Rapid Communication

The freshwater bryozoan *Pectinatella magnifica* (Leidy, 1851) in the Austrian Danube: first evidence in the Upper Danube basin

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Abstract

The phylactolaemate *Pectinatella magnifica* is a rapidly spreading freshwater bryozoan originating in North America that has been observed in several countries, particularly in Europe, in the 19th century. *P. magnifica* forms massive compound colonies whose ecological effects have been poorly studied, but as suspension feeders they likely impact nutrient cycling and food web structure. The Danube is one of the largest rivers in Central Europe and along with its connection to the Rhine, represents a major route for non-native and invasive species spreading from the North Sea to the Black Sea. *P. magnifica* has been previously recorded in the Middle Basin of the Danube at Budapest and further downstream up to the Danube Delta. In this study we first report *P. magnifica* from the Upper Danube Basin, in the vicinity of Vienna (Austria). It appears that *P. magnifica* has previously been overlooked and that it invaded the Upper Danube either via river systems of the Rhine in Western Germany or within the Danube basin via the Czech Republic towards Austria. Alternate dispersal routes are possible via statoblasts attached to waterbirds. As well as the first record in the Upper Danube, this study is the first report of the species in Eastern Austria.

Key words: Klosterneuburg, Pectinatellidae, Phylactolaemata, compound colonies, bioinvasion

Introduction

Bioinvasions are a common phenomenon that either involve species entering new habitats and ecosystems or by range expansion of similar habitats. These may be natural events occurring over space and time, but in previous centuries, bioinvasions have been strongly promoted by anthropogenic influences causing considerable shifts in ecosystems and often deleterious effects on the local biota. Aquatic environments are particularly vulnerable to invasions due to the high connectivity of many waterways. Species introduction may occur via aquaculture operations, ballast water or through fouling communities on e.g. ship hulls, reflecting both commercial and recreational shipping (e.g. De Ventura et al. 2016; Ojaveer et al. 2018).

Bryozoa is a large taxon of benthic, colonial suspension feeders occurring mostly in marine, but to some degree also in freshwater habitats (Ryland 2005). Only about 80–100 of bryozoans inhabit freshwater worldwide

(Massard and Geimer 2008). Several marine bryozoan species are known to have been introduced beyond their native range (e.g. Ryland et al. 2011), whereas a single freshwater bryozoan, *Pectinatella magnifica* (Leidy, 1851), is definitely known to have spread widely beyond its natural extent with human assistance (Wood 2014). Other suspension feeders such as members of the notorious bivalve genus *Dreissena* are famous invasive species that invaded numerous localities in Europe and Northern America (Ward and Ricciardi 2007, 2013). The rapid spread of the zebra and quagga mussels has had drastic consequences for local ecosystems including its fauna. Native bivalves such as unionids experienced a massive decline, whereas other taxa (e.g. hirudineans or turbellarians) benefitted, finding new habitats and ecological niches provided by the invasive mussel (e.g. Burlakova et al. 2000; Ward and Ricciardi 2013). The influence of *P. magnifica* on freshwater ecosystems and aquatic communities remains little known.

Pectinatella magnifica is a massive bryozoan forming large gelatinous aggregations of colonies (compound colonies) (see Mukai 1999; Schwaha 2020). Each single colony is rosette shaped and forms a basal gelatinous ectocyst secretion that connects individual colonies to a compound mass. Colonies in such a compound colony can be clonal, but may also be of different genotypes. Colonies propagate sexually via swimming larvae, and by the prolific production of asexual statoblasts, shelled propagules which are dormant stages used for dispersal and overwintering (Wood 2014). Statoblasts in general are highly resistant to desiccation, extreme temperatures and can even pass through the digestive tract of waterbirds. Consequently, they are a key mechanisms of survival and dispersal in phylactolaemate bryozoans. *Pectinatella magnifica* is monotypic for the family Pectinatellidae and originates from North America. Since the end of the 19th century, it has been reported in Northern Europe and subsequently in the course of the 20th century in numerous other European countries (e.g. Zoric et al. 2015), but also in Japan (Hirose 2017) and other Asian countries, such as its recent finding in China (Wang et al. 2017). The distribution of the species has recently been summarised by Vuorio et al. (2018). In Austria, *P. magnifica* was first recorded in 2010 from the Wood Quarter (Waldviertel) at the Austrian border with Czech Republic (Bauer et al. 2010). Since then, no additional sightings have been reported. The Danube and the Rhine are the two largest central European rivers. The Danube traverses Austria from the Western border of Upper Austria past Vienna to the Eastern border to enter Slovakia and is the largest river in Austria. The two rivers are interconnected via the Main-Danube Canal and this route has a high probability to function as an invasion pathway (Leuven et al. 2009). The Danube basin can be divided into an Upper basin from Germany to the Austrian-Slovakian border, a Middle basin from Slovakia to the Iron Gates at the Romanian border, and the Lower basin extending to the Danube Delta entering the Black Sea (*International Commission for the Protection of the Danube River*, www.icpdr.org).

