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Rapid Communication

The first record of oriental river prawn *Macrobrachium nipponense* (De Haan, 1849 [in De Haan, 1833–1850]) (Decapoda: Palaemonidae) in the Ukrainian part of the Danube Delta

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Abstract

The alien shrimp *Macrobrachium nipponense* (De Haan, 1849 [in De Haan, 1833–1850]), oriental river prawn has been identified in the water bodies of the Ukrainian part of the Danube Delta for the first time. Diagnosis of the species is based on measurements of 35 specimens. Characteristic features: the dorsal side of rostrum armed by 12–13 teeth, with feathery setae between them, 3 (rarely 2) teeth located on the ventral side of rostrum. During 2019–2020, the freshwater shrimp, *M. nipponense*, has become a common element of the benthic fauna of the Kiliya arm of the Danube River. It is supported by regular registrations of numerous shrimp aggregations in different parts of the arm (from the 32nd to the 80th km of the main stream) since the summer of 2019. The record of this alien shrimp species potentially confirms its introduction from other water bodies of the North-Western Black Sea Coastal Area to the Danube Delta by the natural dispersion or the unauthorized introduction. Although the known records suggest an accidental introduction of this species into the area close to the lakes of the Lower Danube area, both hypotheses require further investigation and approbation.

Key words: exotic invertebrate species, freshwater ecosystems, accidental introduction, malacrustaceans, freshwater shrimp

Introduction

The lower part of the Danube River has always been a region of introductions of alien species into Ukraine and their further distribution through the Southern European Invasion Corridor, that links the basins of the Black and the North Seas. During the previous century, dozens of plant and animal species (mostly terrestrial and marine) were introduced there and have naturalized over time (Zaitsev and Mamaev 1997; Zaitsev and Öztürk 2001). As of now, 17 alien invertebrate species have already been recorded in the freshwater ecosystems of the Ukrainian part of the Danube Delta (Yurishinets and Kornyushin 2001; Lyashenko et al. 2005; Lyashenko and Makovskiy 2011; Sanzhak et al. 2012; Zorina-Sakharova and Lyashenko 2020), so the arrival of new alien species in this region can be expected.

Table 1. Locations of shrimp *M. nipponense* in the Ukrainian part of the Danube Delta.

№	Locations	GPS coordinates		Number of caught ind.	Comments
		lat	long		
1	Water reservoir "Lisky-1" on 32nd km of the Danube	45.445500	29.429861	6 (25*)	Continuous finds in crayfish traps in 2020, personal sampling (Nov. 2020).
2	Rice system near Lisky village - 25th km of the Danube	45.499639	29.398667	not surveyed	Present according to the information provided by the local crayfish trappers.
3	Kiliya branch (Solomoniv branch), 31st km	45.451833	29.458611	–	Present according to the information provided by the local crayfish trappers, not revealed during personal sampling (Nov. 2020).
4	Bazarchuk Gulf, 18th km Kiliya branch	45.418194	29.558194	4	Personal sampling (Nov. 2020).
5	Kiliya branch, 32nd km	45.444250	29.425944	–	According to the information provided by the local crayfish trappers is present continuously since 2019, not revealed during personal sampling (Nov. 2020).
6	Kiliya branch, 80th km	45.290889	28.952583	not surveyed	According to the information provided by the local crayfish trappers is present continuously since 2019

* provided by local fishermen.

However, numerous simultaneous records of mass aggregations of an unknown large shrimp, have raised the interest of the public and scientists. These aggregations have been recorded in the main river stream and some floodplain water bodies between Vylkove and Izmail since August 2020. According to local crayfish trappers, the first single finds of this unknown malacrustacean occurred one year earlier, when they were found in crayfish traps with fine mesh net between the 32nd and 80th km of the Danube River.

Materials and methods

Frozen specimens (25 ind.) of shrimps have been provided by local fishermen to a scientific team of the Institute of Hydrobiology of the National Academy of Sciences of Ukraine, which carried out a hydrobiological field survey of the Danube Delta in November 2020. In addition, possible habitats of the unknown malacrustacean have exploratively been sampled (10 ind. have been caught) with a fishing drag equipped with a 10-mm mesh net towed behind a motor boat (speed – up to 5 km/h, 50–100 m per sample) (Table 1, Figure 1).

