

The first records of an invasive land snail *Cepaea nemoralis* (Stylommatophora: Helicidae) in Central and Southern Ukraine

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ABSTRACT. Two colonies of an invasive West European land snail *Cepaea nemoralis* are reported from Kyiv region of Ukraine, as well as a third locality where snails were present in 2019, but no living individuals were found in 2020. One more locality is reported from Odessa City in Southern Ukraine. These localities are the most south-eastern ones for the range of *C. nemoralis* and are the first known records of this species in Ukraine outside its western regions, with closest previously published confirmed colonies in more than 400 km. Distribution of this species in Eastern Europe is discussed, it is argued that invasion of *C. nemoralis* is probably driven by the same processes as invasion of the Spanish slug, *Arion vulgaris*, that invaded Eastern Europe during the last decades.

Первые находки инвазивной наземной улитки *Cepaea nemoralis* (Stylommatophora: Helicidae) в Центральной и Южной Украине

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РЕЗЮМЕ. Мы зарегистрировали две колонии инвазивного вида западноевропейской наземной улитки *Cepaea nemoralis* в Киевской области Украины, а также третье местонахождение, где вид был отмечен в 2019 году, но в 2020 году живых особей не было обнаружено. Еще одно местонахождение выявлено в г. Одесса в Южной Украине. Эти местонахождения являются наиболее юго-восточными для ареала *C. nemoralis* и первыми известными находками этого вида в Украине за пределами её западных регионов, ближайшие из ранее опубликованных подтвержденных находжений колоний находятся на расстоянии более 400 км. В статье обсуждается распространение этого вида в Восточной Европе, и мы предполагаем, что инвазия *C. nemoralis*, вероятно, вызвана теми же процессами, что и распространение испанского слизня, *Arion vulgaris*, вторгшегося за последние десятилетия в Восточную Европу.

Cameron, Cook, 2012]. The native range of this species includes Western Europe and some parts of Central and Northern Europe [Schileyko, 1978; Kerney *et al.*, 1983; Welter-Schultes, 2012]. As an invasive species *C. nemoralis* is also distributed in some regions of Eastern Europe (see below) and across North America [Pilsbry, 1889; Brussard, 1975; Layton *et al.*, 2019].

For the long time *C. nemoralis* was known in Eastern Europe only from the Baltic regions [Schileyko, 1978]. Since 1994 the colony of this species was studied in the park of Lviv City in Western Ukraine [Sverlova, 2002]. Starting from the 2000s this species was reported also from the central part of European Russia [Sverlova, 2007; Tappert, 2009; Schikov, 2016; Mukhanov, Lisitsyn, 2017; Egorov, 2018] and from Belarus [Zemoglyadchuk, 2009; Zemoglyadchuk, Rabchuk, 2014; Ostrovsky, Prokofyeva, 2017; Kruglova, 2018]. In Moscow Region it was said to be present long before these records [Schikov, 2016; Egorov, 2018]. A single shell of *C. nemoralis* collected in the late 2000s was reported from Khmelnytsky Region [Balashov *et al.*, 2013] and recently the colonies of this species were found also in the several other locations of Western Ukraine in the Lviv, Ivano-Frankivsk and Rivne regions [Gural-Sverlova *et al.*, 2020, 2021].

Cepaea nemoralis is one of about 40 species of terrestrial molluscs that extending their natural ranges in Eastern Europe [Sverlova *et al.*, 2006; Son, 2010; Balashov, 2016; Schikov, 2016]. Several species of these molluscs are very significant pests [Balashov *et al.*, 2018a] and some apparently causing decline in the populations of native molluscs in protected areas [Balashov *et al.*, 2018b]. Some spe-

Introduction

Land snail *Cepaea nemoralis* (Linnaeus, 1758) (Fig. 1) is a classic model organism in the studies of the population genetics and polymorphism [Fisher, Diver, 1934; Cain, Sheppard, 1950; Clarke, 1960; Richardson, 1974; Brussard, 1975; Jones, 1982;

cies has synanthropically invaded Eastern Europe long time ago, perhaps during the ancient times in some cases [Korábek *et al.*, 2018]. But most of these molluscs has started or intensified extension of their ranges during the last decades, presumably in response to the climate change [Sverlova *et al.*, 2006; Son, 2010; Balashov, 2016; Balashov *et al.*, 2018a, c]. Therefore, studying the invasions of terrestrial molluscs in Eastern Europe is an important topic that requires significant attention.

We are reporting here the newly discovered colonies of *C. nemoralis* in Central and Southern Ukraine that demonstrating the further expansion of this invasive species in Eastern Europe.

