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First Records of *Pectinatella magnifica* (Leidy, 1851) (Bryozoa: Plumatellida: Pectinatellidae) in the Bulgarian Shoreline Zone of the Danube River

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Abstract: The magnificent bryozoan *Pectinatella magnifica* is a freshwater invertebrate species, which forms large gelatinous colonies that grow attached to submerged surfaces such as rocks or branches. This species is native to eastern North America; in the 19th century, it was introduced to Europe, although for about 100 years its distribution was limited mainly to Central Europe. In the 2000s, the findings of high number of colonies were reported in the Middle and Lower Danube River and the Danube Delta. During Joint Danube Survey 3 (JDS3) in 2013, *P. magnifica* was recorded at nine sites from Hungary to Romania, the only record in the Bulgarian – Romanian sector was downstream of the town of Kozloduy (685 rkm), at about 30 m from the border on the Romanian side. We report the first findings of *P. magnifica* in the Bulgarian shoreline zone of the Danube River and the first findings for Bulgaria. The sampling was conducted in July – October 2019, along the Danube and adjacent water bodies in Bulgaria, in the frame of JDS4. *Pectinatella magnifica* was recorded at two sites. In August, a big colony was found flowing in an open canal near the town of Vidin (790 rkm). In October, numerous colonies were found at the same site. They had smaller size and were attached to the branches of fallen trees. The species was also caught with fishing nets upstream of the village of Archar (771 rkm). Regular monitoring of the population status and spread of the species are needed in order to take appropriate measures to prevent the range extension and the negative impact of *P. magnifica* in Bulgaria.

Key words: Invasive alien species, freshwater bryozoans, spread, Danube River, Bulgaria.

Introduction

The magnificent bryozoan *Pectinatella magnifica* (Leidy, 1851) (Bryozoa: Plumatellida: Pectinatellidae) is a freshwater invertebrate species, which forms large gelatinous colonies that grow attached to submerged surfaces such as rocks or branches. This species is native to the eastern part of North America, particularly to the eastern area

of the Mississippi River, from New Brunswick and Ontario in Canada to Louisiana and Florida in USA (BALOUNOVÁ et al. 2013, ALEKSANDROV et al. 2014). It was first found near Philadelphia by LEIDY (1851) and since then has been recorded not only in the north-eastern part of the United States (MARSH & WOOD 2001, BARNES & LAUER 2003, TATICCHI et al. 2011, MICHELENE et al. 2014) and Canada (RICCIARDI & REISWIG 1994), but all across

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North America, except the areas with cold climate (LACOURT 1968, RODRIGUEZ & VERGON 2002, BALOUNOVÁ et al. 2013).

The first record of *P. magnifica* in Europe was from Germany, in the Bille River near Hamburg in 1883 (ZIMMER 1906, BERNAUER & JANSEN 2006). For about 100 years after the introduction of the species in Europe its distribution was limited mainly to Central Europe, in the basins of the Elbe, Oder and Rhine rivers. Continuously, it has spread in many European countries, including Romania (LACOURT 1968, ZORIĆ et al. 2015, SKOLKA et al. 2017), Poland (KAMINSKI 1984), France and Corsica (D'HONDT & CONDÉ 1996, NOTTEGHEM 2009), the Netherlands (MASSARD & GEIMER 2002, LEUVEN et al. 2009), Luxemburg (MASSARD & GEIMER 2002, MASSARD et al. 2013), Austria (BAUER et al. 2010), Hungary (BALOUNOVÁ et al. 2011, SZEKERES et al. 2013, ZORIĆ et al. 2015), the Czech Republic (BALOUNOVÁ et al. 2011, PAZOUREK et al. 2016), Ukraine (ALEKSANDROV et al. 2014), Serbia (ZORIĆ et al. 2015) and Finland (VUORIO et al. 2018).

