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GARDEN CENTRES AND THE ALIEN LAND MOLLUSK SPREAD IN THE LVIV REGION, UKRAINE

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Garden Centres and the Alien Land Mollusk Spread in the Lviv Region, Ukraine. Gural-Sverlova, N. V., Gural, R. I. — A total of 20 species of land mollusks were recorded near the 12 garden centres surveyed, more than half of which were introduced to Western Ukraine. Of the alien species, *Arion vulgaris*, *Deroceras caucasicum*, *Krynickillus melanocephalus*, *Cepaea hortensis*, *C. nemoralis*, and *Monacha cartusiana* were present at all or most sites. However, the dispersal of *M. cartusiana* may be associated with motor transport rather than garden centres. Garden centres also contribute to increasing the phenotypic diversity of both introduced *Cepaea* species in the Lviv Region. In the case of *C. hortensis*, this includes the recent appearance of several heritable colouration traits, locally occurring even in natural populations of the species. Of greatest economic importance is the invasion of garden centres by two dangerous pests, *Arion vulgaris* and *Deroceras caucasicum.*

Key words: terrestrial mollusks, Gastropoda, *Cepaea*, introduced species, Western Ukraine.

Introduction

Introduced species of land mollusks are known in all parts (Balashov, Gural-Sverlova, 2012) and administrative regions of Ukraine (Balashov, 2016). Moreover, their number is gradually increasing. This is clearly demonstrated by the chronology of the discovery of alien land mollusks in Western Ukraine (Gural-Sverlova & Gural,

2021, Table 2). By the end of 2021, at least 22 such species were reliably known here. In the following years, three more taxa were added to this list, so far known from single localities in the Transcarpathian (Gural-Sverlova & Andrik, 2023), Ternopil (Gural-Sverlova & Lyzhechka, 2024) and Ivano-Frankivsk (Gural-Sverlova et al., 2024 b) Regions.

One of the important ways of penetration of snails and slugs into new areas (Robinson, 1999) is the activities of garden centres and plant nurseries (Hayes et al., 2007; Cowie et al., 2008; Bergey et al., 2014; Krumpálová & Holienková, 2018; Gutiérrez Gregoric et al., 2020). The rapid spread of some alien land mollusks recently observed in Ukraine may be related to garden centres importing ornamental plant seedlings from abroad. This is especially true for *Arion vulgaris* Moquin-Tandon, 1855 and *Cepaea nemoralis* (Linnaeus, 1758), and to a somewhat lesser extent for *Cepaea hortensis* (Müller, 1774) (Gural-Sverlova et al., 2024 a, b). In the Lviv Region, where *C. hortensis* was introduced already in the second half of the 20th century, repeated introductions through garden centres have led to a significant increase in phenotypic diversity (Gural-Sverlova & Gural, 2022 a), which is still observed only in some limited areas (Gural-Sverlova & Gural, 2022 b).

Until now, the potential influence of garden centres on the dispersal of alien land mollusks in Ukraine or its western part has been discussed only for a few species (Gural-Sverlova et al., 2024 a, b). To complete the picture, it was necessary to examine the land mollusc composition either in the garden centres or in their immediate vicinities, where snails and slugs can crawl from the garden centres. However, owners and staff are not interested in finding invasive species in their garden centres and plant nurseries, which would be negative publicity. Therefore, we chose the second approach and started by surveying the immediate surroundings of garden centres (large and small, operating or recently closed) in the Lviv Region.

The aim of our study was to analyse the potential impact of garden centres on the spread of alien land mollusks, including pests, as well as on the phenotypic diversity of two introduced *Cepaea* species using the Lviv Region as an example.

Material and Methods

From 2019 to 2024, we studied the species composition of land mollusks, as well as the phenotypic composition of *Cepaea* species near 12 garden centres in Lviv City and the Lviv Region, operating or recently closed. Their symbols, coordinates and brief descriptions are given below. First of all, we inspected the areas along the fences of the garden centres (Figure), where thujas or other ornamental plants were often planted. Then we explored some of the surrounding areas where the mollusks could reach from the garden centres due to own locomotor activity: small wastelands, tree and shrub thickets, etc.

