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New records of Largemouth Black Bass, *Micropterus salmoides* (Lacépède, 1802) (Pisces, Centrarchidae), in Bulgaria

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Abstract. In the present study we report on new localities of Largemouth Black Bass, *Micropterus salmoides* (Lacépède, 1802), detected on the territory of Bulgaria. This invasive predator was observed for the first time in 2018 in a water basin in the capital city of Sofia city (western Bulgaria) and the following monitoring revealed that seven water bodies in the capital were inhabited by adults, subadults, and juvenile specimens. In 2021 and 2022, this species was captured in water basins in the vicinity of lake Mandra near the city of Burgas (south-eastren Bulgaria). Currently, these sites represent the easternmost localities within the distribution of *M. salmoides* in the Balkan peninsula and perhaps in continental Europe.

Keywords. Citizen science, invasive vertebrates, limnology, monitoring, predator, urban ecology

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Introduction

The Largemouth Black Bass, *Micropterus salmoides* (Lacépède, 1802) is a carnivorous perciform fish in the family Centrarchidae (sunfishes), which is native to Canada, USA, and Mexico in North America (De Vris et al. 2015). The species possesses a high potential for biological invasion and was included among the "100 most dangerous invasive species" list (Lowe et al. 2000). Since the 19th century, the fish was introduced as a commercial species in Africa, Asia, South America, and Europe (Pereira and Vitule 2019). *Micropterus salmoides* became a rather important fish food among the Asian human communities (Rojo-Cebreros et al. 2022) and currently China produces about 99% of the world's harvest of that aquaculture—about 0.7 million tonnes (Jin et al. 2022; Feng et al. 2023). In south-western Europe, *M. salmoides* was introduced as a game aquatic predator, which is predominantly of interest for sport fishing (Carpio et al. 2019), but also as a food source (Hrytsyniak and Guschin 2020). *Micropterus salmoides* were first released in France in 1877 (Drake 2009). Currently, the fish is distributed in Spain, Portugal, France, Italy, and other Mediterranean countries (Kottelat and Freyhof 2007; Carpio et al. 2019). On the Iberian Peninsula, the invasive potential of *M. salmoides* was identified as "high" (Almeida et al. 2013); however, in some parts of Europe (e.g., Ukraine), the species did not form stable populations, despite that it was imported more than a century ago (Kvach and Kutsokon 2017; Hrytsyniak and Guschin 2020).

On the Balkan peninsula, *M. salmoides* was introduced in 1892 in Slovenia (Seebens et al. 2017). In the last decades, this invasive fish was detected in Croatia (Dulčić et al. 2017), Bosna and Herzegovina (Tutman et al. 2017), Serbia (Seebens et al. 2017), and Romania (Stănescu et al. 2020; Iftime and Iftime 2021). This species was recently reported in Bulgaria—in the waters of the Struma River catchment area, but also northwestern from Sofia (Uzunova et al. 2019). In the present study,

we provide new data on the presence of *M. salmoides* in the territory of Bulgaria and discuss the possible impact of this invasive species on the local population of fish and fish-based trophic webs.

Methods

Our investigation started in the spring of 2018. We performed monitoring of permanent water basins in the region of Sofia city in irregular intervals of about 12 days. We studied a total of 15 water bodies and performed a visual inspection for the presence of *M. salmoides*. In several cases, we were able to approach the fishes at a close distance and attempted to capture specimens with a handheld-fish nets (Fig. 1A). In late January 2023, we received information from local hobby-naturalists and fishers about the presence of *M. salmoides* in the region of Burgas city (Fig. 1B). The provided photographs were investigated by professional ichthyologists (KV, NK) and the taxonomy of the detected fishes was confirmed. The authors KV, NK, and NN identified the geographic position of the water bodies and visited the basins at the end of March 2023 (Fig. 2B, C). The water basins were coded as "1" and "2", and their position was matched to the database of the NATURA 2000 nets in Bulgaria (Fig. 2). The photographs by the authors were taken with a Panasonic Lumix DMC-FZ200 camera (Panasonic Corpo-ration, Osaka, Japan). All registrations were protocolled and georeferenced with the use of a handheld GPS System Garmin Etrex 30 GPS receiver (Garmin International Inc., Kansas, USA). The datum used for the recording of the geographical coordinates was WGS84. The exact coordinates of the already-published observations of *M. salmoides* in western Bulgaria (Fig. 2A) were provided by Uzunova et al. (2019). The updated map of the geographic distribution of *M. salmoides* was created using QGIS (QGIS Development Team 2021), and additional data were based on the dynamic map of NATURA 2000 PS in Bulgaria.