The mass occurrence of *P. magnifica* causes an increase in the water transparency during the initial period of colonisation due to filtration of large quantities of autotrophic and heterotrophic organisms as a result of the feeding of individual

zooids (HARTIKAINEN et al. 2009, WOOD 2010). In mussel farms, *P. magnifica* produces lethal or sublethal effect on some bivalve species (WANG et al. 2017). The authors reported about a fouling problem in 2007 in a mussel farm of Lake Poyanghu (China), where the vigorous colonies of the species attached to mussel cages lead to production fall and even widespread death of *Cristaria plicata* (Leach, 1814), because of the strong competition for food and space, the generation of hypoxic environment and lack of oxygen. In a tributary of the St. Lawrence River, massive colonies of *P. magnifica* were reported to overgrow and kill zebra mussels *Dreissena polymorpha* (Pallas, 1771) on rocky substrates, presumably by preventing normal feeding and gas exchange (RICCARDI & REISWIG 1994).

The invasion of *P. magnifica* has also caused significant impact on different industries worldwide, such as fisheries and aquaculture, electricity production and irrigation. Damages on the fishing gear and quay structures, as well as problems to the hydroelectric power plants, irrigation systems and aquaculture facilities due to clogging of the intake screens and water pipes have been reported (PENNAK 1989, WOOD 2010, NAKANO & STRAYER 2014, CHOI et al. 2015, WANG et al. 2017). Furthermore,

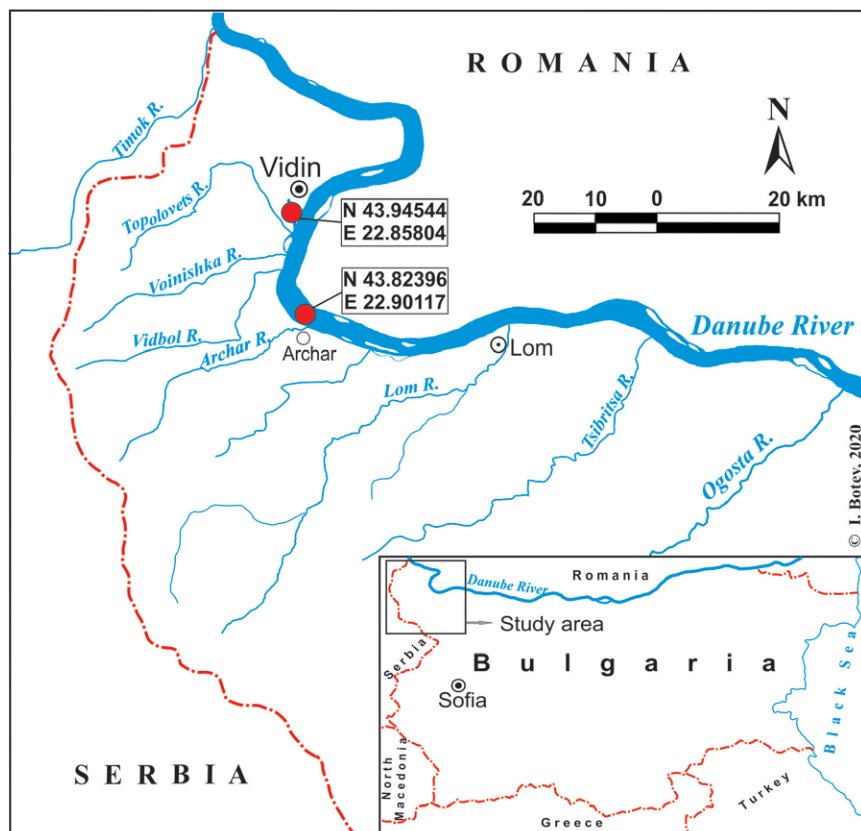


Fig. 1. Map with the sampling sites of *Pectinatella magnifica* in Bulgaria in 2019.

