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FAST RECENT EXPANSION OF THE SPANISH SLUG (GASTROPODA, STYLOMMATOPHORA, ARIONIDAE) ACROSS UKRAINE

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Fast Recent Expansion of the Spanish Slug (Gastropoda, Stylommatophora, Arionidae) across Ukraine. Balashov, I., Khomenko, A., Kovalov, V., Harbar, O. — The Spanish slug, a species that is considered to be the most destructive pest among molluscs of Europe, is reported to spread widely across Ukraine during last 5–7 years. In addition to its 5 known colonies in Western Ukraine, over 60 new localities from Western, Central, Northern, Southern and Eastern Ukraine are reported for the first time using own materials and reports with photo from the general public. Newly reported localities include such major cities as Kyiv, Kharkiv, Donetsk, Khmelnitsky, Vinnytsia, Ternopil, Zhytomyr, Lutsk, Chernivtsi and Ivano-Frankivsk, and also the settlements in Odesa and Mykolaiv Regions. Species is also reported for the first time from Grodno City in Belarus and from Moscow City in Russia. Much wider future expansion of the Spanish slug in Eastern Europe is expected in near time.
Key words: terrestrial molluscs, *Arion vulgaris*, *Arion lusitanicus*, Mollusca, invasion, pest, Europe.

Introduction

Biological invasions are one of the most significant environmental issues of the 21st century and are known to have major negative consequences for both human enterprise and ecological systems (Pimentel et al., 2000). Many species of terrestrial molluscs are spread far from their natural ranges, often damaging agricultures as pests and sometimes causing a decline in local faunas (Cameron, 2016).

In Eastern Europe, about 30–35 species of terrestrial molluscs are known to expand their natural ranges during last decades, which in nearly all cases happens in two directions: from the south to the north and from the west to the east (Sverlova et al., 2006; Son, 2010; Balashov, 2016). Most of these species originate from the territories around the Black and Mediterranean seas or from Western Europe (Son, 2010; Balashov, Gural-Sverlova, 2012; Balashov, 2016). Some of these invasions are known to cause damage of agricultures (Sverlova et al., 2006; Son, 2010; Balashov, 2016) and decline in native biodiversity (Balashov et al., 2018) in Ukraine.

Among these molluscs' invasions, the most notable one is the invasion of the Spanish slug (*Arion vulgaris* auct. non Moquin-Tandon, 1855 or *A. lusitanicus* auct. non Mabille, 1868). There is currently no correct scientific name for this species, an application to validate unavailable *A. vulgaris* name was submitted to the International Commission on Zoological Nomenclature (Balashov, 2018). This species originates from the southern parts of Western Europe and now expands widely across the whole Europe (Quinteiro et al., 2005; Păpureanu et al., 2014; Pfenninger et al., 2014; Rowson et al., 2014). Spanish slug is considered to be the most destructive pest among molluscs of Europe, it is listed among the 100 worst alien species in Europe in DAISIE European Invasive Alien Species Gateway and this is an only mollusc species on the list (Pfenninger et al., 2014; Rowson et al., 2014).

In Ukraine colonies of the Spanish slug are registered since 2007 from Lviv Region and were reported by the locals for at least two years earlier (Gural-Sverlova, Gural, 2011). This region neighbors to Poland, where this species is known since 1993 and especially widely distributed in the areas adjacent to Ukraine (Kozłowski, 2012). More recently, Spanish slug was found in Uzhgorod City (Zakarpattia Region, Ukraine) that is located near the border with Slovakia, some indirect data suggest that it might have invaded that area even before Lviv Region (Gural-Sverlova, Gural, 2015). It was also reported from Rivne City in northwestern Ukraine (Garbar, Kadlubowska, 2015).

We have several findings and numerous reports of Spanish slug from across Ukraine that reveals its much wider distribution.