Bi — Birky village, near the Lviv ring road, 49.910778 N 23.902472 E, 2024. The Kazkovy Sad garden centre was registered in 2007 and positions itself as a garden centre for ornamental plants, selling saplings and seed material from the best nurseries in Europe and Ukraine (details are not specified).

Br — Briukhovychi urban-type settlement near Lviv City, 49.922806 N 23.982778 E, 2023–2024. The Zeleny Ostriv garden centre, another name is the orna-

Figure. Examples of studied areas along garden centre fences: *a* — Lviv (Lv3), *b* — Lviv (Lv1), *c* — Chyshky (Ch), *d* — Pidbirtsi (Pi), *e* — Horodok (Ho), *f* — Birky (Bi)

mental plant nursery Hamulets, was founded in 2016. It sells only plants grown in its own nursery.

Ch — Chyshky village, near the Lviv ring road, 49.801972 N 24.161028 E, 2023–2024. Garden centre and nursery of the company Plantpol-Ukraine, founded in 2003 with the participation of the Polish company Plantpol. The main part of the territory is occupied by greenhouses.

Da — between Davydiv village and the Lviv ring road, 49.766750 N 24.108361 E, 2021 and 2024. The garden centre GalSad was founded in 2005 and initially imported ornamental plants from Poland, then also from other European countries (Germany, Hungary, the Netherlands).

Ho — Horodok town, 49.792500 N 23.717278 E, 2023. A large nursery (55 ha) and garden cenre of the company Elit Flora, specialising in the cultivation of ornamental plants in soil and containers. The company was founded in 2006, and the nursery was laid out in 2007. Information on possible import of plants from other European countries is not available.

Lv1 — Lviv City, between Ivan Chmola Street and Luhanska Street, 49.813083 N 24.023556 E. The site has been periodically observed since 2019, when a large population of *C. nemoralis* was discovered here (Gural-Sverlova et al., 2021). Until 2018, this area housed a large garden centre from Ahrokultura Zakhid LLC, which then moved to the village of Yampil near Lviv. This was one

of the first garden centres in the Lviv Region, which began to import ornamental plants from abroad.

Lv2 — Lviv City, Khutoryvka Street near the entrance to the Shuvar market, 49.799583 N 24.035500 E, 2020–2024. A small retail outlet selling garden and ornamental plants in containers, which closed in 2023, and the wasteland next to it.

Lv3 — Lviv City, Horodotska Street, 49.830639 N 23.966056 E, 2022–2024. The garden centre of Svityaz LLC, which sold seeds, flower bulbs, seedlings of garden and ornamental plants and closed in 2022. The Svityaz company specialises mainly in seed production and cooperates with producers from many other European countries (Germany, France, Italy, the Netherlands, the Czech Republic, Slovakia, Poland, Moldova).

Lv4 — between Lviv City and Sokilnyky village, 49.793306 N 23.980083 E, 2023–2024. The garden centre is owned by Green Port Lviv LLC, which separated from the GalSad company (see above) and was registered in 2019. Among the importing countries are Poland and Italy.

Ma — Malekhiv village, 49.883083 N 24.075417 E, 2022–2024. The garden centre Decorative Plants specialises in growing and selling garden and decorative plants. Information about possible import of plants from other European countries is not available.

Pi — Pidbirtsi village, 49.841722 N 24.151639 E, 2021 and 2024. The garden centre of the Plants Club company, founded in 2008. The company has its own nurseries (more than 30 ha), imports plants from Poland, Germany, the Netherlands and Italy, and maintains partnerships with many nurseries and garden centres from other administrative regions of Ukraine.

St — on the outskirts of the town of Stebnyk, along the road from Drohobych to Truskavets, 49.309139 N 23.507444 E, 2023–2024. The ZelenSad garden centre, another name Green Market Truskavets, has been growing and selling ornamental plants for over a decade. It is possible that the garden centre imports some seedlings from Poland and Germany.