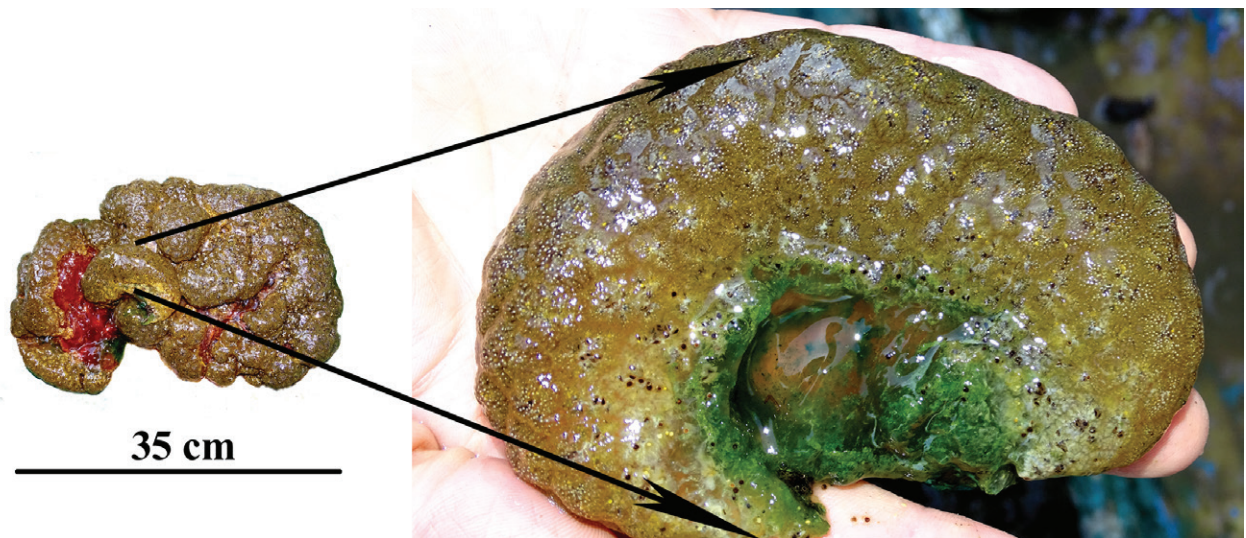


Fig. 2. A large multilobed colony of *Pectinatella magnifica* (35 cm in diameter) free-flowing in an open canal near the town of Vidin; one lobe of this colony showing the numerous rosettes, statoblasts and the symbiotic algae and cyanobacteria disposed in the outer layer of the gelatinous matrix.

P. magnifica is a potential host of the myxozoan endoparasite *Tetracapsuloides bryosalmonae* Canning, Curry, Feist, Longshaw & Okamura, 1999 (CANNING et al. 1999), the causative agent for proliferative kidney disease (PKD), which is known to be detrimental to farmed and wild salmonid fish (STERUD et al. 2007). Recently, molecular evidence has shown that *P. magnifica* may also host the parasite, and thereby, potentially transmit PKD (TOPS & OKAMURA 2005, HRABCOVÁ 2015).

Because of its rapid spread in Europe and particularly in the Danube River basin recently and considering its potential negative ecological and economic impact, *P. magnifica* has been listed as invasive alien species of concern for the Danube River (PAUNOVIĆ & CSÁNYI 2018) and as a priority species for the ESENIAS region (SKOLKA et al. 2017).

With this paper we report the first findings of *P. magnifica* in the Bulgarian shoreline zone of the Danube River and the first findings for Bulgaria.

Materials and Methods

The sampling was conducted in July – October 2019, during five expeditions along the Danube River, its tributaries and the adjacent standing water bodies in Bulgaria, in the frame of the Joint Danube Survey 4 (JDS4).

The colonies of *P. magnifica* were collected by hands or using a dip net with a diameter of 60 cm. The collected material was fixed in ethanol. The samples have been stored at the collection of the

Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences.

The species was identified using an Axio Imager M2-Carl Zeiss compound microscope. LM photographs of the statoblasts were taken using a digital camera (ProgRes C7) and specialised software (CapturePro Software 2.8).

