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Rapid Communication

New data on aquatic alien invertebrates in the Ukrainian Danube Delta with special emphasis on the first records of the trumpet ram's-horn, *Menetus dilatatus* (Gould, 1841)

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Abstract

Studies of alien aquatic invertebrates in 2021–2022 covered fresh marine and transitional waters mostly within the boundaries of the Danube Biosphere Reserve. As a result of these studies, important new findings of six species of aquatic macroinvertebrates were obtained: *Menetus dilatatus* (Gould, 1841) is first indicated for the Danube Basin, and three marine species (*Arcuatula senhousia* (Benson, 1842), *Polydora cornuta* Bosc, 1802 and *Streblospio gynobranchiata* Rice & Levin, 1998) for the first time for Ukrainian Danube Delta. For two species (*Pectinatella magnifica* (Leidy, 1851) and *Ferrissia californica* (Rowell, 1863)), new localities were found within the delta. In the case of *M. dilatatus*, the pathway of entry into the Danube Delta is an absolute mystery. The most likely pathway of dispersal of this species is natural dispersion, both along the river network and associated with waterfowl, however, the large distance between the Danube Delta and the nearest locations in Western Ukraine makes direct transportation unlikely. In all probability, the similarity of this species with local species leads to the formation of cryptic populations, not identified by researchers, which may be intermediate stages of species expansion towards the Northern Black Sea area.

Key words: alien species, invasive species, deltaic zones, Ukraine, Mollusca, Polychaeta, Bryozoa

Introduction

The Danube Delta is one of the key points for the study of aquatic invasions on a European scale. The Danube River, connected by a navigable canal to the Rhine Basin, forms a large-scale route for the dispersal of alien species, the Southern Invasion Corridor (Bij de Vaate et al. 2002; Roche et al. 2013). This is part of a network of such corridors that together connect most of Europe's major river basins (Galil et al. 2008; Leuven et al. 2009; Panov et al. 2009; Son et al. 2020).

At the same time, the Danube Delta, together with many adjacent large lakes, lagoons, and desalinated sea areas, is one of the principal invasion gateways – areas at the border of freshwater and marine ecosystems, where the penetration and subsequent adaptation of brackish-water species into river basins occurs (Panov et al. 2009).

The Danube Delta is extremely intensively researched by a large number of Ukrainian and Romanian institutions working independently in this region, united both by continuous cooperation and various international grants and projects (Gogaladze et al. 2020a, b). It also has an extremely high level of coverage by various conservation statuses that imply a special nature of monitoring and reporting, since its territory is part of the UNESCO International Bilateral Reserve, national nature reserves, is also a Ramsar Site and an area under the protection of the Bern Convention, Habitats and Birds Directives and many other agreements (Gogaladze et al. 2022).

As a result, for this region, new finds of aquatic alien species are reported extremely quickly and probably very accurately reflects the real trends of invasions.

More than twenty alien aquatic animals have been identified in the Ukrainian part of the Danube Delta and water bodies as a result of many years of research and this is mostly related to the findings of invertebrates including both free-living and parasitic species (Aleksandrov et al. 2014; Lyashenko et al. 2005; Son 2008, 2010; Sanzhak et al. 2012; Kvach et al. 2018; Kudriashov 2020; Zorina-Sakharova and Lyashenko 2020; Morhun et al. 2022; Zhmud et al. 2022). In addition to this, as well the new findings of fish are known from this waterbody (Kvach 2012; Kvach and Kutsokon 2017; Kvach et al. 2022).

For the past few years, however, research has been hampered by the COVID-19 epidemic and then by the Russian-Ukrainian war that began in 2022, during which the Danube Delta was the scene of active hostilities. In this connection, new data obtained during expeditions 2021–2022 within the framework of the international IASON project (https://iasonbsb.eu/) are extremely important and have great faunistic novelty, including a new freshwater species for the Danube basin and penetration into the saline bays of the delta of three species that were previously recorded only in the adjacent marine ecosystems.

Materials and methods

Studies of alien aquatic invertebrates in 2021–2022 covered fresh, marine and transitional waters mostly within the boundaries of the Danube Biosphere Reserve (Figure 1). These boundaries also coincide with the area of Emerald Network Site "Danube Biosphere Reserve", UA0000018), which is protected by the Berne Convention. The network of stations covered a wide range of habitats: large and small river channels, lakes, floodplain shallows, freshwater, and brackish-water bays and the adjacent sea coast; artificial channels, and flooded quarries (total 21 stations).