Results

Order Perciformes
Family Centrarchidae
Genus *Micropterus*

***Micropterus salmoides* (Lacépède, 1802)**

New records. BULGARIA – **Sofia** • 42.6592°N, 023.3076°E, 602 m a.s.l.; 19.VI.2020; KV captured 1 individual (Fig. 1A) within a water basin in South park • 42.6894°N, 023.4212°E, 509 m a.s.l. • 42.6893°N, 023.4202°E, 509 m a.s.l; • 42.6659°N, 023.4018°E, 544 a.s.l. • 42.6643°N, 023.4004°E, 544 m a.s.l. • 42.6637°N,

Figure 1. Largemouth black bass (*Micropterus salmoides*) in Bulgaria. **A.** Specimen of *M. salmoides* captured from a water basin in Sofia city. **B.** Two specimens captured at waterbody "1" by Hristo Valyarov on 10 September 2022.

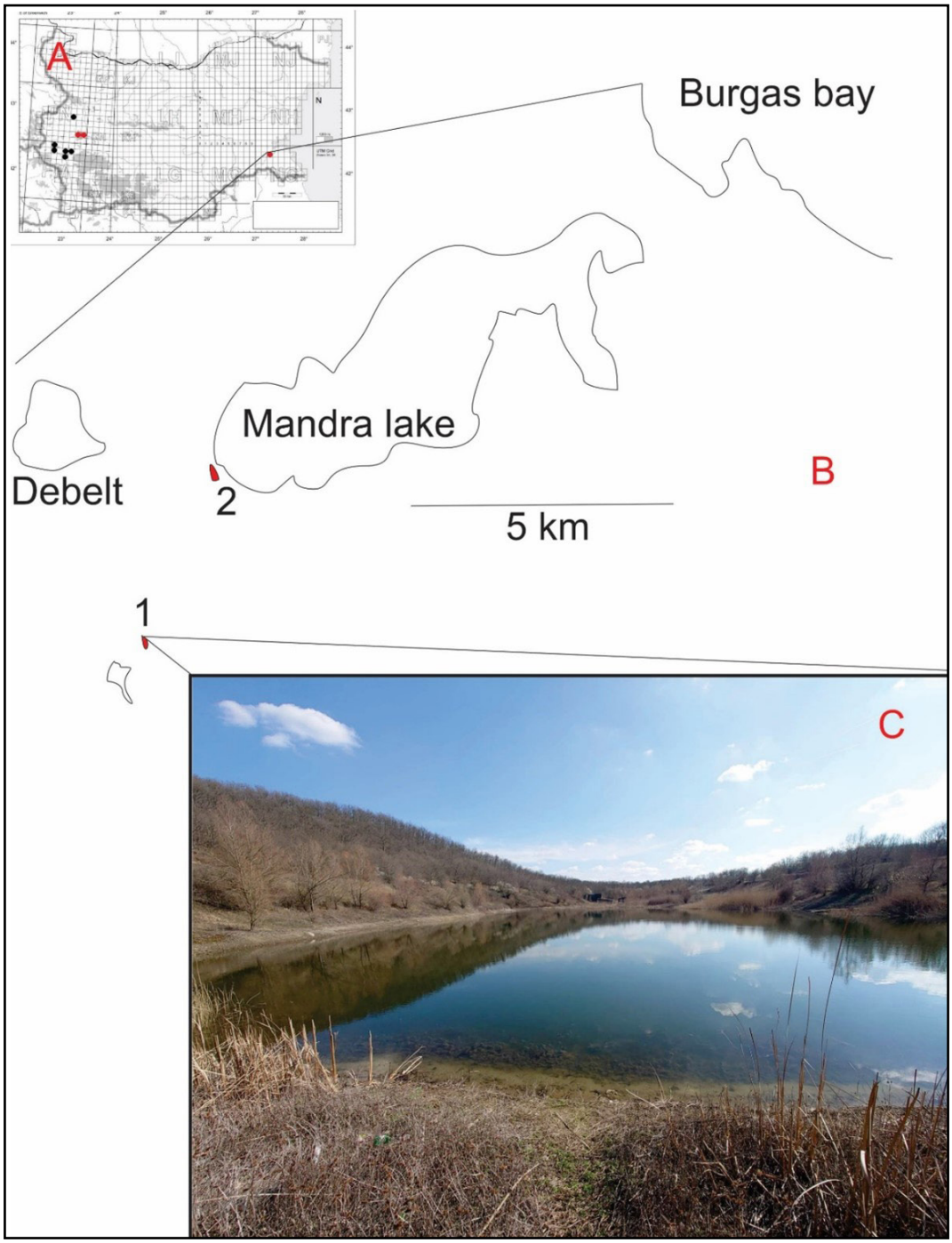

Figure 2. Current distribution of the Largemouth black bass in Bulgaria. **A.** Map of the general distribution: black circles indicate the detected habitats of Uzunova et al. (2019), red dots indicate the newly registered habitats. **B.** Position of the two water basins indicated as "1" and "2" (in red) in the vicinity of Mandra lake. The territory of lake is protected from the of the NATURA 2000 network; however, water bodies "1" and "2" are positioned outside the protected site. **C.** Photograph of water body "1".