Results

Pectinatella magnifica was recorded at two sites in the Bulgarian shoreline zone. In August, a big colony (35 cm in diameter) was found flowing in an open canal near the town of Vidin (790 rkm) (Figs. 1 and 2). This was the canal for warm water of the thermoelectric power plant of the town of Vidin, which was not functioning at the time of sampling. The canal is about 250 m long, 15–20 m wide and has a maximum depth of 3–4 m. In October, numerous colonies were found at the same site. They had smaller sizes (length in the range from 1.5 to 18.0 cm and a width from 2.5 to 7.0 cm) and were attached to the branches of fallen trees (Fig. 3). The species was also caught with fishing nets in the main channel of the Danube River upstream of the village of Archar (771 rkm) (Fig. 1).

The colonies of *P. magnifica* are globular, prolonged or irregular and lobed in outline. They consist of a thick mass of gelatinous, transparent, colourless or green-yellow-reddish matrix, with a layer of small filtering individual polypids or zooids of about 1 mm. The surface of colonies consists of hundreds contiguous rosettes about 1 cm in

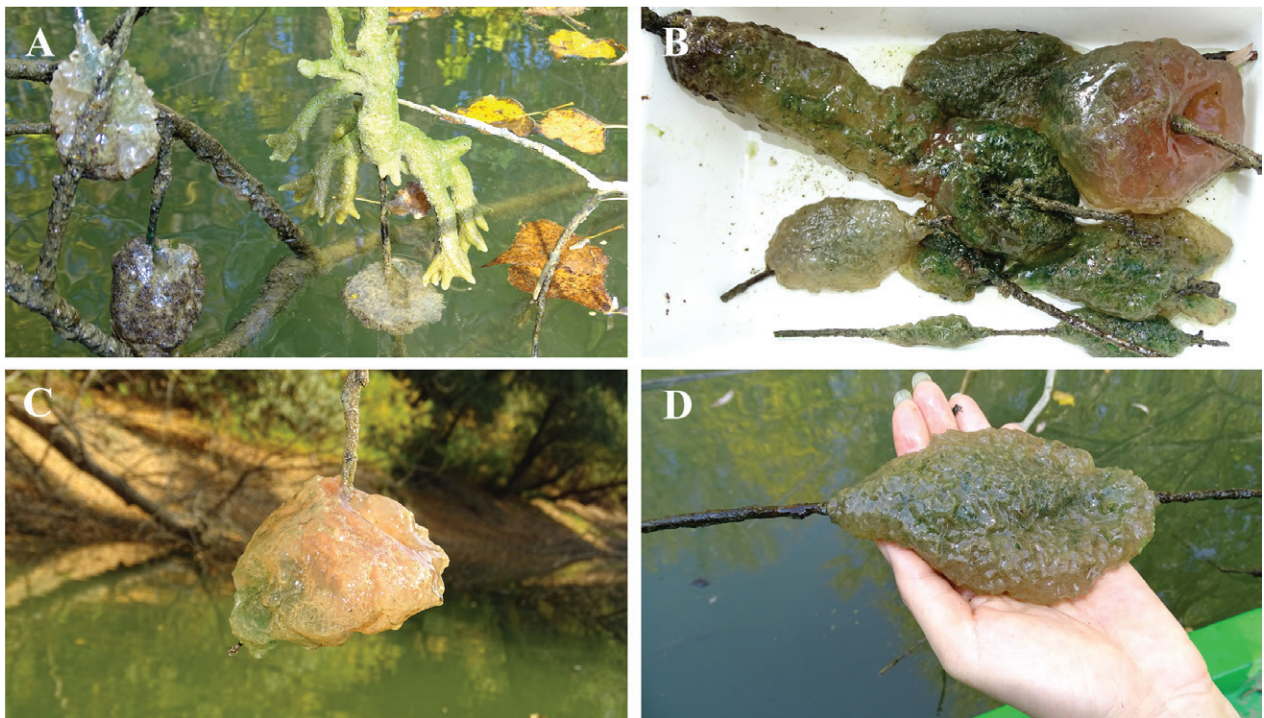


Fig. 3. Colonies of *Pectinatella magnifica* and *Spongilla lacustris* attached to submerged tree branches (A); view of several colonies of *P. magnifica* to illustrate variability in shape, size and colour (B); globular colony (C); and prolonged colony (D).

