

First confirmed record of *Arion intermedius* Normand, 1852 (Eupulmonata: Arionidae) in Austria

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Abstract: The hedgehog slug *Arion intermedius* was reliably recorded for the first time in Austria. Two specimens were found 2018 and 2019 in the Lainzer Tiergarten, Natura 2000 Area in Vienna. Their outer morphology and mitochondrial DNA sequences of the *cytochrome c oxidase subunit 1* gene (*COI*) matched perfectly with published data. As the sampling site was a quite natural forest and the next populations are situated just about 300 km northwest to the new record, one could suppose this species to be native to Austria. On the other hand, *A. intermedius* is known to be a quickly dispersing, invasive species in many countries during the last decades. Also the next known populations in Czech Republic are known to be introduced. Therefore it should be rather suggested as non-native species in Austria.

Keywords: Mollusca, Gastropoda, *Arion intermedius*, Austria, first record

Zusammenfassung: Die Igel-Wegschnecke *Arion intermedius* wurde das erste Mal eindeutig in Österreich nachgewiesen. Zwei Exemplare wurden 2018 und 2019 im Lainzer Tiergarten, einem Naturschutz- und Natura 2000 Gebiet in Wien, gefunden. Die äußere Morphologie sowie die mitochondrielle DNA Sequenzen des *Cytochrom-C Oxidase Untereinheit 1* (*COI*) stimmten mit bereits publizierten Daten überein. Da der Fundort an einem vergleichsweise natürlichen Standort liegt und sich die nächsten Vorkommen nur 300 km nordwestlich des neuen Fundpunktes befinden, könnte auch angenommen werden, dass die Art in Österreich autochthon ist. Allerdings handelt es sich bei *A. intermedius* um eine schnell ausbreitende, invasive Art, welche sich in vielen Ländern in den letzten Jahrzehnten ausgebreitet hat. Auch die nächstgelegenen Vorkommen in Tschechien sind nicht natürlich. Deshalb ist eher anzunehmen, dass die Art in Österreich nicht natürlich vorkommt.

Introduction

The slug *Arion intermedius* Normand, 1852, originally distributed in the north-western part of Europe, is currently found from Southern Scandinavia in the north down to the Iberian and Apennine Peninsulas in the south and from Poland in the east to Ireland in the west (Fig. 1). Additionally, it was introduced in North America (e.g. Coppolino 2008, McDonnell et al. 2008), South America (Cadiz & Gollardo 2007, Landler & Nuñez 2012, summary in Gutiérrez Gregoric et al. 2013), Australia, New Zealand (Barker 1999), North and South Africa and in the Pacific Islands (Cowie 1997). A recently new introduced population was documented in Bulgaria (Dedov et al. 2017). Within most parts of its native range it is not threatened and therefore considered as “Least Concern” by the IUCN (Rowson 2017), only populations in Finland (Rassi et al. 2010) and Switzerland (Rüetschi et al. 2010) are supposed to be endangered.

It was for several times in the past confused with other species, especially *Arion obesoductus* P.L. Reischütz, 1973 and *Arion alpinus* auct. non Pollonera, 1887. Manganelli et al. (2010) clarified the status of these three taxa: While East Alpine and Central European populations were assigned to *A. obesoductus*, *Arion alpinus* and *A. intermedius* were synonymized.

In Austria, *A. intermedius* was also mentioned in some species lists of Austrian molluscs (e.g. Klemm 1960, Rei-



Fig. 1. Native distribution of *Arion intermedius* in Europe (according to Rowson 2017).

schütz 1974), but these records were later on found to represent *A. obesoductus* (*A. alpinus* then) based on an intense investigations by Reischütz (1986).

In the course of the „Geo-Tag der Artenvielfalt 2018“ [Geo-day of biological diversity 2018] in the Lainzer



Fig. 2. Sampling site of *Arion intermedius* in the Lainzer Tiergarten.

