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THE FIRST RECORD OF *HAWAIIA MINUSCULA* (BINNEY, 1841) IN SLOVAKIA, WITH SOME REMARKS ON OTHER GREENHOUSE SNAILS

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ABSTRACT: We recorded the non-native snail *Hawaiia minuscula* (Binney, 1841) from two greenhouses in Slovakia for the first time. The check-list of gastropods recorded in Slovak greenhouses is provided.

KEY WORDS: synanthropic fauna, alien species, urban fauna

INTRODUCTION

Hawaiia minuscula (Binney, 1841) is a widespread minute land snail. Its natural range extends from Alaska and Canada in North America southward to Costa Rica in Central America. It was widely introduced elsewhere, and it was from such an introduced population in Hawaii that the generic name was derived (METCALF & SMARTT 1997). The global distribution of *H. minuscula* was discussed in more detail by KASZUBA & STWORZEWICZ (2008). Among the countries adjacent to Slovakia, *H. minuscula* was reported from greenhouses in the Czech Republic (MÁCHA 1988), Austria (REISCHÜTZ 2002) and Poland (KASZUBA & STWORZEWICZ 2008). Although malacological research in greenhouses from the former Czechoslovakia has a history of more than a century (SLÁVIK 1869, MRÁZEK 1903, BABOR & NOVAK 1909) and is dealt with in numerous papers from the Czech Republic (FLASAR 1962, 1964, FLASAROVÁ & FLASAR 1962, 1965, MÁCHA 1971, 1988, HORSÁK 2001, HORSÁK & DVOŘÁK 2003, HORSÁK et al. 2004, JUŘIČKOVÁ 2006, BERAN & GLÖER 2006), far less attention was paid to greenhouses in Slovakia, and their mollusc fauna was largely overlooked. For this reason, *H. minuscula* was not recorded from Slovakia until now, however its occurrence was taken for granted and presented jointly for both the Slovak and the Czech Republics (HORSÁK et al. 2010, 2013). It should be emphasised that the data on *H. minuscula* (HORSÁK et al. 2010, 2013) came only from the Czech Republic. In Slovakia, only snails from greenhouses in the city of Bratislava (SW Slovakia) were studied. FLASAR & KROUPOVÁ (1976a, b) recorded 36 species from greenhouses in Bratislava, including the first record of *Gulella io*, and DVOŘÁK et al. (2003) provided the first record of *Deroceras invadens*. *H. minuscula* was mentioned in none of those papers.

H. minuscula was reported from various types of habitats. For example, DOURSON & DOURSON (2006) identified it as a species that commonly lives in rich woods and at the base of black walnut and butternut trees, while HUBRICHT (1985) listed it as a species of disturbed areas (e.g. roadsides, along railroads, on waste ground in urban areas), never occurring in leaf litter. In Tennessee it was even found in caves (LEWIS 2005).

MATERIAL AND METHODS

Species records are based on the published data (localities 1–2) and on the new material collected by the authors (localities 3–7, Fig. 1). Note that locality No. 3 is identical with locality No. 2 and serves as a reference point to compare the situation in different years.

1. Flasar & Kroupová (1976a), Bratislava-Karlova Ves, greenhouses of the former "Garden Centre and Recreational Services". They do not exist anymore.
2. Flasar & Kroupová (1976a), Bratislava, greenhouses of the Botanical Garden of the Comenius University in Bratislava.
3. Bratislava, greenhouses of the Botanical Garden of the Comenius University in Bratislava, 21 May 2003, Dvořák & Čejka lgt., 26 April 2013, Čejka lgt. The samples were merged.
4. Zvolen, greenhouse of the Borová Hora Arboretum of the Technical University in Zvolen, 10 October 2012, Čiliak & Šteffek lgt., 16 May 2013, Čiliak lgt., 15 November 2015, Čiliak & Žoldáková lgt. The samples were merged.
5. Košice, greenhouses of the Botanical Garden of the Pavol Jozef Šafárik University in Košice, 28 February – 28 March 2012 and 18 January – 1 February 2013, Martin Suvák with his students lgt. The samples were merged.
6. Nitra, greenhouses of the Botanical Garden of the Slovak University of Agriculture in Nitra, 4 November 2014, Čiliak, Čejka & Holienková lgt.
7. Vieska nad Žitavou, greenhouses of the Mlyňany Arboretum of the Slovak Academy of Sciences, 4 November 2014, Čiliak, Čejka & Holienková lgt.

The material of Gastropoda was collected using visual search. To detect minute species, small amount of soil (ca 1 litre) was taken from the surface and processed using the standard methods (e.g. Čejka et al. 2008). Slugs of the genus *Deroceras* were identified by dissection (according to Horsák et al. 2013). The gastropod taxonomy used in this study follows Horsák et al. (2013).

