

## *On the highly invasive slug *Arion vulgaris* (Moquin-Tandon, 1855) (Mollusca: Gastropoda) in Bulgaria*

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**Abstract.** New localities of the highly invasive slug *Arion vulgaris* were recorded in Bulgaria. Some notes on its habitats in the country observed were also reported. A short review on the taxonomy, biology, ecology and the slug general distribution was also made.

**Key words:** invasive, invertebrate, Balkan Peninsula.

### Introduction

The large invasive slug *Arion vulgaris* (Moquin-Tandon, 1855) is widespread all over Europe and is damaging roots, shoots and leaves of a large variety of crops (including stored products) and wild plants (Gordan, 1983; von Proschwitz, 1997). However, the first specimen of this invasive species was misidentified by Wiktor (1983) as *A. lusitanicus* (Mabille, 1868) and this name was used in many publications. Actually the species *A. lusitanicus* occurs in Portugal and is genetically quite distinct from *A. vulgaris* (Quin-teiro et al., 2005). Later, the name has been fixed to *A. vulgaris* (Anderson, 2005; Rowson et al., 2014).

First occurrence of this species in Bulgaria was registered by Oshanova (1964, 1968) as *Arion empiricorum* Fer. and as *Arion (Arion) rufus* Linne in Vratza town. Later it was found in Sofia city (Dedov & Penev, 2004), Zeleno Darvo village, Stara Planina Mts (Georgiev, 2013), Smolyan town, Rhodopes Mts (Georgiev, 2021), and Plovdiv city, Upper Thracian Lowland (Georgiev, 2022).

In this paper we report some new localities of *A. vulgaris* in Bulgaria and provide notes on its ecology and biology observed in the country.

### Materials and Methods

The study covers the period of 1998-2022. Collections, preservations and processing of the specimens followed standard procedures (Damyantov & Liharev, 1975; Wiktor, 1983). The collected and ethanol preserved specimens were deposited in the collections of I. Dedov and Ulrich Schnepapat (Bündner Naturmuseum, Chur, Switzerland).

### Results and Discussion

#### *Taxonomy*

The taxonomy and synonymy of the species are under discussion. According Castillejo (1997) minimum two different species can be distinguished. The situation is much more complicated because *A. (Arion) vulgaris* hybridizes with the close-related species from the subgenus *Arion* (Zemanova et al., 2017).

#### *Distribution*

The area of origin of the species is controversial. The original range perhaps includes western or south-western France, the north-western part of Iberia, maybe a part of the British Isles (Rowson

et al., 2014). Based on evidences of population genetics and distribution modelling, Pfenninger et al. (2014) claim that *A. vulgaris* belongs to the native Central European fauna but it seems rather unlikely (Zemanova et al., 2016). Therefore, the majority of the authors considers this species an alien to Central Europe (Gojdičová et al., 2014; Papureanu et al., 2014). Currently *A. vulgaris* is spread almost over all of Europe (Zemanova et al., 2016), and is also introduced in the USA and Canada (Robinson, 2015).

As mentioned in the Introduction part, in Bulgaria it was known only from few localities till now. The following new localities of the invasive *Arion vulgaris* were registered by the authors (Fig. 1):

07.07.1998, Lovech town, North Foothills of Stara Planina Mts., gardens, N43.133411 E024.707867, 210 m a. s. l.;

28.06.2000, Varshets town, Stara Planina Mts, N43.194628 E023.290688, 386 m a. s. l.;

30.07.2005, Divchovoto village, near Kordela hut, Teteven town district, edge of *Fagus sylvatica* forest N42.819087 E24.262364, 900 m a. s. l.;

16.08.2015, Plachkovtzi village, Stara Planina Mts, near houses and a road, N42.820750 E25.471556, 566 m a. s. l. (Fig. 2);

23.10.2015, E of Leskovets village, Danube River Plain, edge of deciduous forest, N43.69939 E024.03247, 44 m a. s. l.;

24.10.2015, Lozitsa village, Danube River Plain, between houses and a road in the village center, N43.60322 E024.99733, 117 m a. s. l.;

