

SUPPLEMENT TO THE KNOWLEDGE OF AQUATIC MOLLUSCS OF GREENHOUSES IN THE CZECH REPUBLIC

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ABSTRACT: This study expands and supplements the knowledge of aquatic molluscs of selected public greenhouses, especially in zoological and botanical gardens, in the Czech Republic. In total, 14 freshwater species were found at 23 sites situated mostly in botanical and zoological gardens. Freshwater molluscs were divided into four groups: species occurring in the Czech Republic only in greenhouses, non-native species living also in the wild, native species and alien genotypes of native species. The most frequent mollusc of greenhouses was *Physella acuta* (Draparnaud). *Melanooides tuberculata* (O. F. Müller) and *Helisoma* cf. *duryi* (Wetherby) of the first group were other very common and widespread greenhouse species. On the other hand *Marisa cornuarietis* (Linnaeus), *Bithynia tentaculata* (Linnaeus), *Lymnaea stagnalis* (Linnaeus), *Gyraulus crista* (Linnaeus) and *Ferrissia californica* (Rowell) were found at only one studied site.

KEY WORDS: greenhouses; Mollusca; non-native species

INTRODUCTION

The most recent studies of freshwater molluscs in the Czech Republic focused on molluscs living in wild, while greenhouses and other similar habitats were studied much less frequently even though these habitats may indicate the possible ways of dispersal of non-native species.

All the then known data on the occurrence of molluscs (both freshwater and terrestrial) in greenhouses of the Czech Republic were summarised by HORSÁK et al. (2004). In this paper, the authors included their own records from nine sites (greenhouses in Prague, Brno and Sušice) and summarised all those already published. Altogether, nine freshwater gastropods were recorded. *Pomacea bridgesii* (Reeve, 1856), *Melanooides tuberculata* (O. F. Müller, 1774), *Pseudosuccinea columella* (Say, 1824), *Helisoma duryi* (Wetherby, 1879)/*H. anceps* (Menke, 1830) in the Czech Republic are known to occur only in greenhouses and similar habitats and their survival outdoors is nearly impossible. *Physella acuta* (Draparnaud, 1805), *Gyraulus parvus* (Say, 1817) and *Ferrissia californica*

(Rowell, 1863) are mentioned as non-native species living in the wild, while *Galba truncatula* (O. F. Müller, 1774) and *Bathymophalus contortus* (Linnaeus, 1758) are native. Another “greenhouse” species, *Gyraulus chinensis* (Dunker, 1848), was found in 2006, in two greenhouses in the Prague botanical garden and in the zoological garden in Dvůr Králové, together with *G. truncatula*, *P. acuta*, *H. duryi*, *F. californica* (BERAN & GLÖER 2006). HORSÁK et al. (2013) mentioned six freshwater greenhouse species (*P. bridgesii*, *M. tuberculata*, *P. columella*, *H. duryi*, *H. anceps*, *G. chinensis*) in the Czech Republic and Slovakia without specifying whether those species occurred in both countries or in only one of them.

PATOKA et al. (2017) produced a list of 31 ornamental freshwater gastropods and bivalves traded in the Czech Republic and 10 “hitchhiking” freshwater gastropods which appear incidentally in aquaria. The list of incidental freshwater gastropods was based on articles from Czech aquarium forums and validated by inspection of 12 retail markets offer-



ing freshwater aquarium animals in Prague (Czech Republic).

The objective of this study is to expand and supplement the knowledge of aquatic molluscs of select-

ed public greenhouses, especially in zoological and botanical gardens.

MATERIAL AND METHODS

The data are results of my research during the last 15 years. Different “greenhouse” habitats, especially pools or artificial brooks and also aquaria in botanical and zoological gardens, were visited. In total, 23 sites were studied, some of them more often (Appendix 1). The main sampling method was washing vegetation and sediments using a metal sieve (diameter 20 cm, 0.8 mm mesh) combined with collections by hand from the surfaces of stones, wood and artificial materials (e.g. plastic bags and bottles).

Freshwater molluscs were identified using shell characteristics or dissected and then identified based on their copulatory organs when identification based on shells only was impossible. Specimens for dissection were killed in hot water and then fixed in 80% pure ethanol while specimens for further DNA analysis were directly fixed in 80% pure ethanol. Selected material of shells and specimens fixed in 80% ethanol are deposited in the author’s collection.