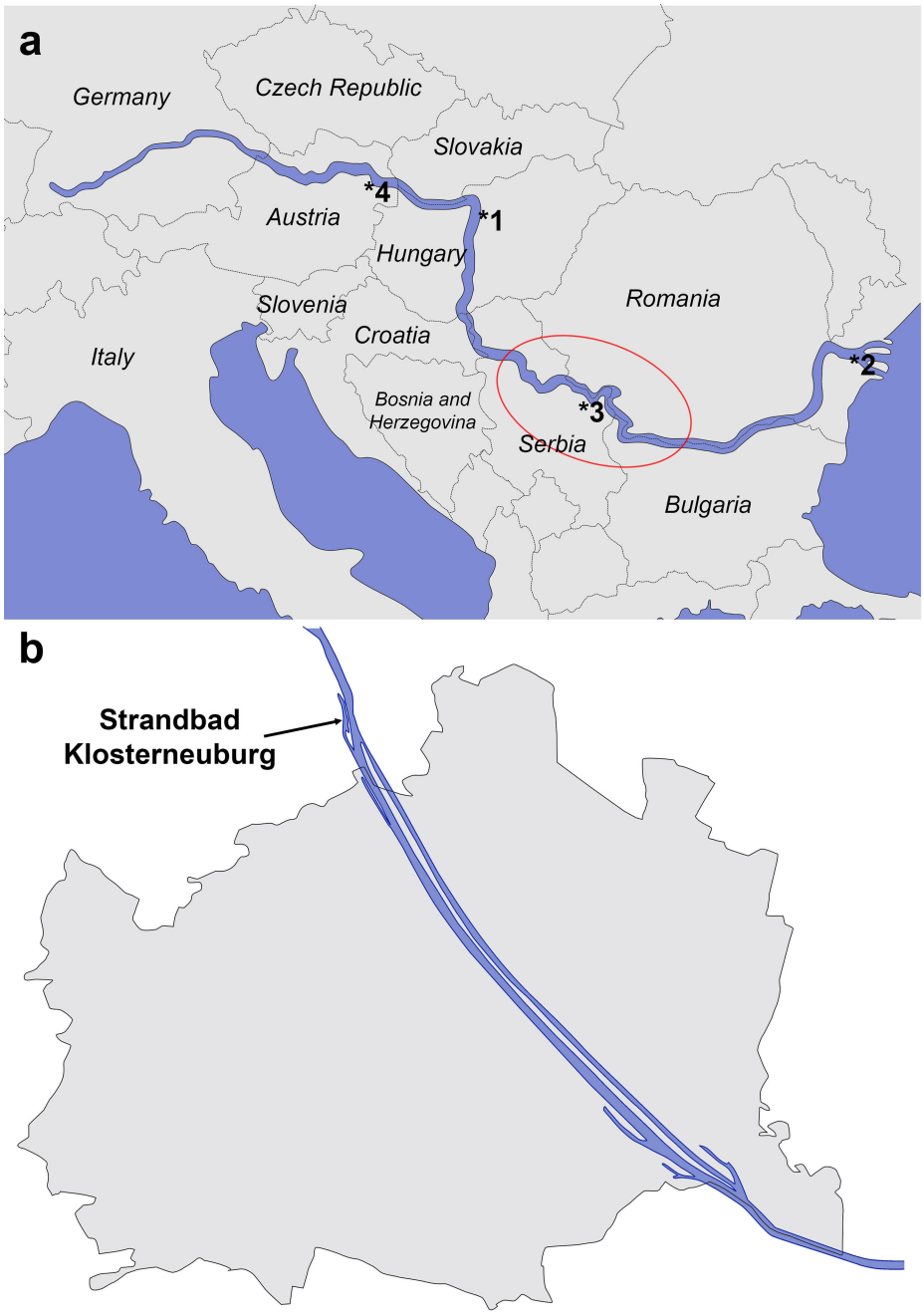

Figure 1. Occurrence of *Pectinatella magnifica* in the Danube. (a) General overview of the Danube including numbered findings of *P. magnifica*. 1: Szekeres et al. 2013, 2: Aleksandrov et al. 2014, 3: Zoric et al. 2015 (multiple sampling sites shown by the red oval), 4: this study. (b) Outline of the Danube traversing Vienna and the location where *P. magnifica* was found in the current study. For details see Supplementary material Table S1.