The sites were inspected during or immediately after the rains, when the molluscs were most active. Each site was examined no less than 2–3 times, at least once during the following time periods: 1) late spring or first half of summer; 2) first half of autumn. Autumn inspections were needed to find and reliably identify some species with an annual life cycle that reach maturity in late summer or autumn. In late spring or early summer, more other species could be recorded and more representative samples of *Cepaea* could be collected.

For a quantitative study of the shell colour and banding polymorphism in *Cepaea*, living adults were used, and less often, also their empty shells with well-preserved colouration. The phenotypes of *C. nemoralis* shells were identified using the standard method (Gural-Sverlova et al., 2021) and then combined into the following groups. For information on the inheritance of the colouration traits mentioned below, see Murray (1975).

Y-0 (yellow unbanded) — yellow and less-frequent white shells without dark spiral bands, as an exception with their weak traces or with one weak blurred band (modifications).

Y-1 (yellow mid-banded) — the same ground colour and only one distinct central band. Occasionally the dark band is absent (modification), but a lighter zone is visible on the shell periphery, which is absent in true (heritable) unbanded specimens.

Y-3 (yellow three-banded) — the two upper bands are completely absent, occasionally as traces or blurred. The three lower bands are distinct, may fuse together, sometimes one of them is missing.

Y-5 (yellow five-banded) — five distinct spiral bands, wich may merge to form wider stripes. Sometimes one of the bands is missing (usually the second or third from the top).

P-0, P-1, P-3, and P-5 are the same banding variations combined with a pink ground colour. The shell colour varies from orange (a combination of yellow and pink) or pale greyish pink to intense pink.

B-0 (brown unbanded) — unbanded shells with a brown ground colour of varying intensity, sometimes with a lilac or cherry tinge.

The phenotypes of *C. hortensis* were combined into similar groups, with some exceptions described below.

1) Shells with a white ground colour were considered separately from yellow ones. This is especially important for identifying populations formed by descendants of the primary introduction of *C. hortensis* into Western Ukraine (Gural-Sverlova & Gural, 2022 a).

2) The "mid-banded" group is completely absent in the west of Ukraine, and the very occasional specimens with traces of a central band are clearly modifications of the unbanded ones.

3) "Three-banded" was used to designate shells lacking the second and fourth bands (phenotype 10305), an inherited colouration form that occurs sporadically in the natural range of *C. hortensis* (Schilder & Schilder, 1957; Gural-Sverlova & Gural, 2023 a) and was recently discovered in Western Ukraine (Gural-Sverlova & Gural, 2023 a, Fig. 2).

In addition to the shell ground colour and banding, the colour of the lip (aperture margins) was noted for each adult specimen of *C. hortensis*:

wl (white lip) — white or almost white, typical for this species;

dl (dark lip) — from pink to reddish brown, in the latter case may resemble *C. nemoralis*.

Special attention was paid to such colouration traits and their combinations, which are absent in the descendants of the primary introduction of *C. hortensis* to Western Ukraine (Gural-Sverlova & Gural, 2022 a):

1) banded shells with a yellow ground colour, a combination common in natural and introduced populations of the species (see map in Gural-Sverlova & Gural, 2022 a, Fig. 8), but until recently completely absent in Western Ukraine (Gural-Sverlova & Gural, 2022 b);

2) pink or brown ground colour (Gural-Sverlova & Gural, 2022 a, Fig. 5; Gural-Sverlova & Gural, 2024, Figs 10, 11);

3) dark lip, see above (Gural-Sverlova & Gural, 2022 a, Figs 3, 4);

4) phenotype 10305, see above (Gural-Sverlova & Gural, 2023 a, Fig. 2);

5) usually well-expressed variability of the body colouration, from whitish to dark gray (almost black) in some individuals.

Western Ukrainian populations of *C. hortensis*, formed by descendants of the primary introduction, have no more than three main shell colouration variants (yellow or white unbanded, and white banded) and an exclusively light body (Gural-Sverlova & Gural, 2022 a, fig. 1).

During our study, we did not collect soil samples, so some small snails (*Vallonia*, *Cochlicopa*, etc.) may have remained undetected.