Material and methods

Material was collected and identified using common methods (Rowson et al., 2014; Balashov, 2016). Directly examined material: Teremky area in Kyiv (2013 and 2017), Holosiiv Park in Kyiv (2017), Botanical Garden of Kharkiv City (2016 and 2017), Lviv (2010), Drogobych (2009, collected by N. Gural-Sverlova). These materials are stored in the Collection of terrestrial molluscs of I. I. Schmalhausen Institute of Zoology of National Academy of Sciences of Ukraine (IZAN, Kyiv). Several slugs were also observed and photographed by O. Harbar and L. Vasilyeva in Zhytomyr on Suryna Hora str. (50.274889° N, 28.634556° E) in 2017.

Received reports of the Spanish slug with photo: Donetsk (2012), Rivne (since 2014, 2 reports), Zhytomyr (2018, 2 reports) and Khmelnitsky (14.09.2013, 2018, 2 reports) Cities; Pervomaisk City of Mykolaiv Region (2018); Lymanka village near Odesa City (former Mizikevycha, Artsyzka str. 4/6, 2017, but not observed in the same area in 2018); Stepanky and Khorosheve villages near Kharkiv City (2018); areas of Kyiv City: Nyvky Park (2017), Kyiv Zoo (2018), Holosiiv District (2017, 2018, over 10 reports); settlements of Kyiv Region: Bila Tserkva (2018), Fastiv (2018), Vorzel (2018), Vasylkiv (2018), Pidhirtsi (2018), Khotiv (2018, 5 reports), Lisnyky (2018), Kozyn (2018, 2 reports, said to be for few years); settlements of Lutsk Region: Lutsk (since 2014, 4 reports), Kovel (2018), Novovolynsk (2018); settlements of Vinnytsia Region: Vinnytsia (2018, 5 reports), Petryk (2018), Hnivan (2018, 2 reports), Velyki Krushlyntsi (2018); settlements of Ternopil Region: Ternopil (2018, 2 reports), Toky (2018), Berezhany (2018); settlements of Chernivtsi Region: Chernivtsi (since at least 2013, in mass, 16 reports), Shchipyntsi (2018, reports without photo since 2015), Panka (2018); settlements of Ivano-Frankivsk Region: Ivano-Frankivsk (2017, 2018, 14 reports), Kosiv and vicinities (2017, 2018, in mass, 7 reports), Kalush (2014-2018, in mass, 4 reports), Kolomyia (2017, 2018, 5 reports), Nadvirna (2018), Yaremche (2018), Iltsi (2018), Verbylivtsi (2018), Burshtyn (2018), Yasen (2018), Ugryniv (2017); settlements of Zakarpattia Region: Uzhgorod (2017, 2018, 3 reports), Mukachevo (2018, in mass; from the other source without photo reported from there "for 10–15 years", i. e. since at least 2007), Vynogradiv (2016, 48.144080 23.034163), vicinities of Boroniava (2017, 48.134169 23.365337), Velyki Lazy (2017), Velykyi Bychkiv (2017), Polyana (2018), Turyi Remety (2018), Khust (2018); Kvasy (2018); Settlements of Lviv Region: Lviv and vicinities (2017, 2018, over 30 reports), Zolochiv (2016, 2018, 2 reports), Truskavets (2018), Sambir (2018), Staryi Sambir (2018), Mostyska (2018), Shydnytsia (2018), Bronytsya (2018), Skole (2018), Morshyn (2018), Stryi (2018), Bibrka (2018), Chervonhrad (2018), Sokal (2018), Vysloboky (2018), Zhyrivka (2018). It was also observed recently by N. Gural-Sverlova in Obroshyne and Briukhovychi villages near Lviv City (pers. comm.). In addition to locations from Ukraine we have also notable reports with photo from Grodno City in Belarus (photos by A. Vintchevski) and from Moscow City in Russia (photo by V. Avdeev).

Photos were mainly received through the social network Facebook from general public after two cases of sharing information about Spanish slug in Ukraine: by us in 2017 and by N. Yunakov in 2018. Reports that were received in the second case were uploaded on the website of Ukrainian Biodiversity Information Network (UkrBIN, ukrbin.com) by its team and available there (including reports without photo that were neglected herein).