RESULTS AND DISCUSSION

In total, 14 freshwater mollusc species were found at 23 sites situated mostly in botanical and zoological gardens in the Czech Republic (Appendix 1). All these species were gastropods (Appendix 2). Bivalves, even small species of Sphaeriidae, were not recorded. The species could be divided into four groups. The first group included species occurring in the Czech Republic exclusively in greenhouses: *P. bridgesii*, *Marisa cornuarietis* (Linnaeus, 1758), *M. tuberculata*,

P. columella, *G. chinensis*, *H. cf. duryi*. Identification of species of the genus *Helisoma* is especially difficult due to the highly variable shell shape. *H. duryi* is usually mentioned as the most common species in Europe (e.g. WELTER-SCHULTES 2012, HORSÁK et al. 2013, GLÖER 2019). The taxonomic status of collected specimens is still uncertain, so the identification is preliminary and the occurrence of other similar species, such as *Helisoma trivolvis* (Say, 1817) or *H. an-*

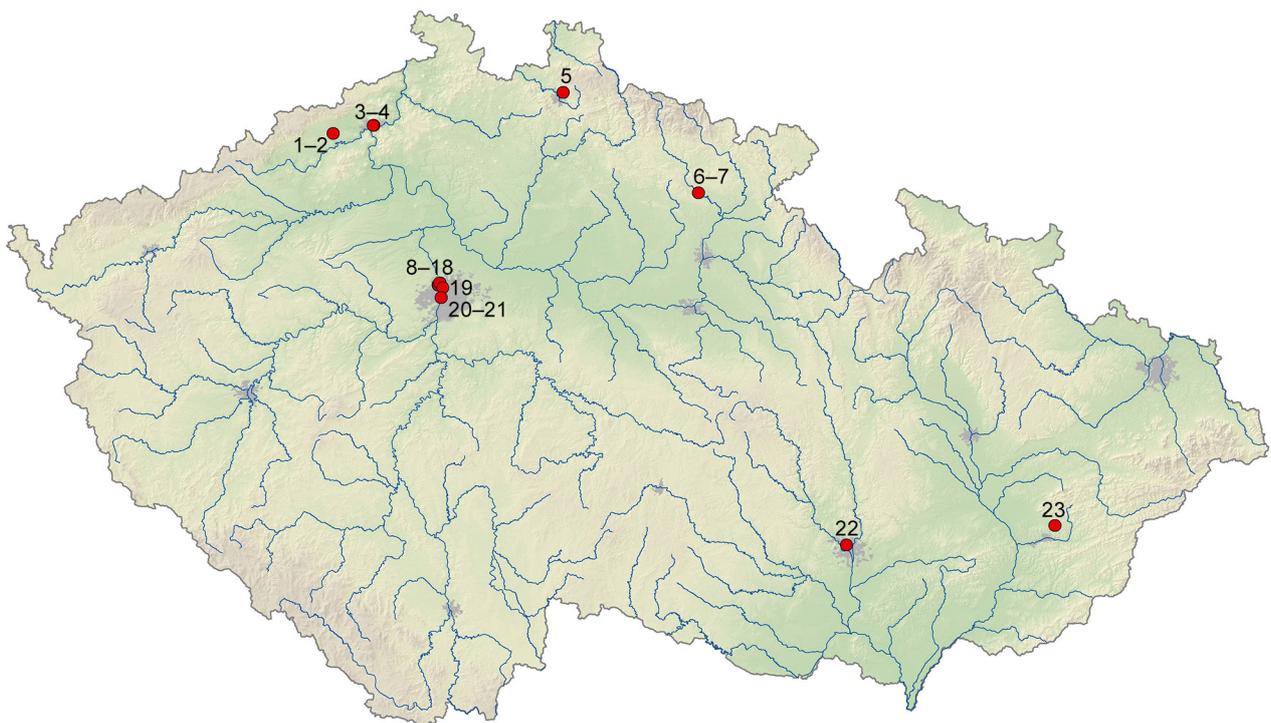


Fig. 1. Map of the Czech Republic with geographical distribution of the sampling sites. Drawn by JAN VRBA