The terms "introduction" and "introduced species" are used in this paper. We consider introduced species to be any species that live outside their natural ranges, if they got there due to human activities (anthropochory), intentionally or accidentally. For invertebrates, including land mollusks, introduction is most often unintentional. Recently, the term "invasive species" has been increasingly used instead of "introduced species". However, in a stricter sense, not all alien species are invasive, but only those that harm its new environment, causing ecological, environmental, and/or economic damage. In particular, many introduced species of land mollusks in Ukraine do not penetrate into natural ecosystems and at the same time do not harm cultivated or ornamental plants. Similar definitions exist, in particular, in the present legal framework of the United States. Executive Order 13112 (1999) defines introduction as "the intentional or unintentional escape, release, dissemination, or placement of a species into an ecosystem as a result of human activity", and invasive species as "an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health". Replacing the term "introduced species" with "invaders" is also not entirely correct. Some species can penetrate beyond their natural ranges without the direct participation of people, due to own locomotor activity, passive transport by wind, water, etc.

Results

A total of 20 species of land mollusks were recorded at the studied sites, less than half of which can be considered native (Table 1). *A. vulgaris* and *C. hortensis* were present near all garden centres. *Deroceras caucasicum* (Simroth, 1901) was not found near only one of them. *C. nemoralis*, *Monacha cartusiana* (Müller, 1774), *Krynickillus melanocephalus* Kaleniczenko, 1851 and *Succinea putris* (Linnaeus, 1758) can also be considered as common. Of all the species listed above, only *S. putris* is native to Western Ukraine.

Near the studied garden centres, a wide variety of the shell colouration was recorded in *C. nemoralis*, both in terms of ground colour and banding (Table 2). The rarer brown shells were present at three sites, i.e. near every third garden centre where this species was found. Slightly more frequently, the samples contained yellow unbanded shells and pink ones with three lower bands.

Near five of the 12 garden centres, *C. hortensis* was represented exclusively by the shell and body colouration variants characteristic of the descendants of the primary introduction of this species into Western Ukraine (Table 1). In the remaining cases, phenotypic markers indicating the repeated introductions of *C. hortensis* through garden centres were found (Table 3). Most often these were yellow banded and/or pink shells, darker (grey) body pigmentation. Near four garden centres, the pink shell colour was always accompanied by an atypical colouration of the lip. Occasionally a dark lip was present in a few shells with a different ground colour. The rare phenotypes were pink shells with a white lip and brown ones regardless of the lip colour. The phenotype Y10305 was found only on the fence of the garden centre in Horodok.

Table 1. **Species composition of land mollusks near the studied garden centres**

Species	Note	Garden centres												Ng
		Bi	Br	Ch	Da	Ho	Lv1	Lv2	Lv3	Lv4	Ma	Pi	St	
Succinea putris (Linnaeus, 1758)	n	+	+	+	+	–	+	–	–	+	–	+	–	7
Merdigera obscura (Müller, 1774)	n	–	–	–	–	–	+*	–	–	–	–	–	–	1
Laciniaria plicata (Draparnaud, 1801)	n	–	–	–	+	–	+	–	–	–	+*	+	–	4
Arion vulgaris Moquin-Tandon, 1855	i	+	+	+	+	+	+	+	+	+	+	+	+	12
A. fuscus (Müller, 1774)	n	–	–	–	+	–	–	–	–	–	–	–	–	1
A. distinctus Mabille, 1868	i	–	–	–	+	–	–	–	–	–	–	–	–	1
Oxychilus translucidus (Mortillet, 1854)	i	–	–	–	–	–	+*	–	–	–	–	–	–	1
Limax maximus Linnaeus, 1758	i	–	+	–	–	–	–	–	–	–	–	–	–	1
Deroceras reticulatum (Müller, 1774)	i?	–	+	–	–	–	–	–	+	–	–	–	–	2
D. caucasicum (Simroth, 1901)	i	–	+	+	+	+	+	+	+	+	+	+	+	11
Krynickillus melanocephalus Kaleniczenko, 1851	i	+	+	+	–	+	–	+	–	+	–	+	+	8
Fruticicola fruticum (Müller, 1774)	n	–	+	+	–	–	–	–	–	–	–	+	–	3
Trochulus hispidus (Linnaeus, 1758)	n	+	–	–	–	–	+	–	–	–	–	–	–	2
Euomphalia strigella (Draparnaud, 1801)	n	–	–	–	–	–	+	–	–	–	–	+	–	2
Monacha cartusiana (Müller, 1774)	i	+*	+	+*	+*	–	–	+*	–	+*	–	+*	+*	8
Cepaea nemoralis (Linnaeus, 1758)	i	+*	–	–	+*	+*	+*	+*	–	+*	+*	+*	+*	9
C. hortensis (Müller, 1774)	i	S*	P	P*	S*	S*	S*	P	S*	S*	P*	S*	P*	12
Cornu aspresum (Müller, 1774)	i	–	–	–	+*	+*	–	–	–	+*	–	–	–	3
Helix lutescens Rossmässler, 1837	n	–	+*	+	–	–	–	–	–	–	–	+*	–	3
Helix pomatia Linnaeus, 1758	n	–	–	–	–	–	–	–	–	–	–	+*	–	1
Number of species		7	10	8	10	6	10	6	4	8	5	12	6	