Anatomically we have checked the identity of specimens from Kyiv and Kharkiv Cities. It was also checked anatomically for Lviv, Vynnyky, Drogobych and Uzhgorod Cities by N. V. Gural-Sverlova (Gural-Sverlova, Gural, 2011, 2015; pers. comm.) and for Rivne by N. Kadlubowska (Garbar, Kadlubowska, 2015; pers. comm.). Therefore, specimens from all other discussed locations were distinguished by external view only, mainly by photo, and potentially may represent some other species of subgenus *Arion*, first of all, *Arion rufus* (Linnaeus, 1758). However, since there are no confirmed records of *Arion* s. str. other than Spanish slug in Ukraine so far it is most likely that all our data represent the later species.

Results

In Kyiv City the first known record of the Spanish slug was that by T. Redchuk in 2013, on the edge between Teremky area of Kyiv and adjacent Novoselky settlement (the slugs were deposited to the collection of IZAN). Examination of Teremky in August of 2017 confirmed that this colony still exists. In this area, along highway Kyiv–Odesa, the small forest is located (mainly used as recreation area) and some private estates next to it. Slugs were found in anthropogenic habitats between the forest and the estates.

In 2017 we received numerous reports and photos of Spanish slugs from the adjacent to Teremky areas of Holosiiv District of Kyiv, first of all, around two large forest massifs — Holosiiv Forest and Feofania. In August 2017, after a brief search, we have found one living specimen on the bank of a large pond near Holosiiv Forest (fig. 1).

In Kharkiv City, numerous Spanish slugs were found in one locality in Botanical Garden in 2016 and 2017. Therefore, this colony apparently survived here at least over one winter on the open ground.

Since the Spanish slug is a pest with striking appearance and there are no other species of *Arion* subgenus known to occur in Ukraine we decided to ask general public about findings of these slugs in Ukraine. In 2017 we posted a note with slug's photo on Facebook and shared it between colleagues and in the few Ukrainian groups on the wild animals and nature of Ukraine. In 2018 similar information was posted and shared on Facebook in UkrBIN group by N. Yunakov. The response was unexpectedly high in both cases: tens of reports with photos were received from across Ukraine (fig. 2). Most of these reports were from Western Ukraine and Kyiv Region, but there were also notable reports from the Eastern and Southern Ukraine: from Donetsk City in 2012 (by A. Martynov), Odesa and Mykolaiv Regions in 2017 and 2018 (by V. Gutsalyuk and A. Burakova).

Discussion

Received data (fig. 2) suggests wide distribution of the Spanish slug across Ukraine. Probably this species also occurs in other settlements of Ukraine and should be expected to occur on all territory, as well as in all adjacent countries.

Fig. 1. Spanish slug from Kyiv, August 2017 (photo I. Balashov).