diameter, each formed by several zooids. Numerous free statoblasts are disposed in the outer layer of the gelatinous matrix (Figs. 2 and 3). They are of one type only, namely discoidal, laterally asymmetrical, about 1 mm in diameter. The centre of the statoblast is formed of a capsule with two chitinous, brown-black valves (periblasts). The surface of the dorsal and ventral periblasts is reticulated with a raised net-like pattern. A single row of 12–20 flattened, anchor-like thorns radiate from the entire periphery, each thorn composed of fused extensions of the dorsal periblast (Fig. 4). Around this dark capsule, a lighter and clearly visible hyaline mass forms the floatation ring which allows the statoblast to float freely.

Discussion

The first records of *P. magnifica* in the Danube River basin were from 1906 when the species was reported in north-eastern Romania, the Jijia River, without an exact location, and from 1962 in southern Romania, Greaca Pond, near the Danube River (SKOLKA et al. 2017). Since then the species has not been reported until the 2000s. In August 2011, numerous colonies of *P. magnifica* were found in the Danube River side arm Ráckevei-Soroksári Duna, at Tass, in Hungary (SZEKERES et al. 2013). The same authors confirmed their findings in 2012

and 2013 at the same site and two additional sites in this side arm. During the Joint Danube Survey 3 (JDS3) (2013), *P. magnifica* was recorded at nine sites from 1,586 rkm (Hungary), through Serbian – Romanian sector, to 685 rkm (Romania). The only record in the Bulgarian – Romanian sector was downstream of the town of Kozloduy, at about 30 m from the border on the Romanian side (ZORIĆ et al. 2015). Between 2011 and 2013, many colonies were found also in the Ukrainian part of the Danube Delta Biosphere Reserve (in canals and ponds east of Vilково) (ALEKSANDROV et al. 2014). Based on those previous records in the Lower Danube River, we may presume that *P. magnifica* has been found earlier in the Bulgarian sector of the Danube River. However, despite the regular annual monitoring of the Bulgarian shoreline zone of the river in the period 2012–2016 (TRICHKOVA et al., unpublished), this species has not been recorded. During the survey in 2019, the fishermen reported about regular clogging of the nets with *P. magnifica* at the village of Archar, in the last two years. The results may indicate that the number and size of colonies has increased recently.

The most important pathways for the introduction and spread of *P. magnifica* are the international shipping, ballast water transfer, aquaculture, fishing, construction of canals connecting river basins, sand and gravel river