Tiergarten, a Natura 2000 Area in the west of Vienna, which is also part of the Wienerwald Biosphere Reserve, a single specimen of *A. intermedius* was found. Another specimen could be recorded on the same place one year later. These are the first confirmed records of this species in Austria.

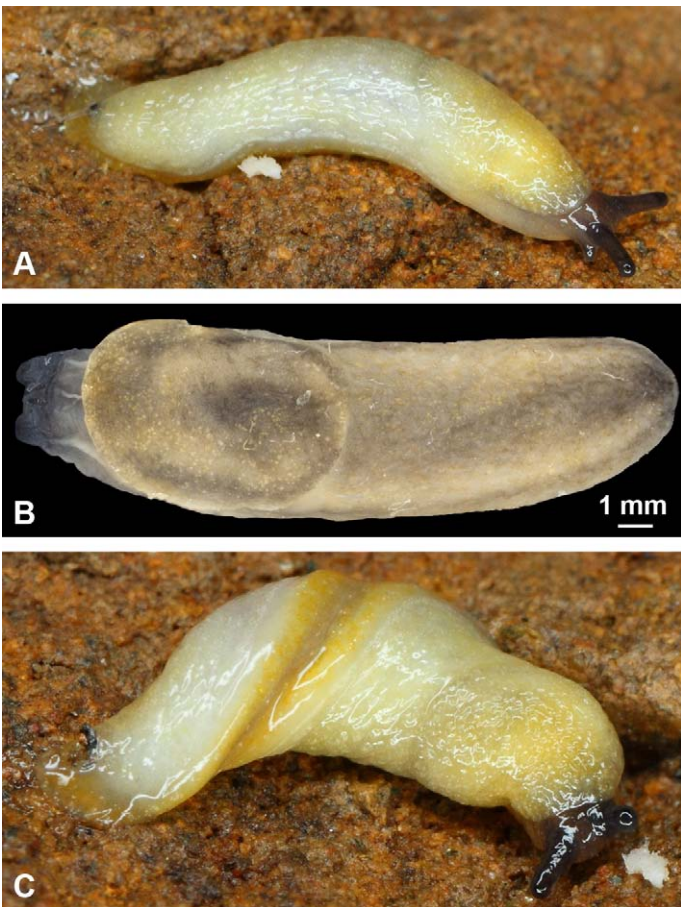


Fig. 3. *Arion intermedius*. **A.** Lateral view of a living specimen from the Lainzer Tiergarten. Photo: A. Mrkvicka ©. **B.** Dorsal view of a preserved specimen from the Lainzer Tiergarten. **C.** Living specimen from the Lainzer Tiergarten showing a characteristically yellowish colour of the foot mucus. Photo: A. Mrkvicka ©.

Material and Methods

The first sampling took place in the Lainzer Tiergarten, on the 08th of June 2018. The sampling site was a natural black alder forest situated at the Rothwasser creek (Fig. 2) in the North of the Lainzer Tiergarten. It was characterized by soil partly ransacked by wild boar, some dead wood and partly open canopy. The sampled area extended to a radius of 50 m around the coordinates 48°11,311'N, 16°12,247'E. Mollusc samples were collected by Michael Duda by hand catch or sieved from creek deposits or soil with different sieves of 4 mm, 1 mm and 0.5 mm mesh width from 10.00-15.00 CET+1. An additional survey was conducted on the 09th of July 2019, to prove, if this record was more than a singular record. Therefore, five persons again scanned the same sampling site from 17.30-19.30 CET+1 focussed on the finding of *A. intermedius*. The second specimen was found on the 09th of July 2019 by hand catch just 20 m westwards of the above mentioned coordinates. The collected animals were killed according to Reise (2013) by drowning in sparkling water in which drops of alcohol were added. The individuals are registered under the internal accession number of the Museum of Natural History Vienna as Mollusca NHMW 10900/AL/01983/8229 and NHMW 10900/AL/01815/8131.