REMARKS

Hawaiia minuscula (Binney, 1841) (Fig. 2) was recorded in two greenhouses – in the Borová Hora Arboretum of the Technical University in Zvolen and in the Botanical Garden of the Comenius University in Bratislava (Table 1). The former specialises in more than 40 species of ornamental houseplants which originate from the tropical and subtropical zones of both Americas, Asia and Africa. Specimens of *H. minuscula*, comprising mostly empty shells but also live snails, were found on the soil surface among

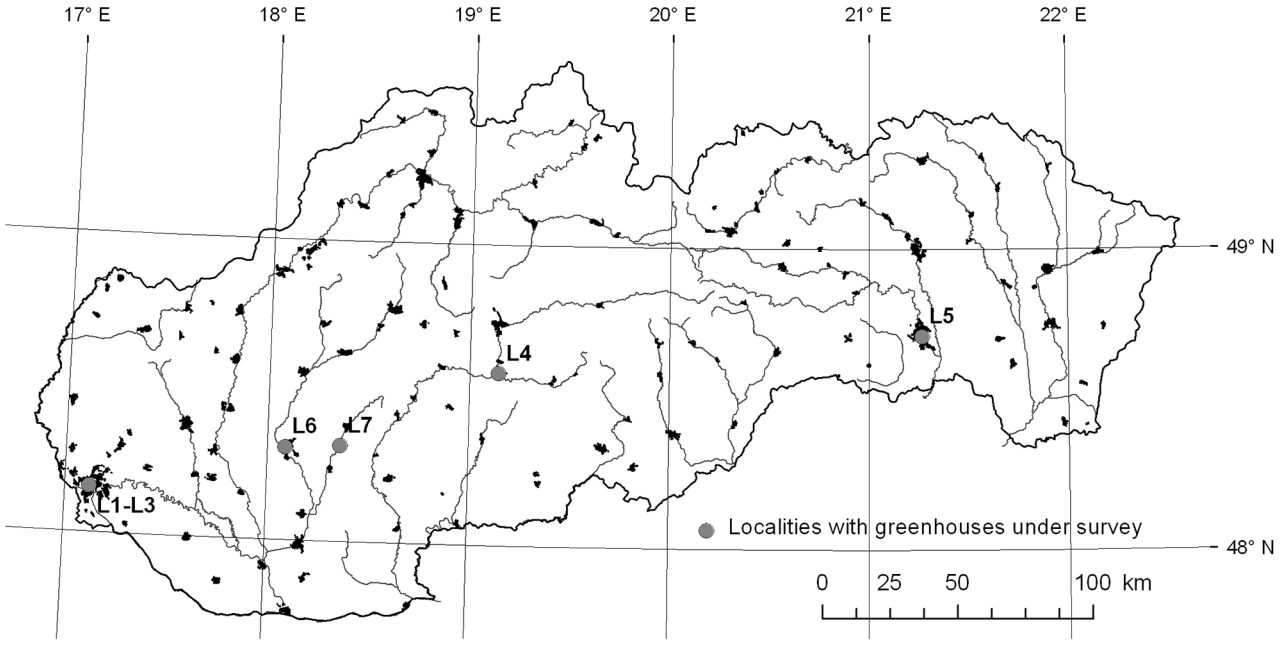

Fig. 1. Map of Slovakia showing the distribution of localities with greenhouses under study. For locality numbers see "Material and Methods"

plants and beneath the flower pots. In the Botanical Garden in Bratislava, *H. minuscula* was found in the tropical greenhouse, especially beneath the flower pots and in smaller numbers in the soil around the pool with tropical macrophytes. Most of the plants kept in the greenhouse come from South America. Altogether, six live snails and three empty shells of *H. minuscula* were found. Only the second visit to the greenhouse in 2013 revealed the occurrence of this species. FLASAR & KROUPOVÁ (1976a) did not record it during their research in 1973 and 1974.

H. minuscula was probably imported with horticultural merchandise – soil substratum and plants. In Israel, it belongs (along with other species recorded in Slovak greenhouses, e.g. *Zonitoides arboreus*, *Lehmannia valentiana*, *Pseudosuccinea columella*, *Melanoides tuberculata*) to species typically found in commercial shipments (MIENIS 2006).

In addition to *H. minuscula*, six other alien species exclusively occurring in greenhouses (Table 1) and more than 40 predominantly native species with outdoor occurrence (Table 2) were recorded in the greenhouses under survey. In case of *Gulella io*, the species recorded by FLASAR & KROUPOVÁ (1976a, b) only, we were not able to confirm its occurrence, as the greenhouses no longer exist. Another species found by FLASAR & KROUPOVÁ (1976a), *Opeas hannense*, was not confirmed either, despite the efforts made during the survey in 2003 and repeated in 2013. The most common alien greenhouse snails were *Z. arboreus* and *L. valentiana*. *Z. arboreus* is thus far only known from greenhouses in Slovakia, although several outdoor populations have already been found in the Czech Republic, Germany, Hungary and Sweden (DVOŘÁK & KUPKA 2007). A new record of *Deroceras invadens* was made in greenhouses of the Botanical Garden in Košice (locality No. 5). Thus, the species still remains unknown outdoors in Slovakia. HORSÁK & DVOŘÁK (2003) expected it to be more commonly distributed in the cultural landscape of the Czech Republic, however, the latest review of molluscs from the Czech and the Slovak Republics (HORSÁK et al. 2013) does not provide any further records. In the Czech Republic, the species has been recently found at two sites within the town of Hrádek nad Nisou, close to the German and Polish borders (HUTCHINSON et al. 2014). The only species recorded in all the greenhouses was the common Western and Central European *Discus rotundatus*. Its form with an elevated spire known as *pyramidalis* was common as well.