Under the conditions of the 2022 war, the Danube Delta became an arena of direct hostilities, and after their intensity decreased, a large part of this area remained closed to research due to mine danger or a special regime of protection of strategic infrastructure. In this regard, the research in 2022 was carried out according to an abbreviated scheme, in spite of this, preserving the diversity of the types of biotopes studied.

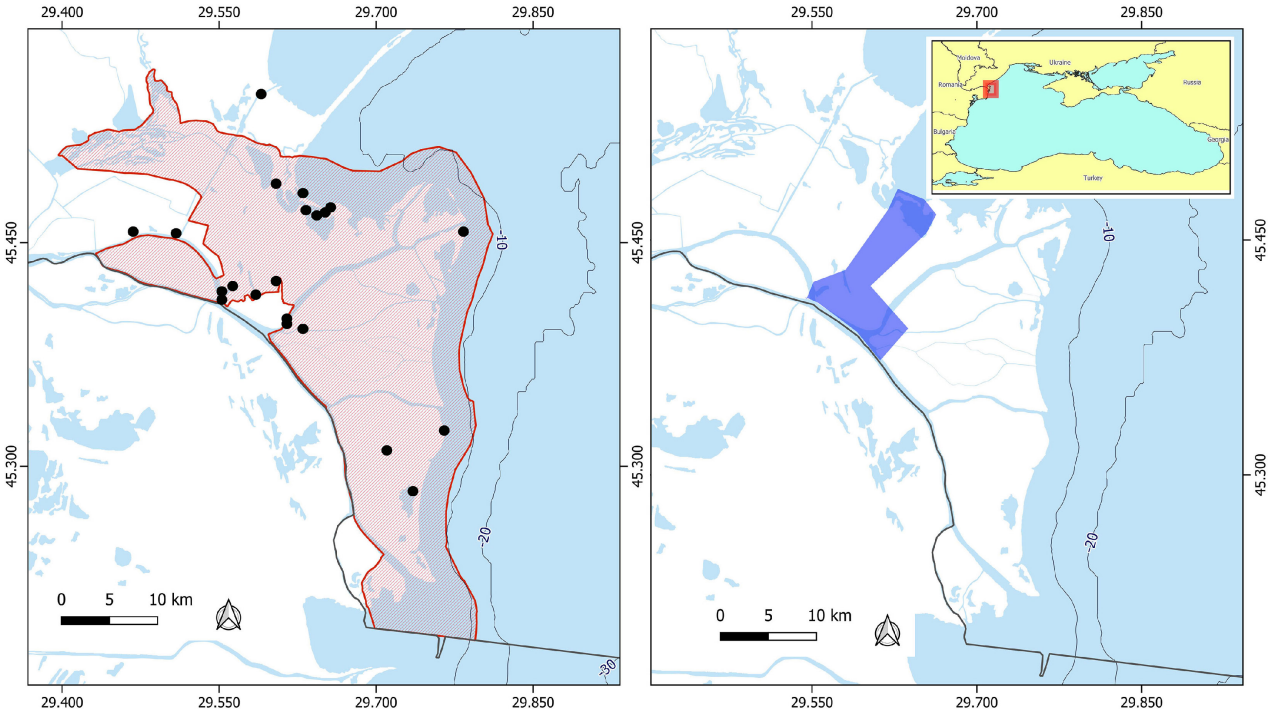

Figure 1. Study area in the Ukrainian Danube Delta: black dots – sampling stations; highlighting in red – boundaries of the Danube Biosphere Reserve; highlighting in blue – area available for research under military action in 2022.

The Assessment System for the Ecological Quality of Streams and Rivers throughout Europe using the Benthic Macroinvertebrates (AQEM) protocol was used for the sampling stations (AQEM Consortium 2002). At each station, benthic samples were taken in all microhabitats that covered more than 5%. A kick-net (ISO 7828) was dragged along the shore at a 5 m distance. The collector moved in zigzags to cover depths from the water edge to one meter for 15 minutes, with 4–5 replicates. Supplementary to our standard sampling protocol described above, we also used additional macroinvertebrate benthos sampling techniques where appropriate/necessary, such as snorkeling with hand sampling, especially for stones, flooded wood, and other large objects.

Bottom sediments were washed through laboratory sieves for sediment granulometry with a metal wire mesh (mesh diameter = 2 and 1 mm).

Collected macroinvertebrates were immediately preserved in 70% ethanol in the field (individual specimens were fixed in 96% alcohol for subsequent molecular studies), and later in the laboratory, samples were sorted and macroinvertebrate taxa counted and identified.