i — introduced; n — native; Ng — number of garden centres near which the species was recorded; P — only the colouration variants characteristic of descendants of the primary introduction of *C. hortensis* to Western Ukraine are found; S — there are phenotypic markers of a later independent introduction(s). For the legend of garden centres, see Material and Methods. Asterisks indicate data confirmed by the stock materials of the State Museum of Natural History in Lviv.

Table 2. **Phenotypic composition of *C. nemoralis* near the studied garden centres**

Phenotypes	Garden centres, years													Ng
	Bi	Da	Da	Ho	Lv1	Lv1	Lv2	Lv2	Lv4	Ma	Pi	Pi	St	
	2023	2021	2024	2023	2019–2020	2024	2020	2023	2024	2022–2024	2021	2024	2023–2024	
Y-0	–	–	–	20	5	–	–	–	–	–	5	14	3	4
Y-1	–	1	1	14	120	11	63	24	–	–	2	19	–	5
Y-3	1	–	1	3	23	–	5	2	–	+	1	14	+	8
Y-5	+	–	6	27	291	19	–	1	–	1	5	24	–	7
P-0	–	–	14	23	73	10	–	–	–	1	8	13	2	6
P-1	–	–	3	12	66	13	18	15	–	–	3	7	1	6
P-3	–	–	–	+	27	3	8	2	–	–	2	2	–	4
P-5	–	+	3	12	127	21	–	1	1	3	–	15	+	8
B-0	–	–	–	19	–	–	13	6	–	–	–	1	–	3
Total	1	1	28	130	732	77	107	51	1	5	26	109	6	

Ng — number of garden centres near which this colouration variant is recorded. Pluses indicate phenotypes that were found only in immature snails. For other symbols, see Material and Methods.

Table 3. **Phenotypic composition of *C. hortensis* near the studied garden centres**

Colouration		Garden centres, years												Ng
Shell	Lip	Bi*	Ch	Da*	Da*	Ho*	Lv1*	Lv1	Lv3*	Lv4*	Pi*	Pi*	St	
		2023	2023–2024	2021	2024	2023	2020	2024	2022–2023	2024	2021	2024	2023–2024	
A-0	wl	3	6	–	2	–	76	37	8	2	4	2	1	8
A-5	wl	34	5	2	7	3	15	13	–	+	3	8	2	8
Y-0	wl	82	52	5	7	26	282	127	77	14	76	99	11	9
	dl*	–	–	–	–	–	–	–	–	–	1	–	–	1
Y-3*	dl*	–	–	–	–	1	–	–	–	–	–	–	–	1
Y-5*	wl	1	–	6	6	59	2	–	4	–	18	34	–	6
	dl*	–	–	–	–	7	–	–	–	–	–	2	–	2
P-0*	wl	–	–	1	–	–	–	–	35	–	–	–	–	2
	dl*	17	–	–	–	24	–	–	–	4	1	13	–	4
P-5*	dl*	–	–	–	–	7	–	–	–	1	4	13	–	3
B-0*	wl	–	–	–	–	–	–	–	–	–	3	6	–	1
	dl*	–	–	–	–	–	–	–	–	1	–	–	–	1
Total		137	63	14	22	127	375	177	124	22	110	177	14	
Phenotypic markers of secondary introductions through garden centres														
Yellow banded shell (Y-5, Y-3)*		+	–	+	+	+	+	–	+	–	+	+	–	6
Pink shell (P)*		+	–	+	–	+	–	–	+	+	+	+	–	6
Brown shell (B)*		–	–	–	–	–	–	–	–	+	+	+	–	2
Dark lip (dl)*		+	–	–	–	+	–	–	–	+	+	+	–	4
Dark (grey) body*		+	–	+	+	+	–	–	+	+	+	+	–	6