Fig. 2. Shell of *Hawaiia minuscula* (Binney, 1841), diameter 2.21 mm, from the greenhouse of the Botanical garden of the Comenius University in Bratislava

We intentionally did not include the non-native *M. tuberculata* in Table 1 as it is also known from several natural and artificial thermal water habitats outside the greenhouses (VARGA 1976, MÁJSKY 2000). Besides this species, five other non-native species with outdoor occurrence, *Physella acuta*, *Ferrissia fragilis*, *Oxychilus draparnaudi*, *Boettgerilla pallens* and *Arion vulgaris* were found in the greenhouses.

Table 1. List of published (1–2) and unpublished records (3–7) of gastropods occurring exclusively in greenhouses in Slovakia. For locality numbers see "Material and Methods"

Species	Localities						
	1	2	3	4	5	6	7
Pomacea bridgesii (Reeve, 1856)			×				
Pseudosuccinea columella (Say, 1817)	×	×			×		
Helisoma anceps (Menke, 1830)		×	×		×		
Opeas hannense (Rang, 1831)		×					
Zonitoides arboreus (Say, 1817)	×	×	×	×	×	×	
Hawaiia minuscula (Binney, 1841)			×	×			
Lehmannia valentiana (A. Férussac, 1822)	×	×	×		×	×	×
Deroceras invadens Reise, Hutchinson, Schunack et Schlitt, 2011			×		×		
Gulella io Verdcourt, 1974	×						
Total	4	5	6	2	5	2	1

Table 2. List of published (1–2) and unpublished records (3–7) of gastropods recorded in greenhouses with outdoor occurrence in Slovakia. For locality numbers see "Material and Methods".

Species	Localities						
	1	2	3	4	5	6	7
Melanoides tuberculata (O. F. Müller, 1774)		×	×				
Bithynia tentaculata (Linnaeus, 1758)			×				
Hydrobiidae indet.			×				
Galba truncatula (O. F. Müller, 1774)	×		×				
Stagnicola palustris (O. F. Müller, 1774)	×						
Radix auricularia (Linnaeus, 1758)		×					
Radix labiata (Rossmässler, 1835)	×	×					
Lymnaea stagnalis (Linnaeus, 1758)		×					
Physella acuta (Draparnaud, 1805)	×	×					
Planorbis planorbis (Linnaeus, 1758)	×		×				
Bathyomphalus contortus (Linnaeus, 1758)	×		×				
Gyraulus albus (O. F. Müller, 1774)		×					
Planorbarius corneus (Linnaeus, 1758)		×					
Ferrissia fragilis (Tryon, 1863)		×					
Carychium minimum O. F. Müller, 1774	×			×		×	
Carychium tridentatum (Risso, 1826)	×						
Succinea putris (Linnaeus, 1758)				×			×
Cochlicopa lubrica (O. F. Müller, 1774)		×		×			
Vallonia costata (O. F. Müller, 1774)		×			×		
Vallonia pulchella (O. F. Müller, 1774)	×	×		×		×	
Vertigo pygmaea (Draparnaud, 1801)				×			
Cochlodina laminata (Montagu, 1803)		×					
Laciniaria plicata (Draparnaud, 1801)	×						
Alinda biplicata (Montagu, 1803)	×	×	×		×		×
Cecilioides acicula (O. F. Müller, 1774)	×						
Discus rotundatus (O. F. Müller, 1774)	×	×	×	×	×	×	×
Zonitoides nitidus (O. F. Müller, 1774)				×			
Vitrea transsylvanica (Clessin, 1877)		×					
Nesovitrea hammonis (Strøm, 1765)				×			
Oxychilus cellarius (O. F. Müller, 1774)					×	×	
Oxychilus draparnaudi (Beck, 1837)	×	×	×		×	×	×
Tandonia rustica (Millet, 1843)		×	×				
Limax maximus Linnaeus, 1758			×	×			
Deroceras laeve (O. F. Müller, 1774)	×	×	×			×	×
Deroceras reticulatum (O. F. Müller, 1774)	×	×	×				
Boettgerilla pallens Simroth, 1912				×			
Arion distinctus Mabille, 1868	×		×				
Arion fuscus (O. F. Müller, 1774)		×					
Arion vulgaris Moquin-Tandon, 1855			×	×		×	×
Monachoides incarnatus (O. F. Müller 1774)					×		
Trochulus hispidus (Linnaeus, 1758)							×
Cepaea hortensis (O. F. Müller, 1774)	×	×	×	×		×	
Helix pomatia Linnaeus, 1758			×		×		
Total	18	21	17	12	7	8	7

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