ceps (Menke, 1830), is not excluded. More taxonomic studies on the status and occurrence of this genus in Europe are needed. The second group was composed of non-native species living also in the wild: *P. acuta* and *F. californica*. The third group included native species: *Bithynia tentaculata* (Linnaeus, 1758), *G. truncatula*, *Lymnaea stagnalis* (Linnaeus, 1758), *Gyraulus crista* (Linnaeus, 1758), *Hippeutis complanatus* (Linnaeus, 1758). The last group was composed of *G. parvus*. This gastropod was regarded as non-native, originally from North America, but LORENCOVÁ et al. (2021) confirmed its conspecificity with *G. laevis* (Alder, 1838); it is native in Europe although its invasive populations are of North American origin. Probably most populations in the greenhouses represent these invasive lineages, but this assumption was confirmed only in the case of population found at one site (no. 20) (LORENCOVÁ et al. 2021). It was the reason for the inclusion of this species in a separate group. *G. truncatula*, which is among the most common species in the Czech Republic (BERAN 2002), was found at four sites. It was found at four sites. It cannot be ruled out that some sibling species may occur in greenhouses. *G. cubensis* (Pfeiffer, 1839) was discovered in Spain (SCHNIEBS et al. 2018) while *G. schirazensis* (Küster, 1862) was known from France (ALDA et al. 2021). These species are morphologically indistinguishable from *G. truncatula*.

The most frequent mollusc of greenhouses was *P. acuta* (second group; Appendix 2). This is in accordance with the results of HORSÁK et al. (2004). *P. acuta* was also found to be the most widely distributed of all non-native aquatic molluscs reported from the Czech Republic (LORENCOVÁ et al. 2015). *M. tuberculata* and *H. cf. duryi* of the first group were other very common and widespread aquatic molluscs in greenhouses. On the other hand, *M. cornuarietis*, *B. tentaculata*, *L. stagnalis*, *G. crista* and *F. californica* were found at only one studied site.

The number of species intentionally kept in aquaria is much larger than the number found in the studied botanical and zoological gardens. PATOKA et al. (2017) presented a list of 25 ornamental gastropods and six bivalves traded in the Czech Republic and 10 incidental (hitchhiking) species. All the mentioned incidental species except *Tarebia granifera* (Lamarck, 1822) and two ornamental gastropods (*M. cornuarietis*, *P. bridgesii*) were also found during this study. It cannot be excluded that also other ornamental gas-

tropods and bivalves will be found in botanical and zoological gardens in the Czech Republic.

Some sites were studied over a longer period of time. In most of them, different changes in mollusc assemblages were documented, similar to those in the wild. These changes included both an increase and a decrease in the number of species and often a change in the composition of the assemblages (see Appendix 2). The changes may have been due to many factors but it can be assumed that the most important were measures such as the emptying and maintenance of these artificial habitats which were documented for example in the Prague zoological garden. During these measures most molluscs may have become extinct. This may also be the reason why no bivalves were found, not even *Musculium lacustre* (O. F. Müller, 1774), which is able to colonise isolated and often short-term habitats, or pea mussels of the genus *Pisidium*. New species may have been introduced, for example, through aquatic plants. The extensive trade in aquatic plants can be conducive to the introduction of populations of native species from different parts of their native range. These introductions are very difficult to prove and their discovery without the use of molecular genetic methods is rather accidental (e.g. BERAN 2006, BERAN & HORSÁK 2009). Therefore it cannot be ruled out that some native species found in greenhouses come from distant parts of their distribution range.

PATOKA et al. (2017) dealt with the risks of introduction from aquaria into the wild, for example with waste water from aquaria. I suppose that due to the large number of traded and bred species this risk cannot be excluded. At the same time, as in the cases mentioned above, alien genotypes of native species may be introduced.

Due to the ongoing climate change the survival of some species of the first group (e. g. *M. tuberculata*, *P. columella*, *G. chinensis*, *Helisoma* spp.) which have already formed established populations in southern Europe (e.g. CIANFANELLI et al. 2007, ŠTAMOL et al. 2015), especially in artificially heated waters (e.g. from coal or nuclear power plants) is not to be excluded.

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APPENDIX 1

LIST OF INVESTIGATED SITES

Data in the list are as follows: site number, geographical co-ordinates, name of the nearest settlement, description of the site, date of investigation. For location of sites see Fig.1.