Material and methods

Three locations with *Cepaea nemoralis* in Kyiv Region of Ukraine were investigated during the 2020: 1 – Halyavyna Kazok Park of Vyshgorod Town (Vyshgorod District, 50°34'50"N, 30°28'57"E, visited on 22.10.2020); 2 – park along Druzhby Narodiv Blvd. in Pechersk District of Kyiv City (50°25'26"N, 30°33'40"E, visited on 13.07.2020); 3 – Sofiivska Borshagivka Village (Kyiv-Sviatoshyn District) adjacent to Kyiv City (50°24'12"N, 30°23'32"E; visited on 28.05.2020). Two specimens from Odessa City were collected in the private estate in the Bolshoi Fontan microdistrict by Dr. V. Lobkov in May of 2020.

Online databases iNaturalist (www.inaturalist.org) and UkrBIN (ukrbin.com) were widely used in this study to search locations of *Cepaea nemoralis*.

Material was collected, handled and identified using common methods of work with terrestrial molluscs [Schileyko, 1978; Kerney *et al.*, 1983; Balashov, 2016]. All shells from Kyiv Region and one shell from Odessa are kept in the Collection of terrestrial molluscs of I.I. Schmalhausen Institute of Zoology (Kyiv, Ukraine). Second shell from Odessa is kept in the collection of Zoological Museum of Odessa National University.

The phenotypes were described by the usual for *Cepaea* methods showing variability of their coloration with “P” meaning that the background coloration is pink, “Y” – yellow, and, for example, “12345” – all five bands are present and not fused, “00000” – all five bands are absent, “123(45)” – all bands are present, but last two are fused [Cain, Sheppard, 1950; Clarke, 1960; Sverlova *et al.*, 2006].

Results

We have initially found all locations of *Cepaea nemoralis* reported here via the online database iNaturalist where people from the general public uploading photos of random organisms with geo-location and date. Existence of the two colonies of

C. nemoralis was confirmed by us in the field, while in the third place only a single empty shell was found.

The first confirmed colony of *C. nemoralis* in Central Ukraine is in Vyshgorod Town in Kyiv Region. The photo of an alive adult snail uploaded on iNaturalist was taken on 23.10.2019 (observation 34819309). We have visited this locality a year later on 22.10.2020 and have found 3 alive adult snails, 12 alive juveniles and 9 empty shells of *C. nemoralis* after several hours of search. The phenotypes represented among the collected shells from this locality are P00000, P(12)3(45), P12345 and Y12345. This locality is a town park and an adjacent front garden of a nearby 9-storey living building that is actively used by the locals to grow various crops. The snails were found along the fence between the park and garden. Most snails were found among the grass on the ground, some on the fence and one on a tree (about 2 m above the ground). Apparently *C. nemoralis* is mostly depending on the garden in this locality, the park is well-maintained, with a lawn. The colony seems to be insular, we have not found *C. nemoralis* in other places around. Other invasive terrestrial molluscs were also found in this locality in Vyshgorod: *Oxychilus translucidus* (Mortillet, 1854), *Deroceras caucasicum* (Simroth, 1901) and *Arion fasciatus* (Nilsson, 1823).

Another photo of an alive adult *C. nemoralis* on iNaturalist (30809918, phenotype P00300) was taken on 14.08.2019 in the Pechersk District of Kyiv City in the park along a motorway. We have visited this locality on 13.07.2020. After several hours of search, we have found only a single juvenile shell of *Cepaea* sp. (phenotype Y00000) and no living snails. In this locality we have observed extremely numerous invasive Spanish slug *Arion vulgaris* Moquin-Tandon, 1855 (= *A. lusitanicus* auct.) that recently invaded Kyiv city [Balashov *et al.*, 2018a]. Perhaps the numerous large slugs have extruded *C. nemoralis* during the last year from this locality somehow (e.g. by eating the eggs or juveniles). We have found also some other molluscs in this locality during the search: *Succinea putris* (Linnaeus, 1758), *Cochlodina laminata* (Montagu, 1803), *Laciniaria plicata* (Draparnaud, 1801), *O. translucidus*, *Arion fuscus* (Müller, 1774) (= *A. subfuscus* auct.), *Fruticicola fruticum* (Müller, 1774), *Caucasotachea vindobonensis* (Pfeiffer, 1828), *Pseudotrichia rubiginosa* (Rossmässler, 1838).

The second confirmed colony of *C. nemoralis* in Central Ukraine is in the Sofiivska Borshagivka Village near the border line of Kyiv City (practically part of the city). The first photo from this area was uploaded on iNaturalist on 25.05.2020 (47272643) and we have visited it shortly afterward on 28.05.2020 (47605276). About 20 living snails of *C. nemoralis* were collected in this locality. The phenotypes represented among the collected shells from this local-



FIG. 1. *Cepaea nemoralis* from Sofiivska Borshagivka Village near Kyiv.