Ng — number of garden centres near which this colouration variant is recorded. Pluses indicate phenotypes that were found only in immature snails. Asterisks indicate phenotypes and traits that are not typical for descendants of the primary introduction of *C. hortensis* to Western Ukraine, as well as the garden centres near which they were found. Unlike Table 2, Y-3 here denotes phenotype 10305. For other symbols, see Material and Methods.

Discussion

So far, we have considered the potential influence of garden centres only on the dispersal of alien mollusks introduced into Ukraine from the west (Gural-Sverlova et al., 2024 a, b). This is especially logical for the Lviv Region, whose garden centres have close ties with neighbouring Poland and some other European countries, see Material and Methods. In addition to the species listed in Introduction, since 2023 we have begun to find near several studied garden centres a large land snail of Mediterranean origin, *Cornu aspersum* (Müller, 1774), introduced into many countries of the world, including other continents (North and South America, Australia). Since 2021, we have been observing this species sometimes in Lviv City and the Lviv Region, but previously we associated its spread here mainly with the activities of snail farms (Gural-Sverlova & Gural, 2021). Now we can state that the dispersal of *C. aspersum*, at least within the Lviv Region, occurs from two main sources — snail farms and garden centres, which can significantly accelerate this process. Previously, *C. aspersum* was found in garden centres and plant nurseries in Central Europe (Krumpálová & Holienková, 2018) and North America (Bergey et al., 2014).

No less important is the frequent discovery near garden centres of two small slug species of Caucasian origin, *D. caucasicum* and *K. melanocephalus*. Taking into account their size, not only egg clutches and young individuals, but also adults of these species may well remain unnoticed even in small containers with ornamental plant seedlings. Unlike the group of "western invaders", it is difficult to say how these species penetrated the system of garden centres and plant nurseries in the Lviv Region. But it is precisely the invasion of garden centres that could easily explain the rapid spread of *D. caucasicum* and *K. melanocephalus* in the central and then western parts of Ukraine, observed in recent decades (Gural-Sverlova & Gural, 2024). To confirm this hypothesis, comparative data from other administrative regions of Ukraine are needed, which are not yet available.

Not all species of land molluscs found near garden centres are directly related to their activities. Both autochthonous species and introduced molluscs that appeared in Western Ukraine no later than the second half of the 20th century (Gural-Sverlova & Gural, 2021, Table 2), could have inhabited these areas before. It is no coincidence that near some garden centres we found only limited colouration variants of *C. hortensis*, which appeared in the Lviv Region already in the second half of the 20th century (Gural-Sverlova & Gural, 2022 a, b). In other cases, the descendants of the primary introduction of *C. hortensis* into Western Ukraine and later independent introductions of this species through garden centres could have mixed. This is evidenced by the appearance of other colouration traits, both common for this species as a whole (yellow banded and pink shells, variable body colouration), and more rare and/or sporadically occurring even in the natural range of *C. hortensis* (brown shells, dark lip, phenotype 10305) (Gural-Sverlova & Gural, 2022 a, 2023 a). Such a mixture of descendants of different "waves" of introduction is now known for the Lviv (Gural-Sverlova & Gural, 2022 b) and Ternopil Regions (Gural-Sverlova & Gural, 2023 a).