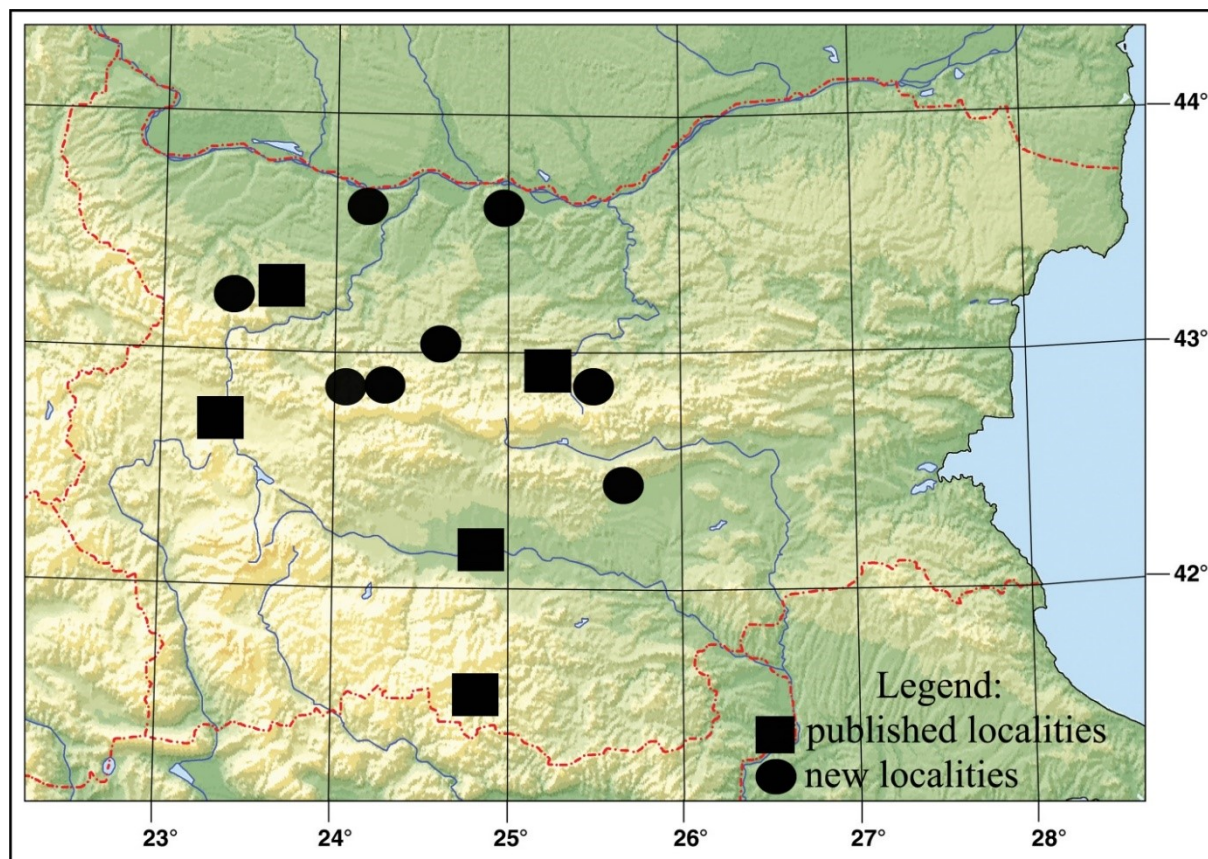
19.10.2017, Gabrovo town, Stara Planina Mts, park forest, N42.87462 E025.31191, 450 m a. s. l.;

28.10.2017, Cherni Vit village, Stara Planina Mts, N42.84694 E024.18406, 434 m a. s. l.;

16.09.2022, Stara Planina Mts, Ribaritsa village, *Fagus sylvatica* forest, near a stream, N42.839004 E24.342695, 617 m a. s. l.;

13.11.2022, Sarnena Sredna Gora Mts, N of Stara Zagora city, park "Krairechen", mixed broad leaf forest, near a small river, under dead tree trunks, N42.447355 E25.634550, 240 m a. s. l.

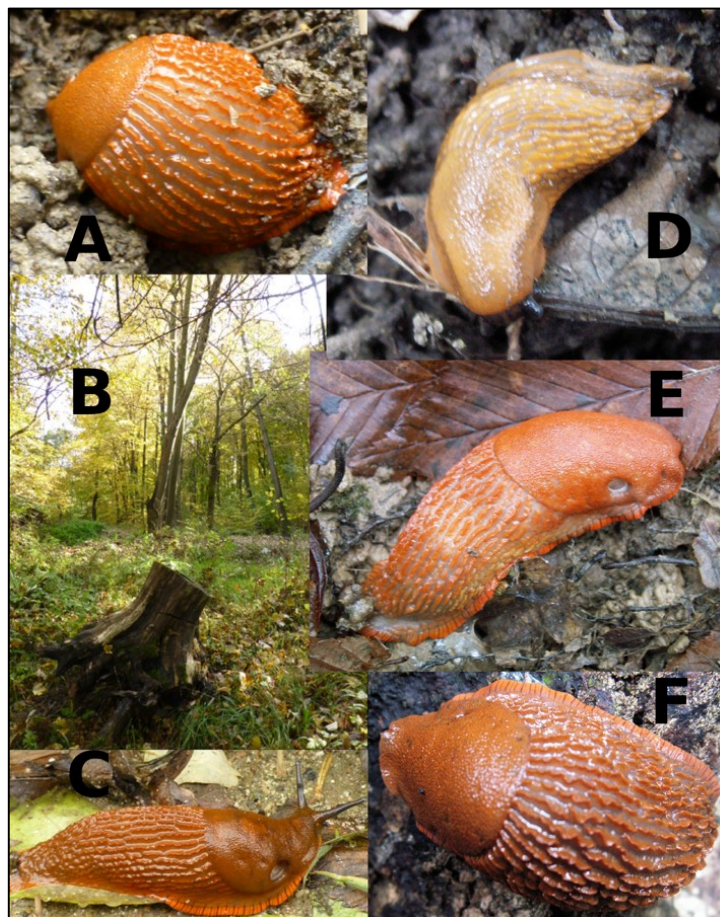
Some of the previously published localities were also visited and the occurrence of *A. vulgaris* was confirmed (Fig. 3).