РИС. 1. *Cepaea nemoralis* из с. Софиевская Борщаговка возле Киева.

ity are Y(12)3(45), P(12)3(45), P123(45), P12345, Y12345, Y(123)(45), Y00300, P00300, Y00345, Y003(45). Snails have occupied the single block of the private cottages here and we have collected them around the perimeter of this block from the fences, in the grass and under the stones. Since then several more photos of *C. nemoralis* were uploaded on iNaturalist during 2020 from the adjacent areas in Sofiivska Borshagivka (57015096, 61312655, 61856903) and from the nearby Teremky area of Kyiv (55963924). Together with *C. nemoralis* in this locality we have found two other species of molluscs: *Chondrula tridens* (Müller, 1774) and *Monacha* sp..

Two living specimens of *C. nemoralis* in Odessa City were collected by Dr. V. Lobkov in May of 2020 (phenotype Y00300). Reportedly this species was seen in the area about 5 years ago for the first time.

It is also notable that in the UkrBIN online database there are photos of numerous living specimens of *C. nemoralis* from the two previously unpublished localities in Western Ukraine. First one is in the Chortkiv City of Ternopil Region with numerous photos from spring of 2020 (photos 145253, 149617, 149618, 149621, etc) and the second one is in Yarmolyntsi Town of Khmelnytsky Region with photos from May of 2020 (photo 153275, etc). There were no published records of *C. nemoralis* from Ternopil Region and only one empty shell was reported

from the different locality of Khmelnytsky Region [Balashov *et al.*, 2013; Gural-Sverlova *et al.*, 2020].

Discussion

As *Cepaea nemoralis* is a very well-known species, often some other species being confused with it by non-malacologists or beginners who expecting to find it rather than some other species that they don't know. It makes problematic to clearly trace the history of its invasions in Eastern Europe. It is reasonably considered that some older records of “*C. nemoralis*” from Ukraine are most likely representing a similar *Caucasotachea vindobonensis* [see discussion in Sverlova *et al.*, 2006: 52]. The latter species is native to the southern half of Eastern Europe and till recently was also placed in the genus *Cepaea* [Neiber, Hausdorf, 2015]. From our experience, sometimes also some specimens of *Fruticola fruticum* with prominent coloration are being confused with *C. nemoralis* by non-malacologists.

It is being argued recently that a previously discarded record of *Helix nemoralis* from Moscow by Dwigubsky [1802] may in fact represent *C. nemoralis* [Schikov, 2016; Egorov, 2018]. It is not completely impossible, but considering that in this work [Dwigubsky, 1802] there were no records of any other terrestrial snails except *C. nemoralis*, we

find it highly unlikely that this identification was correct. In such context it could refer to any helicoid-like species, first of all *F. fruticum*.

Even if there were some singular old-living colonies of *C. nemoralis* in Eastern Europe, apparently this species much intensified its expansion during the last 10 or 15 years. Current distribution of this species in Belarus and central part of European Russia, although largely reported in literature, is missing the details and being not summarized. As it is seen from the numerous photos uploaded by the people from the general public on iNaturalist, this species is currently rather common in Belarus, with numerous records across Minsk and Brest cities, as well as in some adjacent settlements, also present in Mogilev, Kobryn and Begoml cities; in European Russia there are at least 20 locations around Moscow City, some records in Nizhniy Novgorod and Pushchino cities (only checked undoubtful identifications). It is not likely that all these colonies were overlooked for the long time. Apparently, at least most of the mentioned locations, as well as our findings in Central Ukraine and most of the recently published records of *C. nemoralis* [Zemoglyadchuk, Rabchuk, 2014; Schikov, 2016; Egorov, 2018; Mukhanov, Lisitsyn, 2017; Ostrovsky, Prokofyeva, 2017; Kruglova, 2018; Gural-Sverlova *et al.*, 2020, 2021] are representing the intensified expansion of this species across Eastern Europe during the last 10-15 years.

The similar tendencies are known for another invasive terrestrial mollusc, *Arion vulgaris*, the Spanish slug. Native range of this species is located largely in the same West European regions as those of *C. nemoralis* (though its boundaries are uncertain) and it is massively conquered Eastern Europe during the two last decades with some singular uncertain records in the 1990s or before [Balashov *et al.*, 2018a]. Same as in the case with *C. nemoralis* the Lviv Region was among the first territories where this species was found in Eastern Europe and, same as *C. nemoralis*, recently became common in the most of East European cities listed above, including Kyiv, Minsk and Moscow. Apparently, current intensification of the expansions of *C. nemoralis* and *A. vulgaris* across Eastern Europe is driven by the same processes as both species have similar climatic preferences and, apparently, the global change of climate is favorable for them (though probably not simply in warming itself). It leading to the similar extension of their ranges in the similar direction during the same period of time. Among the factors that allowing these invasions is also probably an intensified easier spreading of the orchard crops during the last decades due to the globalization, especially in the post-Soviet countries. But, in our opinion, this factor was existing earlier, though to a lesser extent, and it is rather explaining how these invasions are happening, but not why they are often successful in

recent years. The latter is probably rather due to the climate. Therefore, it could be said, that *C. nemoralis* and *A. vulgaris* are probably representing the same “wave” of invasions in Eastern Europe from the west during the last decades, mainly in response to the climate change.

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