023.3991°E, 544 m a.s.l. • 42.6622°N, 023.3082°E, 616 m a.s.l • 42.6644°N, 023.3042°E, 616 m a.s.l.; 22.IV.2018–18.IX.2021; KV obs.; adults, subadults, juveniles – **Burgas** • Debelt • 42.3492°N, 027.2943°E, 90 m a.s.l.; water body "1" (Fig. 2B); 22.X.2021, Denis Toshev captured 1 individual; 10.IX.2022, Hristo Valjarov captured 2 individuals (Fig. 1B); 42.3831°N, 027.3147°E, 10 m a.s.l; water body "2", 15.IX.2022, Hristo Valjarov captured 4 individuals.

Identification. This species is the only representative of the genus *Micropterus* in Bulgaria. The only other centrarchid species that inhabits Bulgaria is the invasive Pumpkinseed Fish, *Lepomis gibbosus* (Linnaeus, 1758); however, it differs drastically in form and coloration from *M. salmoides* (Davis and Lock 2007). The fishes from the family Percidae, which inhabit the freshwaters of Bulgaria differ from *M. salmoides* in the coloration, the form of the body, the form of the fins, the body proportions, the position of the mouth, and the form and position of the eyes; for characteristics of these species, see Kottelat and Freyhof (2007) and van der Walt et al. (2019).