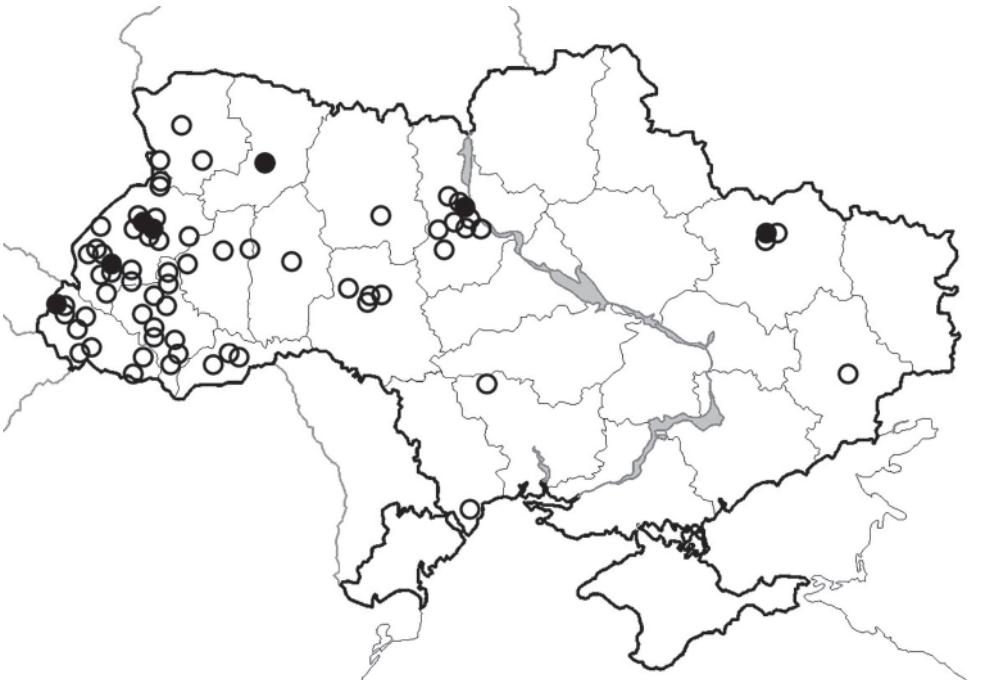

Fig. 2. Distribution of the Spanish slug in Ukraine. Black circles — anatomically confirmed locations; empty circles — by external view only.

The oldest records and unconfirmed indirect data suggest that for the first time in Ukraine this species appeared in Lviv and Zakarpattia Regions before 2007. In Zakarpattia Region, Spanish slug might have appeared even earlier (Gural-Sverlova, Gural, 2015). These two regions are the most western parts of Ukraine. Therefore, expansion takes place in general from the west in east direction. However, one of the relatively early records (2012) was in Donetsk in Eastern Ukraine.

In Kyiv City, Spanish slug was found for the first time in 2013, but was not widely distributed here before 2016–2017, when it became very abundant in Holosiiv District of Kyiv (south-western part of the city), reportedly often reaching huge biomass. We have recent reports from other parts of Kyiv: in Nyvky Park and Kyiv Zoo (western part of the city). Therefore, being first introduced probably in Teremky area, it is gradually spreading across the city. It is notable that small forest in Teremky area was the first know place of invasion in Kyiv for at least two other slug species: *Krynickillus melanocephalus* Kaleniczenko, 1851 (since 1998) and *Bielzia coerulans* (Bielz, 1851) (since 2002) (Korol, Korniushin, 2002; Sverlova et al., 2006; our data). Since then *K. melanocephalus* has become very common in Kyiv and its abundant colony still lives in Teremky. Another species, *B. coerulans*, was not reported from Kyiv outside this area, several specimens were found here in following years, including one in August 2017 during our search for the Spanish slug. Therefore, it is possible that some important source of invasions is located in this area.

It is notable that in the Botanical Garden of Kharkiv City the Spanish slug co-occurs with invasive snail *Cepaea hortensis* (Müller, 1774). Until now this species was known in Ukraine from its western regions only, mainly from Lviv Region (Sverlova et al., 2006; Balashov, 2016). Perhaps both invasive mollusc species came to Kharkiv from the same source. It suggests that this was rather far invasion, at least from Western Ukraine, but much less likely from Kyiv or some other place in Central or Eastern Ukraine where *C. hortensis* is not known to occur. Recently *C. hortensis* was also discovered in one more city in Eastern Ukraine: in Lugansk (photo by T. Sova, 65561 on ukrbin.com, 21.04.2018).

It seems that at its spreading the Spanish slug first forms local colonies from the far invasion and then from these "hotbeds" spreads more gradually in adjacent areas, becoming more and more abundant in the region. Therefore, its far invasions (e. g. between centers of the regions) are relatively uncommon events, but within districts it spreads much faster. After forming first colonies in Lviv and Zakarpattia Regions before 2007 the Spanish slug has become much more common and abundant there in following years infesting at least several settlements. Around 2012–2013 colonies of this species also appeared in Donetsk, Kyiv, Khmelnitsky and Chernivtsi. Since then, the species has become much more abundant at least in Kyiv and Chernivtsi and in some settlements around these cities. The whole process is extremely fast, it took only 10 years for Spanish slug to spread across almost entire country and to become abundant pest causing very significant damage to agriculture. Therefore, it is very likely that we are witnessing only the beginning of the Spanish slug's expansion in Eastern Europe, it is expected to become more abundant in the regions where it is already known and to spread across all other regions of Ukraine.

Most of the reports of Spanish slug from Ukraine are adjoined with complaints about huge damage caused by it to the various cultivated plants. This species is much worse pest than any other slug in Ukraine, therefore its invasion and future wider spread involves new significant economic issue for whole country.

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