Results

As a result of these studies, important new findings of six species of aquatic macroinvertebrates were obtained (Table 1 and Table 2, Figure 2).

The trumpet ram's-horn *Menetus dilatatus* (Gould, 1841) is first reported for the Danube Basin, and three marine species (Asian date mussel *Arcuatula senhousia* (Benson, 1842); spionid polychaetes *Polydora cornuta* Bosc, 1802 and *Streblospio gynobranchiata* Rice & Levin, 1998) for the first time for

Table 1. New records of aquatic alien invertebrates in Ukrainian Danube Delta

Taxon	Date	Locality	Latitude	Longitude
Arcuatula senhousia (Benson, 1842)	09.11.2022	maritime edge of the delta	45.47414	29.65272
Ferrissia californica (Rowell, 1863)	22.10.2021	The branch of the Danube "Skhidne Gyrlo"	45.54820	29.58781
F. californica	21.10.2021	Danube-Sasyk Canal	45.31118	29.70441
F. californica	10.11.2022	flooded sand pit	45.41458	29.58593
Menetus dilatatus (A. Gould, 1841)	09.11.2022	The branch of the Danube "Ankudinove Gyrlo"	45.39141	29.62801
Pectinatella magnifica (Leidy, 1851)	20.10.2021	Buzunchuk Bay	45.41813	29.56458
Polydora cornuta Bosc, 1802	09.11.2022	Solonyi Kut Bay	45.46791	29.64757
Streblospio gynobranchiata Rice & Levin, 1998	09.11.2022	Solonyi Kut Bay	45.47239	29.63321
S. gynobranchiata	09.11.2022	Solonyi Kut Bay	45.46791	29.64757

Table 2. General information on aquatic alien invertebrates in Ukrainian Danube Delta considered in this article

Species	Phylum, Class	Origin	Habitat type	Year of the first record in Ukraine	References
Arcuatula senhousia (Benson, 1842)	Mollusca: Bivalvia	Indo-Pacific	Marine, estuarine	2017	Zhulidov et al. 2021
Ferrissia californica (Rowell, 1863)	Mollusca: Gastropoda	North American	Freshwater	1919	Son 2007
Menetus dilatatu (A. Gould, 1841)	Mollusca: Gastropoda	North American	Freshwater	1991	Stadnychenko 2019
Pectinatella magnifica (Leidy, 1851)	Bryozoa: Phylactolaemata	North American	Freshwater	2005	Aleksandrov et al. 2014
Polydora cornuta Bosc, 1802	Annelida: Polychaeta	Atlantic	Marine, estuarine	1962	Radashevsky and Selifonova 2013
Streblospio gynobranchiata Rice & Levin, 1998	Annelida: Polychaeta	Atlantic	Marine, estuarine	2011	Radashevsky and Selifonova 2013