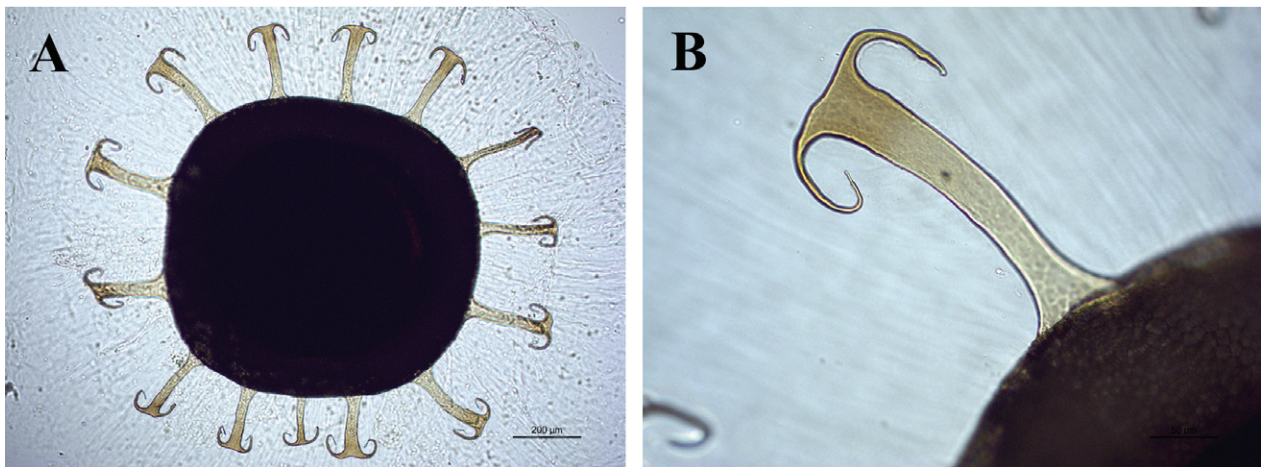


Fig. 4. Free statoblast with a brown-black central capsule, a single row of 14 flattened, anchor-like thorns that radiate from the entire periphery and a hyaline mass which forms the floatation ring of the statoblast (A); close up view of the anchor-like thorn (B).

exploration, and recreational boating within and between waters (SEO 1998, JOHNSON et al. 2001, NOTTEGHEM 2009, BALOUNOVA et al. 2013, DE VENTURA et al. 2016, VUORIO et al. 2018). In the Bulgarian sector of the Danube River, *P. magnifica* has been most likely introduced and spread through secondary natural dispersal. The species reproduces both sexually and asexually but the sexual method is less common. Statoblasts are means of asexual reproduction, representing resistant stages, which allow the organism to overwinter, to survive unfavourable conditions, to spread and initiate new colonies (BROOKS 1929, BROWN 1933, RODRIGUEZ & VERGON 2002). Natural dispersion into new areas can happen with passive transport of statoblasts by the aquatic plants, water birds, bivalves and fish (BUSHNELL 1973, ODA 1974, FIGUEROLA & GREEN 2002, WOOD 2002, CHARALAMBIDOU et al. 2003, MARKOVIC et al. 2009, HIROSE & MAWATARI 2011, REYNOLDS et al. 2015). It is also possible that statoblasts of this species exist in the droppings of birds because their viability is not changed after digestion (OPRAVILOVA 2005). BROWN (1933) found that 38% of the statoblasts of *P. magnifica* pass through the digestive system of *Anas platyrhynchos* Linnaeus, 1758 unharmed. Statoblasts have also been recorded viable in the stomach contents of fish, which can be a potential vector of dispersal of the species (OSBURN 1921, BROWN 1933, MARKOVIC et al. 2009, WANG et al. 2017). NOTTEGHEM (1999) states that the introduction of young fish into rivers and ponds may also be a potential pathway for the spread of *P. magnifica*.

The colonies of *P. magnifica* occur in warm, lentic habitats, predominantly in shallow, shaded

areas. They are generally absent from turbid water, possibly because their larger surface area is more frequently exposed to siltation (COOPER & BURRIS 1984). This species is considered to be a warm-water species; it has been reported that most colonies disintegrate at 12°C (BUSHNELL 1974). The colonies with immature statoblasts are more resistant to lower temperatures but can endure a temperature of 10°C only for very short time. In general, the large colonies decay in autumn with decreasing water temperatures (BROOKS 1929, BROWN 1933). As both high alkalinity (RICCIARDI & REISWIG 1994) and high nutrient concentrations (HARTIKAINEN et al. 2009) have been shown to favour bryozoans, many nutrient-enriched waters may offer potential new habitats. The species has also been found in relatively oligotrophic and mesotrophic waters (BALOUNOVÁ et al. 2013). Therefore, there are many suitable habitats of *P. magnifica* along the Bulgarian shoreline zone of the Danube River, including the tributaries, canal systems and the adjacent water bodies.

Currently, there is no information about the ecological impact of *P. magnifica* in the Bulgarian sector of the Danube River. The further spread of this invasive alien species upstream of the Danube tributaries and in the inland waters may threaten the native species and ecosystems in Bulgaria. According to VUORIO et al. (2018), the eradication or even prevention of further spread of *P. magnifica*, when it has been established in a watercourse, might be impossible as the statoblasts are very abundant, resistant, long lived and easily dispersed. Hence, regular monitoring of the population status and spread of the species, together with assessment of

the related risks and ecosystem effects, need to be performed in order to take appropriate measures to prevent the range extension and the negative impact of *P. magnifica* in Bulgaria.

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