The identification of caught shrimps was carried out according to scientific publications (Hanamura et al. 2011; Afanasyev et al. 2020).

Results

Diagnosis

In total, 35 specimens of the caught shrimps have been identified as *Macrobrachium nipponense* (De Haan, 1849 [in De Haan, 1833–1850]). Length from the end of rostrum to the end of telson ranged from 53 to 82 mm, average length: 65 ± 8 mm (Figure 2a). Carapace with hepatic spine,

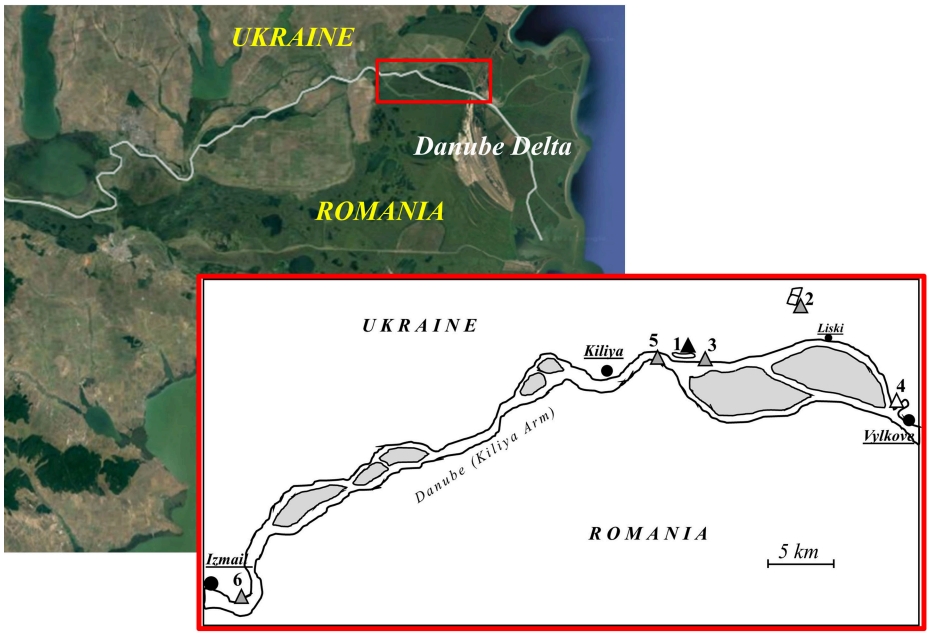

Figure 1. Map with the sites of drag and trap fishing of shrimps (white triangle – species was detected by personal sampling Nov. 2020, gray triangles – species was registered by local fishermen, black triangle – species was registered by local fishermen and was confirmed by personal sampling Nov. 2020) (station numbering according to Table 1).

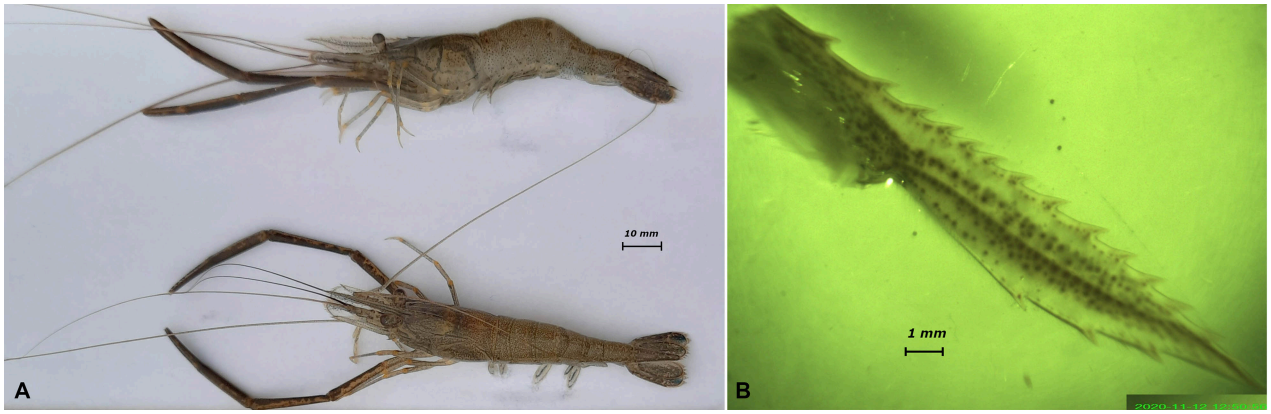

Figure 2. *Macrobrachium nipponense* from the Ukrainian part of the Danube Delta: A) general view; B) rostrum. Photographs by Mykhailo Ye. Zhmud (A) and Volodymyr I. Yuryshynets (B).