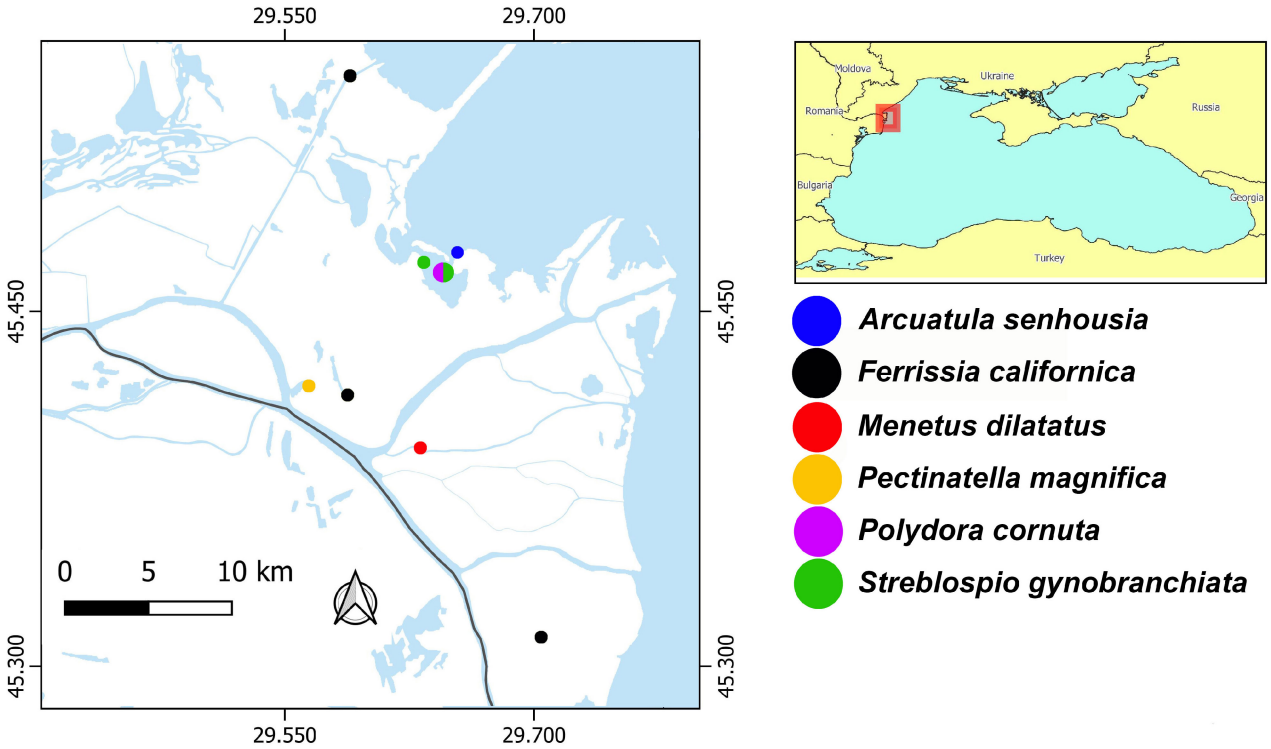

Figure 2. Map of localities for new records of aquatic alien invertebrates in Ukrainian Danube Delta

Ukrainian Danube Delta. For two species (magnificent bryozoan *Pectinatella magnifica* (Leidy, 1851) and freshwater limpet *Ferrissia californica* (Rowell, 1863)), new localities were found within the delta.

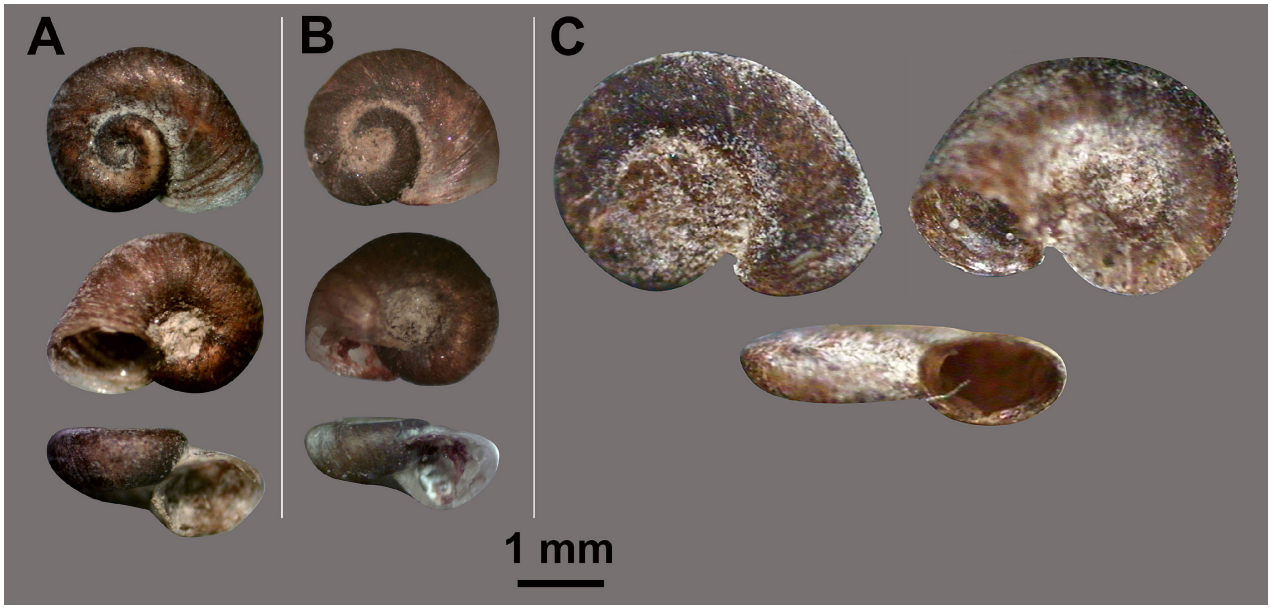

Figure 3. Shells of the alien *Menetus dilatatus* (A. Gould, 1841) with different vertical position of the mouth (A, B) and native *Gyraulus crista* (Linnaeus, 1758) with reduced spines (C). Photo: M.O. Son.