- 1 – 50°38'17"N, 13°50'30"E, Teplice, aquaria in the tropical pavilion in the botanical garden, 14.2.2016;
- 2 – 50°38'17.1"N, 13°50'30.3"E, Teplice, pool in tropical pavilion in the botanical garden, 14.2.2016;
- 3 – 50°39'57.6"N, 14°03'37.4"E, Ústí nad Labem, aquaria in the zoological garden, **a)** 10.12.2006, **b)** 18.1.2014, **c)** 20.11.2016;
- 4 – 50°39'58.5"N, 14°03'23.6"E, Ústí nad Labem, the pool in the pavilion for elephants in the zoological garden, **a)** 18.1.2014, **b)** 20.11.2016;
- 5 – 50°46'44.1"N, 15°04'29.7"E, Liberec, aquaria in the botanical garden, 1.4.2006;
- 6 – 50°26'02.3"N, 15°48'01"E, Dvůr Králové, aquaria and pools in the pavilion Water World in the zoological garden, 4.2.2006;
- 7 – 50°26'04"N, 15°48'03.7"E, Dvůr Králové, an artificial brook and pools in the Bird pavilion in the zoological garden, **a)** 4.2.2006 (BERAN & GLÖER 2006), **b)** 30.10.2015;
- 8 – 50°07'02.7"N, 14°24'36.9"E, Prague, aquaria in the pavilion Indonesian Jungle in the zoological garden, 27.1.2019;
- 9 – 50°07'03.4"N, 14°24'36.7"E, Prague, artificial brook and adjacent habitats in the pavilion Indonesian Jungle in the zoological garden, **a)** 25.3.2006, **b)** 24.7.2006, **c)** 17.1.2015, **d)** 17.11.2015, **e)** 27.1.2019;
- 10 – 50°07'03.8"N, 14°24'36.6"E, Prague, aquaria in the non-public part of the pavilion Indonesian Jungle in the zoological garden, 27.1.2019;
- 11 – 50°07'01.5"N, 14°24'32.4"E, Prague, pools in the Parrots House in the zoological garden, 17.11.2019;
- 12 – 50°06'59.5"N, 14°24'22.5"E, Prague, pools in the Bird pavilion in the zoological garden (Sichuan), **a)** 26.5.2005, **b)** 19.3.2006, **c)** 17.11.2015, **d)** 27.1.2019;
- 13 – 50°06'58.3"N, 14°24'14.8"E, Prague, aquaria in the pavilion Feline and Reptile House in the zoological garden, 27.1.2019;
- 14 – 50°06'58.1"N, 14°24'28.1"E, Prague, pools in the pavilion Chambal with gavials (*Gavialis gangeticus*) in the zoological garden, 21.12.2019;
- 15 – 50°07'19.5"N, 14°24'50.9"E, Prague, extensive pool with fish in the tropical part of the greenhouse Fata Morgana in the botanical garden, **a)** 12.2.2006 (BERAN & GLÖER 2006), **b)** 4.3.2018;
- 16 – 50°07'19.7"N, 14°24'50.6"E, Prague, artificial brook under waterfalls in the tropical part of the greenhouse Fata Morgana in the botanical garden, **a)** 29.1.2006, **b)** 12.2.2006, **c)** 5.4.2015, **d)** 4.3.2018;
- 17 – 50°07'20.2"N, 14°24'49.1"E, Prague, small pool in the tropical part of the greenhouse Fata Morgana in the botanical garden, 5.4.2015;
- 18 – 50°07'20.5"N, 14°24'48.6"E, Prague, pool in the cooler part of the greenhouse Fata Morgana in the botanical garden, **a)** 29.1.2006, **b)** 12.2.2006, **c)** 4.3.2018;
- 19 – 50°06'20.1"N, 14°25'53.4"E, Prague, freshwater aquaria in the Sea World, **a)** 25.3.2006, **b)** 29.3.2015, **c)** 26.12.2019;
- 20 – 50°04'16.5"N, 14°25'12.9"E, Prague, pools in the tropical part of the greenhouse in the botanical garden "Na Slupi", 17.11.2016;
- 21 – 50°04'16.6"N, 14°25'13.1"E, Prague, aquaria in the tropical part of the greenhouse in the botanical garden "Na Slupi", 17.11.2016;
- 22 – 49°12'16.5"N, 16°35'47.7"E, Brno, greenhouses in the botanical garden of Masaryk University, **a)** 9.2.2006, **b)** 9.2.2007, **c)** 12.2.2009;
- 23 – 49°16'23.1"N, 17°42'52"E, Zlín, aquaria in the tropical pavilion in the zoological garden, 27.8.2020.