The DNA barcoding of a 655 bp section of the mitochondrial *cytochrome c oxidase subunit 1* gene (COI) gene followed the protocol of Duda et al. (2017). The sequence of the specimen NHMW 10900/AL/01815/8131 is stored in BOLD (Barcode of Life Data System, <http://www.bold-systems.org/>) under the accession number AMOL574-19. The identification tool in the BOLD database was used for sequence comparison.

Results

The outer appearance of both specimens resembled the whitish coloured morph of *Arion intermedius* (Fig. 3A) with only vague recognisable longitudinal ribbons on the lateral sides in one specimen (Fig. 3B). When alive, they also showed a slightly yellowish foot (Fig. 3C). Rowson et al. (2014) confirm that whitish individuals of *A. intermedius* can be determined on these outer traits. Greyish individuals, as mentioned e.g. by Falkner & Fechter (1990) and Rowson et al. (2014), have not been found yet. The individual collected in 2019 was a bit more juvenile and showed the typical „hedgehog“ appearance when contracted. Measures of the conserved specimens were 9,3 mm total length and 2,6 mm broadness at the first specimen and 6,7 mm total length/2,5 mm broadness at the second specimen. The comparison of the sequence with sequences available in the BOLD database allowed an assignment to the BIN of *A. intermedius* (Barcode Index Number BOLD: AAB7120). Twenty one of the 23 sequences in this BIN were identical

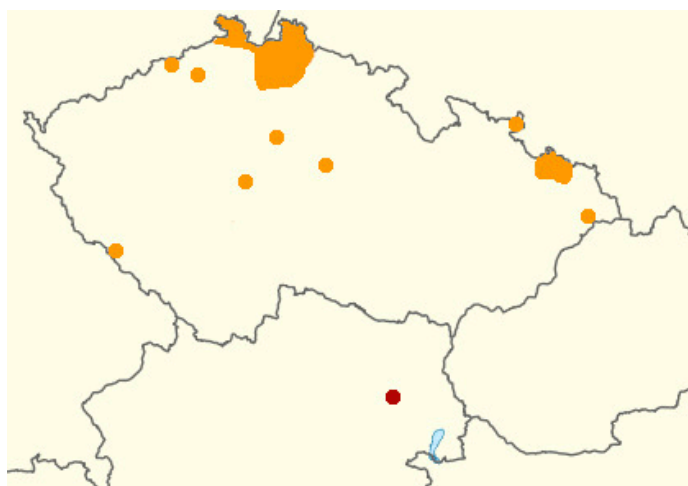


Fig. 4. Comparison of the Czech records of *Arion intermedius* (according to Horsák et al. 2018). Orange: known Czech records. Red: Austrian record from the Lainzer Tiergarten.

with our sequence, the two remaining had more than 99% similarity. Within this BIN one sequence was labelled as *Arion* sp., but it is very likely also represents *A. intermedius* - as the authors stated, they could not separate many of the different *Arion* species they found (Pfenninger et al. 2014). Nevertheless, as the authors did not mention *A. intermedius* in their article, this specimen should be revised by a specialist. Concerning the geographic origins, the vast majority (18/23) of the samples were from the United States and single ones have originated from Argentina, Belgium, Canada, Portugal and the United Kingdom.