Data on the morphology and identification features of most of these species in the Danube Delta or nearby regions have been already published in several papers (Son 2007; Radashevsky and Selifonova 2013; Aleksandrov et al. 2014; Teacă et al. 2021; Zhulidov et al. 2021), so we will not elaborate on them.

Menetus dilatatus has a very small size and is probably mostly confused with the juvenile native Planorbidae. Therefore, it is necessary to give the identification signs of this species.

The shells in our sample (Figure 3A, B) is brown, discoidal, pseudodextral, small, solid, up to 2.53 mm in diameter at 3 whorls (mean 2.17 ± 0.29 mm for adults with a fully developed shell) and up to 1.09 mm of height (mean 1 ± 0.28 mm), smooth with fine growth lines on last whorl, spire convex, umbilicus is open and deep. Shell index is 0.43–0.50: there is an individual variability in the vertical position of the orifice relative to the spiral plane (Figure 3A, B), which affects this index. The lower edge of the mouth is noticeably pulled back, which gives it angularity and makes the mouth irregularly rumpy.

Such a small size of adult shells sharply distinguishes the species from most of the numerous local species of small Planorbidae, but, in practice, this leads to misidentification with juvenile specimens of native mollusk species. Among native species, the form of variation *Gyraulus crista* (Linnaeus, 1758) with reduced spines (Figure 3C) is extremely similar in shell habitus to *M. dilatatus*. At the same time, *M. dilatatus* clearly differs from it by the angular lower edge of the mouth (as well as from other local small Planorbidae) and less expanded umbilicus.

Discussion

With this study, we provided 6 new reports of the invasive alien species in the Ukrainian sector of the Danube River. Some of the findings (*A. senhousia*,

P. cornuta, and *S. gynobranchiata*) represent species already known from the marine ecosystems of the Northwest Black Sea (Bondarenko 2011; Teacă et al. 2021; Zhulidov et al. 2021), but reported for the first time in the estuarine habitats of the Danube Delta.

In the case of *A. senhousia* invasion, it is of particular interest that this is the second attempt to colonize this region after the unsuccessful colonization in 2002, when it was recorded in the Constanța port (for the first time in the Black Sea) area, Romania near the Danube Delta (Micu 2004). This was, however, just a single finding of a live animal and there has been no further confirmation of the occurrence of this species in Romania. However, re-entry into the Azov-Black Sea basin began in 2015 and over several years has covered many locations in Russia, Ukraine, and Bulgaria (Kovalev et al. 2017; Chartosia et al. 2018; Zhulidov et al. 2021).

In general, the trend of increasing penetration of marine alien species into estuaries and lower reaches of rivers is characteristic of the Black Sea region (Son et al. 2013; Zorina-Sakharova and Lyashenko 2020; Teacă et al. 2021, 2022; Zhulidov et al. 2021). This becomes a particular problem because these areas contain habitats of vulnerable relict Ponto-Caspian fauna, for which biological pollution becomes a relevant factor for its decline (Gogaladze et al. 2021).

In the case of the two freshwater species (*P. magnifica* and *F. californica*), we see that their range in the Danube Delta is gradually expanding compared to the previously published data (Aleksandrov et al. 2014; Năstase et al. 2017; Zorina-Sakharova and Lyashenko 2020), indicating their successful naturalization.

In the case of *M. dilatatus*, the pathway of entry into the Danube Delta is an absolute mystery. This North American species has spread to several European countries, such as the United Kingdom, France, Germany, the Netherlands, Belgium, Poland, and the Czech Republic (Mouthon 1986; Jansen 1999; Kerney 1999; Beran 2005; Müller et al. 2005; Kolodziejczyk and Lewandowski 2015), and it also occurs in various river basins of the lowland part of western Ukraine (Stadnychenko 2019).

The location in which the species was found does not imply entry by shipping or ornamental trade (and these paths were not indicated as being presumed for this species). The most likely pathway of dispersal of this species is natural dispersion, both along the river network and associated with waterfowl (Kolodziejczyk and Lewandowski 2015; Stadnychenko 2019). However, the large distance between the Danube Delta and the nearest locations in Western Ukraine makes direct transportation unlikely. In all probability, the similarity of this species with juvenile individuals of native small Planorbidae leads to the formation of cryptic populations, not identified by researchers, which may exist in large rivers in Ukraine and Moldova (such as the Dniester and Prut) and are intermediate stages of species expansion towards the Northern Black Sea area.

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Author contribution

MS and YK: conceptualization and methodology; MS and OB: investigation; MS, OB, and YK: writing – original draft; YK: project administration.

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