It is especially interesting that the atypical lip colouration in *C. hortensis*, associated mainly with the pink shell ground colour, was recorded by us near four garden centres. Garden centres in the Lviv Region compete rather than cooperate with each other. There are also no common bases where seedlings brought from abroad could be initially delivered. Therefore, it can be assumed that different garden centres may have common sources of supply abroad, for example in neighbouring Poland, where the mentioned trait is locally found (Ożgo, 2010).

An attempt to introduce *C. nemoralis* to Lviv was made already at the end of the 19th century (Łomnicki, 1899). However, by the end of the 20th century, only one population of this species was reliably known in Western Ukraine, with a small number of individuals and limited phenotypic composition, living in one of Lviv's parks (Sverlova, 2002). A greater variety of colouration traits and their combinations can now be found near garden centres in the Lviv Region. This explains well not only the increasing occurrence of *C. nemoralis* in Lviv and its surroundings (Gural-Sverlova et al., 2024 a), but also the considerable variability in the phenotypic composition of this species in recently inhabited areas (Gural-Sverlova et al., 2021). Already Boettger (1926) wrote about the strong influence of horticulture on the dispersal of *C. nemoralis*.

Even such a rare colouration trait in *C. nemoralis* in Lviv and its immediate surroundings as the brown shell ground colour (Gural-Sverlova et al., 2021, 2024 a) can be found somewhat more frequently near garden centres. Firstly, there is a high probability of repeated introductions from one or more sources, as well as the import of large batches of invaded seedlings. Secondly, during subsequent random transport of mollusks from garden centres to household plots and other sites, rarer phenotypes are more likely to be missing among founder individuals. It is no coincidence that the colouration variants of *C. hortensis* found in small numbers near single garden centres (brown shells with a white lip in Pidbirtsi, the phenotype 10305 in Horodok) have not yet been found in other areas we studied in Lviv City and the Lviv region.

M. cartusiana, which was unknown in the Lviv Region until 2000 (Gural-Sverlova & Gural, 2021, table 2), may be frequently found near garden centres for another reason (Gural-Sverlova & Gural, 2023 b). Like some other land snails (Aubry et al., 2006) inhabiting open dry biotopes (including roadsides), motor transport may play an important role in the spread of *M. cartusiana* (Trautner, 2000; Kurek & Najberek, 2009; Gural-Sverlova & Gural, 2023 b). The rapid dispersal of *M. cartusiana* from the south to the more northern regions of Ukraine (Balashov & Markova, 2023; Gural-Sverlova & Gural, 2023 b) could have been caused by the increase in transport traffic, especially the significant increase in the number of private cars, in combination with global warming.

Judging by the species composition of land mollusks found on their periphery, garden centres of the Lviv Region have played and will continue to play an important role in the dispersal of such dangerous pests as *A. vulgaris* and *D. caucasicum*. Both species are capable of quickly reaching high numbers and damaging a wide range of cultivated and ornamental plants, which in particular is confirmed by our personal observations in the Lviv Region. A negative, although not so pronounced, effect may be caused by the spread of *C. aspersum* and possibly *K. melanocephalus* (von Proschwitz, 2020).

Conclusions

Our study confirms that garden centres and plant nurseries may play an important role in the rapid spread of some introduced species of land mollusks, recently observed in different parts of Ukraine. In the Lviv Region, this applies primarily to *A. vulgaris*, *D. caucasicum*, *K. melanocephalus*, and *C. nemoralis*, the first two of which are dangerous pests. Another species, *C. hortensis*, had already spread widely throughout Lviv City and the Lviv Region by the end of the 20th century, before the current garden centres were founded. However, we are now seeing the penetration of various hereditary variants of the shell colouration of this species through regional garden centres, which were absent in the descendants of its primary introduction to Western Ukraine.

A similar set of species may be dispersed from garden centres throughout Western and Central Ukraine. However, to obtain a more complete picture in the future, it would be desirable to compare our results with similar data from other administrative regions. One of the regional peculiarities may be the infiltration of some garden centres in the Lviv Region by carriers of such a rare and locally occurring hereditary trait as a dark lip in *C. hortensis*.

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