités de présence de *Pseudorasbora parva* révèle une expansion notable de son aire de distribution vers le nord-ouest de l'Algérie. Cette espèce a en effet été observée dans des bassins hydrographiques aménagés par l'homme, tels que les réservoirs d'eau et les barrages, où sa présence résulte accidentellement de l'introduction de *Cyprinus carpio*. Il est donc crucial de réaliser des études supplémentaires sur son écologie dans ces nouvelles zones colonisées afin de mieux comprendre l'invasion de cette espèce et son impact sur la diversité ichthyologique indigène algérienne.

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