APPENDIX 2

LIST OF AQUATIC MOLLUSCS RECORDED IN GREENHOUSES

groups: 1 – species occurring in the Czech Republic only in greenhouses; 2 – non-native species living in the Czech Republic also in the wild, 3 – native species, 4 – probably alien genotypes of native species. x – few specimens, xx – scattered occurrence, xxx – abundant occurrence, Σ – number of sites

Species	Group	Site no.																				Σ				
		1	2	3a	3b	3c	4a	4b	4c	4d	5	6	7a	7b	8	9a	9b	9c	9d	9e	10		11	12a	12b	12c
<i>Pomacea bridgesii</i> (Reeve, 1856)	1	x			x																					
<i>Marisa cornuarietis</i> (Linnaeus, 1758)	1																			xx						
<i>Melanooides tuberculata</i> (O. F. Müller, 1774)	1	xx	x	xxxx	xxxx	xxxx								x			xx	xxxx	xxxx	xxxx						
<i>Bithynia tentaculata</i> (Linnaeus, 1758)	3																									x
<i>Galba truncatula</i> (O. F. Müller, 1774)	3																									
<i>Lymnaea stagnalis</i> (Linnaeus, 1758)	3	xx	x											xx						x						
<i>Pseudosuccinea columella</i> (Say, 1824)	1	xx	xx	xx										xx						x	xxx	xx				
<i>Physella acuta</i> (Draparnaud, 1805)	2	xx	xx	xx										xx	xxx	xxx				x	xxx	xx				
<i>Physella crista</i> (Linnaeus, 1758)	3	xx	xxx											x								xx				x
<i>Gyraulus chinensis</i> (Dunker, 1848)	1	xx	xxx																							
<i>Gyraulus parvus</i> (Say, 1817)	4					xxx																				
<i>Hippeutis complanatus</i> (Linnaeus, 1758)	3												xx												x	x
<i>Helisoma cf. duryi</i> (Wetherby, 1879)	1		xxx	xx	xxx	xx	xxx	xx						xxx	xx					xxx	xxx	xx				x
<i>Ferrissia californica</i> (Rowell, 1863)	2						xx																			
Number of species		5	4	3	3	1	1	1	4	3	3	3	3	2	2	2	1	1	2	5	3	2	1	3	2	1

Species	Group	Site no.																				Σ				
		13	14	15a	15b	16a	16b	16c	16d	17	18a	18b	18c	19a	19b	19c	20	21	22a	22b	22c		23	23	23	23
<i>Pomacea bridgesii</i> (Reeve, 1856)	1																									4
<i>Marisa cornuarietis</i> (Linnaeus, 1758)	1																									1
<i>Melanooides tuberculata</i> (O. F. Müller, 1774)	1														xxx	xxx	xx	xx						xx	xx	12
<i>Bithynia tentaculata</i> (Linnaeus, 1758)	3																									1
<i>Galba truncatula</i> (O. F. Müller, 1774)	3																									4
<i>Lymnaea stagnalis</i> (Linnaeus, 1758)	3																									1
<i>Pseudosuccinea columella</i> (Say, 1824)	1			xx	xx	xx	xx	xx	x																	8
<i>Physella acuta</i> (Draparnaud, 1805)	2	xxx	xx	x	xx	x	xx	xx	xx					xxx	xx	xx	x	xx	xx	x	xx	xx			xx	19
<i>Gyraulus crista</i> (Linnaeus, 1758)	3																									1
<i>Gyraulus chinensis</i> (Dunker, 1848)	1																									6
<i>Gyraulus parvus</i> (Say, 1817)	4														xx	xx							xx	xx	4	
<i>Hippeutis complanatus</i> (Linnaeus, 1758)	3																									2
<i>Helisoma cf. duryi</i> (Wetherby, 1879)	1	xxx	x											xxx			xx	xx	x	x	xx			x	13	
<i>Ferrissia californica</i> (Rowell, 1863)	2																									1
Number of species		2	1	5	1	2	2	2	2	2	1	2	2	2	3	3	4	4	4	4	3	1	3	1	3	