branchiostegal spine absent, simple dactylus of third to fifth pereiopods. The second pereiopods were significantly longer than other legs, the length of the right pereiopod was 49 ± 14 mm, the left one was 50 ± 11 mm, usually their size differed by 3–5 mm, but two individuals with sharply asymmetric second legs were registered (the difference was 18 and 30 mm). The average length of the second pereiopod was 0.7–0.8 times body length. Antennas in most specimens were longer than the body (average ratio was 1.22 ± 0.16 times) (Figure 2a).

All examined specimens had a straight rostrum with a convex ventral part. The dorsal side of the rostrum was armed by 13 (rarely 12) teeth with feathery setae between them. Three orbital teeth located behind the eyes. Distance from the first tooth to the second tooth exceeds distances between other teeth. There are 3 (rarely 2) teeth on the ventral side of the rostrum

(Figure 2b). In the largest individual (length 82 mm), the rostrum armament was slightly different from the others and contained 18 dorsal and 4 ventral teeth.

Remarks

Examined malacrustaceans can be distinguished from native brackish shrimps, *Palaemon* sp., by the carapace holding a hepatic spine and the absence of a branchiostegal spine.

Discussion

Two species of shrimps, *Palaemon elegans* Rathke, 1836 and *Palaemon adspersus* Rathke, 1836 live in the brackish areas of the Danube Delta. The lower salinity limits for these two shrimp species are 1.9 and 4.0, respectively (Makarov 2004). There are no registrations of these species in the freshwater ecosystems of the region. Therefore, the detection of a large size shrimp with peculiar morphological features in typical freshwater habitats suggests the emergence of a new malacrustacean species in the region.

According to the identified diagnostic features of the carapace and the structure of the limbs, the recently revealed malacrustaceans significantly differ from the native representatives of the Palaemonidae family (Burukovsky 1974; Fransen 2014) and belong to the genus *Macrobrachium*, and—according to the rostrum structure—to the species *M. nipponense*, Oriental River Prawn (Hanamura et al. 2011; Afanasyev et al. 2020). The species originates from the Indo-Pacific region, where *M. nipponense* is widespread in the estuaries and freshwaters of Japan, China, Korea, Vietnam, Myanmar, and Taiwan (Yu and Miyake 1972; Khmeleva et al. 1997; Cai and Ng 2002; De Grave and Ghane 2006; Yakovleva and Yakovlev 2010). In Russia, the natural distribution of this shrimp species is the reservoirs of the Far East and the Caucasus. Since the 1960s, they were repeatedly introduced into Central Russia, Belarus, Moldova, and Ukraine, where *M. nipponense* was naturalized into the many water bodies. Successful naturalization of this species was possible due to its high tolerance to many environmental factors and, in particular, the ability to exist for a long time at low temperatures of 2–4 °C (Khmeleva et al. 1988; Alekhnovich and Kulesh 2001; Stepanok 2014; Leont'yev 2015; Son et al. 2020). In the 1980s, the shrimp was acclimatized in the Kuchurgan liman in the lower Dniester, and since then, according to both local fishermen and scientists, has periodically been found in the Turunchuk and Dniester Rivers and near the Tsargrad liman of the Dniester River Estuary (Filipenko 2014; Stepanok 2014; Shekk and Astafurov 2017; Son et al. 2020). These numerous records suggest the successful naturalization of *M. nipponense* in the Dniester basin.

The research projects of M.O. Son, with collaborators, which were carried out in 2018–2020, established the naturalization of *M. nipponense*

in the Sukhyi liman basin. The maximum density of the shrimp population in this location was 3–4 specimens/m^2 (adults, including females with eggs) (Son et al. 2020). According to the authors, these shrimps are quite widespread in the south of the Odessa region, and now, according to unverified personal communications, they inhabit fish ponds near the town of Sarata, from where they can spread to the Danube River basin through the Sarata river. To our opinion, such a path may be quite plausible, although the location of the first records and the most dense populations at 32nd km, i.e., above the source of the Danube-Sasyk canal, raise some doubts.