Pectinatella magnifica was first reported in the Middle Basin of the Danube in Hungary (Szekeres et al. 2013) and subsequently further downstream in the Lower Basin in other South East European countries (Aleksandrov et al. 2014; Zoric et al. 2015; see also Figure 1a). Although reported at the Czech-Austrian border, the invasion pathway to South-East Europe has not been entirely clarified. Here, we report *P. magnifica* in the Upper basin of the Danube for the first time in the Viennese area of Austria.

Figure 2. Two images of *Pectinatella magnifica*. (a) Large globular part detached from submerged substrate, also showing individual rosette-shaped colonies on the large gelatinous ectocyst. (b) More spindle-shaped colony on a twig. Photographs by T. Schwaha.

Materials and methods

The first observation and collection of *P. magnifica* in an old side arm of the Danube near the "Strandbad Klosterneuburg" (48°30′71″N; 16°33′91″E, 163 m a.s.l.) dates to August 10th, 2019. Subsequently, additional samples were collected for this study on September 4th 2019 at the same locality, which is a public bathing area in the city of Klosterneuburg, North of Vienna. Colonies were attached to various hard substrates such as pieces of wood or thin branches of submerged plant material.

Results and discussion

Numerous gelatinous masses were collected from submerged, mostly wooden substrates. *P. magnifica* was easily identifiable by their large basal gelatinous ectocyst of mostly brownish colour that forms a massive substrate for the rosette-shaped colonies on top of it (Figure 2). Rosette-shaped colonies were abundant, with each colony often consisting of 30+ zooids. All colonies showed zooids in good condition without any clear signs of degradation. Several statoblasts were also evident in the colonies.

The Danube has been previously recorded as an invasion route for non-native and invasive species, and the distribution of *P. magnifica* in this river has recently been reviewed by Zoric et al. (2015). In that recent survey, the most upstream location within the Danube was Budapest (see also Szekeres et al. 2013; Figure 1), followed by several locations in Serbia and Romania almost down to the Black Sea. The current finding of *P. magnifica* is the most upstream record within the Danube. Particularly

its presence in a popular public bathing area indicates that a general awareness of such species should be more publicized. It is not clear whether *P. magnifica* only recently entered the Danube or if it just remained undetected.

There are several scenarios how *P. magnifica* might have spread into the Upper Danube: Either it could have spread downstream, from the origin of the Danube in Southwestern Germany, for which, however, no recent data is available. Still, *P. magnifica* has been reported in the Upper Rhine, North of Karlsruhe, Germany, in 2005 (Grabow 2005). Because this area is close to the Danube origin, it is a potential route for entering the Danube. Alternatively, *P. magnifica* occurs in South Bohemia, Czech Republic, at the Northern Austrian border (Balounová et al. 2011), which most likely is the source of invasion towards the adjacent Austrian Wood Quarter, where *P. magnifica* has been first recorded in Austria (Bauer et al. 2010). There are numerous waterbodies in the border area of both countries that are interconnected by smaller streams and canals. It is possible that *P. magnifica* managed to spread south- or south-eastwards from the Woodquarter into the Danube. Especially the river Kamp is located slightly south and flows into the Danube close to the city of Krems. Besides aquatic pathways, dispersal of bryozoan statoblasts is also mediated by waterbird-mediated zoochory. Released statoblasts can be transported externally or internally by birds. Particularly spinoblasts, statoblasts with spines or hooks, as found in *P. magnifica* have a high capability of attaching to structures such as feathers (see also Okamura et al. 2019). Surprisingly, despite the fact that *P. magnifica* is a very conspicuous species and reported over 10 years ago, it has never been reported anywhere else from Austria, particularly not from the East in recent years (Schwaha, *personal observation of several surveys*). Although *P. magnifica* is the most prominent and largest bryozoan worldwide, its presence is apparently often not even noticed and even less reported.

Despite records in Europe since the end of the 19th century, *P. magnifica* has spread comparatively slowly within Europe. Ever since its first discovery in Hamburg, Northern Germany (Kraepelin 1884), it has successively spread into various Southern areas of Europe (besides non-European locations such as Asia, summarized in Vuorio et al. 2018). It is not entirely clear why spreading of *P. magnifica* has been so slow, but it has been hypothesized that environmental change and global warming might be contributing factors in Europe (Vuorio et al. 2018).

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Supplementary material

The following supplementary material is available for this article:

Table S1. Geo-referenced records of *Pectinatella magnifica* in the Danube.

This material is available as part of online article from:
http://www.reabic.net/journals/bir/2021/Supplements/BIR_2021_Schwaha_Bauder_SupplementaryMaterial.xlsx