Discussion

According to Clavero and Garcia-Berthou (2005), biological invasions are one of the main factors or even the main cause for the extinction of animal species. *Micropterus salmoides* inflict crucial negative effects on the ecosystems, where it was introduced (Azuma 2001). Experimental data indicate that *M. salmoides* may radically impact species richness (67.86%) and biomass (up to 83.29%) of other fishes (Han et al. 2016). In the European freshwater basins, potential predators praying on *M. salmoides* can be *Esox lucius* Linnaeus, 1758 and some percids (Drake 2009). However, due to various factors, these predators cannot diminish the population of *M. salmoides* to critical levels. In many of the invaded waterbodies, *M. salmoides* becomes a top predator and, as such, it impacts by the "top-down" effect of various connections within the trophic webs (Han et al. 2016). The bass is specialized in the pursuit hunting of fish (Luger et al. 2020), and the levels of piscivory in this predator are among the highest recorded worldwide (Jang et al. 2006). The potential of this invasive predator to diminish dramatically the population of the local fish species is well documented and investigated (Han et al. 2016). Another rather alarming aspect is that *M. salmoides* is unable to "top-down" control the populations of other invaders, such as the sunfishes of the genus *Lepomis*. When these centrarchids coexist together, they prevail over the native fish species and create a great imbalance in the ichthyofauna, i.e., the sunfishes may appear in great numbers and totally dominate over the other fish species (Hossain et al. 2013). Another topic, that must be clearly understood is whether the European waters are invaded only by *M. salmoides*, or if Spotted Bass, *M. punctulatus* (Rafinesque, 1819) is also present (see van der Walt et al. 2019). Both species are closely related, externally look rather similar, and produce hybrids (Godbout et al. 2009). In eastern Europe, *M. salmoides* was detected rather sporadically. The species was recorded from the Volyne region in Ukraine (Kvach and Kutsokon 2017; Hrytsyniak and Guschin 2020) and in the region of Bucharest and two northern districts in Romania (Iftime and Iftime 2021). In this contribution, we report the presence of *M. salmoides* at the Black Sea coast in southeastern Bulgaria, being, to our best knowledge, the easternmost point of the range of that invasive species on the Balkan peninsula, or even in continental Europe.

The presence of *M. salmoides* at the very proximity to the Protected Site BG 0000271 Mandra lake is rather alarming; water basin "1" is located at about 4000 m and water basin "2" is less than 100 m from its boarder (Fig. 2B). Lake Mandra is a part of the so-called "Burgas lakes", or "Burgas wetlands", which are of great ecological importance. The Burgas lakes complex is highly sensitive and is recognized as Ramsar sites and is also a part of the Natura 2000 Protected Site network. It is important as permanent or transient habitat for a great variety of bird species, including many piscivorous species (Solakov 2010). Burgas wetlands are subject to intensive sport fishing, and the tendency in the last years is that the fishers practice the so called "catch and release" method. We propose that *M. salmoides* may spread in the system of lakes around Burgas city rather rapidly in the future. The Burgas wetlands are characterized by a strong variation in the water salinity—it ranges between 0.01 and 16.1‰ (Rabadjieva et al. 2019). While most freshwater fishes have a low tolerance toward increased conductivity of the waters they inhabit (Peterson and Meador 1994), *M. salmoides* is rather plastic concerning that factor (Susanto and Peterson 1996). Sun et al. (2021) explained the ability of this species to adapt to increased ionic pressure by the activation of a complex of genes, which switches a particular molecular mechanism for adaptation during the transition from fresh to brackish water. *Micropterus salmoides* is able to tolerate even seawater for at least some time (for an overview see Sun et al. 2021). The ability to inhabit waters with increased conductivity may allow for *M. salmoides* to invade large sections of the Burgas wetlands. The pressure from invasive carnivorous species may lead to drastic change in the behavior of highly protected species, such was the case with Lake "Srebarna" (Koshev et al. 2020). Having in mind the anthropogenic selective pressure and the genetic plasticity of *M. salmoides* (see Sun et al. 2023), we propose that *M. salmoides* may represent a severe threat for the fauna of the Burgas wetlands in the near future. Future field investigations using direct capture of the species and detection of its presence on the basis of environmental DNA (see Laramie et al. 2015) will provide detailed information on the spread of the invasive predator within the territory of Bulgaria. Urgent action plans for the elimination of *M. salmoides* must be issued and all good practices concerning its eradication must be applied immediately.

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Author Contributions

Conceptualization: KV, NK, TK, NN. Data curation: NN. Funding acquisition: KV, NK, TK, NN. Investigation: KV, NK, NN. Methodology: KV, NN. Resources: KV, NK, NN. Visualization: TK, NN. Writing – original draft: KV, NN. Writing – review and editing: KV, NK, TK, NN.

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