The investigation has shown that during 2019–2020, the freshwater shrimp, *M. nipponense*, became a common element of the benthic fauna of the Kiliya arm of the Danube River. It is supported by regular registrations of numerous shrimp aggregations in different parts of the arm (from the 32nd to the 80th km of the main stream) since the summer of 2019. It is likely that the abnormally warm winter of 2019–2020 was beneficial to the spread and reproduction of this alien species. In 2020, at 32nd km of the Kiliya arm of the Danube River and some shallow floodplain reservoirs, this species began to occur in fine net crayfish traps more often than common *Pontastacus leptodactylus* (Eschscholtz, 1823). The introduction of this invasive shrimp species will potentially affect the structure of benthic macroinvertebrates, as *M. nipponense* is a predator that feeds on different water animals (Afanasyev at al. 2020). Also, numerous populations of edible shrimp can change the trophic preferences of some native fish species (De Grave and Ghane 2006).

According to crayfish trappers from the 80th km area of the Danube River in 2020, this species has also become common in benthic communities, especially in autumn. We did not carry out questionnaires' trials or personal sampling in the area above the 80th km of the main Danube River's stream. As for the habitat of shrimp in the area below the 32nd km of the Danube River, the drag sampling carried out in November 2020 revealed only one shrimp individual in the Bazarchuk Gulf, located 18 km from the Danube Mouth. Surveys among the crayfish trappers, who use the appropriate traps directly in the Vylkove area and downstream, did not confirm the capture of any shrimp of this species, although the habitats in this area resemble the preferences of *M. nipponense*. Hydrobiological studies in November 2020 did not find this shrimp in the other arms of the Ukrainian part of the Danube Delta (branches: Bystryi, Vostochnyi, Tsyganka, Starostambulskyi).

In summer 2019, an expedition of the Institute of Hydrobiology did not find *M. nipponense* in the Ukrainian part of the Danube River while sampling with crayfish traps with the appropriate mesh net. The reported distribution suggests that this species was not introduced through the Danube-Dniester interfluve way (estuarine and marine biocenoses), but rather it was brought from limnic freshwater ecosystems (probably Danube

lakes) in which this species was illegally introduced (unverified data). Indirectly, this is confirmed by the absence of this species in shrimp catches of the Danube-Dniester interfluve, despite the findings in the Dniester estuary (Bushuyev 2020, *pers. comm.*).

Solving the question of the introduction pathway requires a search for *M. nipponense* further upstream of the Danube River and in the Lower Danube lakes (Kugurlui, Kartal, and Kahul), which will include both hydrobiological research through the appropriate methods and surveys among the local fishermen.

Despite the way of introduction of *M. nipponense* into the water bodies of the Ukrainian part of the Danube Delta, the fact that this species of shrimp lives in these ecosystems may indicate both the adaptation of the species to existence outside the temperature optimum and significant regional climate changes that made such existence possible.

Conclusions

The oriental river prawn *M. nipponense* was identified as an alien species in the water bodies of the Ukrainian part of the Danube Delta for the first time.

This introduction may be explained by either (1) the expansion of this species from other water bodies of the North-Western Black Sea Coastal Area, or (2) an unauthorized introduction. Although the known records suggest an accidental introduction of this species into the area close to the Lower Danube lakes, both hypotheses require further investigation and approbation.

It is likely that *M. nipponense* will be recorded in the Danube basin in the following years. Further hydrobiological research will allow to estimate the invasion potential of *M. nipponense* and further introductions through the Southern European Invasion Corridor.

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Authors' contribution

Mykhailo Ye. Zhmud – investigation and data collection, data analysis and interpretation, writing – original draft, writing – review and editing; Volodymyr I. Yuryshynets – research conceptualization, data analysis and interpretation, writing – original draft, writing – review and editing; Artem V. Liashenko – research conceptualization, data analysis and interpretation, investigation and data collection, writing – original draft, writing – review and editing; Kateryna Ye. Zorina-Sakharova – investigation and data collection, writing – original draft; Ihor I. Abramiuk – investigation and data collection.

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