Besides *A. intermedius*, 22 mollusc species were recorded in the sampling site. We found 19 land snails: *Arion vulgaris* Moquin-Tandon, 1855, *Alinda biplicata* (Montagu, 1803), *Boettgerilla pallens* Simroth, 1912, *Carychium minimum* O.F. Müller, 1774, *Carychium tridentatum* (Riss, 1826), *Cochlicopa lubrica* (O.F. Müller, 1774), *Cochlodina laminata* (Montagu, 1803), *Discus rotundatus* (O.F. Müller, 1774), *Discus perspectivus* (Megerle von Mühlfeld, 1816), *Euconulus praticola* (Reinhardt, 1883), *Fruticicola fruticum* (O.F. Müller, 1774), *Monachoides incarnatus* (O.F. Müller, 1774), *Oxychilus draparnaudi* (Beck, 1837), *Macrogastrea ventricosa* (Draparnaud, 1801), *Malacolimax tennellus*, O.F. Müller, 1774, *Petasina monodon* (A. Férrusac, 1807) [= *unidentata* (Draparnaud, 1805)], *Trochulus hispidus* (Linnaeus, 1758), *Vallonia pulchella* (O.F. Müller, 1774) and *Vitrea diaphana* (Studer, 1820). Three aquatic mollusc species were detected in the Rothwasser creek: the snails *Galba truncatula* (O.F. Müller, 1774) and *Radix labiata* (O.F. Müller, 1774) and the freshwater clam *Pisidium casertanum* (Poli, 1791).

Discussion

This record opens an important question, whether *A. intermedius* is native or it was introduced in Austria. To answer it, some aspects have to be taken into considera-

tion: The habitat of our sampling site accords the description of Falkner & Fechter (1990), who mentioned beech, oak and black alder creek forests as a natural habitat of this species in Germany. In addition, the Lainzer Tiergarten is comparably natural, as it was and is not affected by intense foresting and agriculture and besides marked walking paths not accessible for the public. For this reasons, an anthropogenous introduction seems to be rather unlikely. The next known natural populations are situated (Fig. 4) in the North of Bohemia Moravia (Hlaváč & Horsák 2000, Horsák et al. 2018, M. Horsák pers. comm.). Within this area, *A. intermedius* has a patchy distribution. Moreover, other westerly distributed species have small occurrences in the western surroundings of Vienna, like *Cochlostoma septemspirale* (Razoumovsky, 1789), currently detected by A. Reischütz & P.L. Reischütz (2019). These facts support the assumption that the occurrence of *A. intermedius* on our sampling site is natural.

But it also has to be taken into consideration that this species occurs as neobiont in many countries, as mentioned in the introduction. This process seems to be ongoing also in Europe, as the most recent record from Bulgaria (Dedov et al. 2017) shows. Concerning the habitat needs, several authors (e.g. Rowson et al. 2014) state that this species is quite euryoecious and therefore not restricted to a specific habitat type. Its ability to self-fertilisation facilitates quick dispersal and establishment of new populations even by one single specimen. This is also reflected by the 100 % identity of the published *COI* sequences among each other and with our specimen. The geographically nearest records in the maps of Horsák et al. (2018) are not parts of the cohesive distribution area, but south-western outposts. These records are also likely of recent origin as suggested by a modern record of this species in the well-surveyed pristine forest in northern Moravia (Horsák et al. 2006). This species has been found at this site for the first time in 2014 (M. Horsák pers. comm.), though the site has been regularly studied since the 1950s (see Horsák et al. 2006). In contrast, the area of cohesive distribution in northern fringes of Bohemia and Silesia are likely of native origin and the species behaves there as a rare species of preserved deciduous and mixed upland forests (Hlaváč & Horsák 2000; M. Horsák pers. comm.), which accords with the observation of Falkner & Fechter (1990). The recent record of this species by Dedov et al. (2017) in Bulgaria is perhaps a hint, that *A. intermedius* is currently more often accidentally introduced to south-eastern parts of Europe. Their sampling site was an artificial park landscape and the next natural occurrences are more than 1000 km to the north-east, therefore their record really seems to originate from human introduction. In addition two other introduced species (Reischütz 2002) – *Arion vulgaris* Moquin-Tandon 1855 and *Boettgerilla pallens* Simroth, 1912 – were also found in the same sampling site in the Lainzer Tiergarten.

Although we cannot be sure if *A. intermedius* is native or introduced in Austria, the latter estimation seems currently to be the more reliable one, especially if the non-native origin of the nearest records in Czech Republic is taken into consideration. Therefore we suppose this species as non-native in Austria.

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