**Fig. 1.** Known distribution of *A. vulgaris* in Bulgaria with approximate positions of the localities recorded. The unconfirmed scientific records from iNaturalist were not pointed.



**Fig. 2.** *A. vulgaris*: A – external view of crawling specimen, B – copulating specimens (Plachkovtsi village, Stara Planina Mts). Photo: D. Georgiev.



**Fig. 3.** *A. vulgaris* records in Bulgaria: A – Adult specimen in rest position from the region where the species was found for the first time for Bulgaria (Vratsa town district, road to Veslets village), B – View of the habitat at the same locality, C – Vratsa town district, after Glozhene village, D – Vitosha Mts foothills, a juvenile specimen, E – Troyan town, a senile specimen, F – Vitosha Mts foothills, an adult specimen. Photo: I. Dedov.

A total of 10 new localities of *A. vulgaris* in Bulgaria were found. Reviewing the photographs posted in the iNaturalist network ([www.inaturalist.org](http://www.inaturalist.org)) wider distribution in the country could be supposed. Individuals of large *Arion* (cf. *vulgaris*) were registered in many localities in Bulgaria: Pleven town, Medkovets village (Danube River Plain), Pancharevo, Botevgrad and Tryavna towns, Devetaki and Gorno Trape villages (Stara Planina Mts and its N foothills), Devin, Batak and Rudozem towns, Tzigov Chark area, Iskra and Levochevo villages (Rhodopes Mts), Samokov and Kostenets towns (Rila Mts), Blagoevgrad town (Pirin Mts), Burgas city (Black Sea Coast).

The new findings of the species after it was reported for Bulgaria from the region of Vratsa town (Oshanova 1964, 1968), shows that *A. vulgaris* has expanded its distribution in the country.

### **Biology and Habitats**

*Arion vulgaris* is a hermaphrodite. The species copulates in late spring and early summer, as both copulates exchange sperm. Each individual lays about 400 eggs, which hatch after 3-5 weeks. The species can self-fertilize also, although the resulting eggs have a low hatching rate. In most cases, the adults die in autumn. *Arion vulgaris* is a very fertile species, often living in populations with numerous specimens. It needs lots of food and may cause considerable damage in horticulture and agriculture which is easily explained by its large body mass and short one-year life cycle (Rowson et al., 2014). In Bulgaria, copulation was observed on 16.08.2015 in the morning at 6:50 a. m. near a road at Plachkovtsi town, Stara Planina Mts (Fig. 2B).

The species occurs synanthropic habitats, parks, ruderal habitats, ecotone (forest edges), open habitats, dumps, and agricultural areas (Damyanov & Liharev, 1975; Oshanova, 1964; Wiktor, 1983; Dedov & Penev, 2004). According to Wiktor (1983), its presence in Bulgaria is the result of an introduction from southwestern Europe. In Bulgaria, the closer relationship of *A. vulgaris* with water is striking. This attachment of the species to water determines its distribution in Sofia city and its surroundings: Severen Park - Kakach River, Loven Park - Dragalevska River, Mladost and Musagenitsa Rivers, Rekmariša, South Park - Perlovska River, Orlandovtsi - Suhodolska River, Buchino village - rural canal. *Arion vulgaris* can

often be found next to the rivers themselves, in the flood zone, on the muddy soil, and specimens often fall into the water during high water (for example, near the Maritsa River). During the rainy seasons - spring and autumn, dozens of specimens crawl along the park paths, sidewalks, roads and are smashed by cars and pedestrians (established for Loven Park, Mladost 1 area). During the drier months the slug becomes inactive and hides in rotten stumps or under their bark (found at Loven Park and North Park). Its spread in the capital is also favored by its omnivorousness. *A. vulgaris* has been reported to feed on both live plant parts and semi-dead snails of the same and other species (found for South Park, 11.05.1998). What has been said so far is the reason why this species follows the various water sources in its distribution and is not found en masse in drier habitats, like other slugs, for example *Tandonia kusceri* (H. Wagner, 1931) and *Arion fasciatus* (Nillson, 1823).

### **Impact**

*Arion vulgaris* is considered a serious pest by all recent authors in the whole region of its occurrence (Godan, 1983; Rowson et al., 2014). Nowadays, it is one of the most aggressive invasive gastropods in and outside of Europe, causing damages to garden plants, stored productions and saplings of deciduous forests (von Proschwitz, 1997; DAISIE, 2009; Rowson et al., 2014). The impact of the species on other Bulgarian gastropods and habitats, its role for transfer of parasites and interactions with other species still needs additional study. Welter-Schultes (2012) reports that *A. vulgaris* competes and replaces the closely related species *Arion rufus* (Linnaeus, 1758). The arionid slugs have been reported to attack nestlings of some ground- or shrub-nesting passerine birds, mainly in Europe. The slugs can cause grave or even fatal injuries to the nestlings. The information on the frequency of slug predation on bird populations is scanty, and the scale of the phenomenon is unknown (Turzańska & Chachulska, 2017).

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