



## The spreading of the Brown Lipped Snail, *Cepaea nemoralis*, in the Czech Republic

Libor Dvořák<sup>1</sup> and Alois Honěk<sup>2</sup>

<sup>1</sup>Šumava National Park Administration, Sušická 399, 34192 Kašperské Hory, Czech Republic;  
libor.dvorak@npsumava.cz

<sup>2</sup>Research Institute of Crop Production, Ruzyně 507, 16106 Praha 6, Czech Republic; honek@vurv.cz

Received November 10, 2003

Accepted March 25, 2004

**Abstract.** *Cepaea nemoralis*, a species widely distributed in western Europe and north and south of the territory of the Czech Republic. Here it was first observed in 1890s and since then it has been recorded many times, perhaps not only because of the greater surveying intensity but also due to spreading of the species distribution. The number of the known localities was increased nearly twice only since 1989. The main direction of spread of the area of *C. nemoralis* “continuous” distribution is from the north-west to south-east. The number of isolated localities in the rest of the territory was also increased. The spread may be supported by human activities.

■ Gastropoda, Helicidae, *Cepaea nemoralis*, distribution, spreading, Czech Republic

### INTRODUCTION

*Cepaea nemoralis* (LINNAEUS, 1758) is a helicine species with Atlantic and Central European distribution (e.g. Ložek 1956). The species is widespread west of 14° E. North of 51° N the species area is spread far east, to Poland, Lithuania and south Sweden, and south of 48° N it extends to Hungary, Serbia, and western Ukraine. The preference for particular habitats changes as one moves from west to east. In western Europe many populations live at grassy or forest habitats while in the East the species is nearly exclusively restricted to urbane areas (Kerney et al. 1983).

Unlike west European populations whose existence may be traced for thousands of years ago (Currey et Cain 1968), populations at the territory of the Czech Republic are probably of recent origin. The species was not mentioned in the first review of Czech molluscs (Slavík 1868). Later on, the occurrence of *C. nemoralis* was reported by Uličný (1892–95), who found it at several localities. Several authors since then have published records of *C. nemoralis* (e.g. Hlaváč 1940; Petrbock 1940, 1954). All the known data were reviewed by Flasar (1989); he listed 84 localities where *C. nemoralis* has been found since late 1800s. Honěk (1995a, b) studied the geographic variation of the shell colour and band polymorphism in western Czech Republic (Bohemia) but did not provide a synthetic review of *C. nemoralis* distribution.

In this paper we summarize the published data and several new records of *C. nemoralis* distribution in the Czech Republic. From this material we attempt at investigating the direction and rate of spread of this species, which might have occurred during 1900s.

## MATERIAL AND METHODS

Data. In this work we record the occurrence of *C. nemoralis* known up to 2003. The data were retrieved from the published sources, the review compiled by Flasar (1989), and the later published studies (Honěk 1995a, b). Furthermore, the unpublished findings made by several authors are also included. The localities of *C. nemoralis* were either invented by a systematic (Honěk 1995a, b) or a random search (others). The systematic survey was limited predominantly to the western part of the Czech Republic (Bohemia). It consisted of visiting urban sites convenient for *C. nemoralis* life (cemeteries, surroundings of railway stations, old gardens, ruins). The data for the Czech Republic include those summarised by Flasar (1989), more recent published data (Honěk 1995a, b; Kovanda in Juříčková 1995; Kolouch 1997; Dvořák 1998, 1999; Flasar 1998; Juříčková 1998; Hlaváč et al. 2002; Dvořák et al. 2003) and unpublished data collected by the authors and several collaborating persons (Appendix 1).

Mapping. The geographic distribution of localities was plotted onto a standard reference grid of the Czech Republic. In order to investigate geographic increases in the distribution (=spreading) of *C. nemoralis*, the territory of the Czech Republic was divided into northern ( $>50^\circ$  N), central ( $49\text{--}50^\circ$  N) and southern ( $<49^\circ$  N) zones. Each zone was divided into  $1^\circ$  N  $\times$   $1^\circ$  E rectangles, then grid quadrants were laid onto these rectangles. The number of quadrants at least partly situated within the Czech territory was counted for each rectangle. The number of quadrants containing at least one locality of *C. nemoralis* was determined for three periods, before 1950, between 1950–1989, and 1989–2003.

Testing the species spread. The probability of finding *C. nemoralis* was calculated for each rectangle as (number of quadrants with *C. nemoralis*)/(total number of quadrants in the rectangle). The average probability for each zone was derived from the arithmetic mean of the probabilities of rectangles belonging to this zone. The differences between the zones were tested, separately for each time period, by one-way analysis of variance (ANOVA) with probability of finding *C. nemoralis* in particular rectangles as replicates and zones as factors.

## RESULTS

### Present distribution

The present distribution in the Czech Republic is patchy. The presence of *C. nemoralis* was recorded in 107 squares. The species distribution over the Czech territory is uneven (Fig. 1). The area of “continuous” distribution extends in the north-west of the country. The boundary of this area could be traced rather precisely (Honěk 1995a, b). Approximately it extends between  $13^\circ50'$  E and  $15^\circ20'$  E, north of  $50^\circ24'$  N; between  $15^\circ20'$  E and  $16^\circ00'$  E this area extends south to  $50^\circ00'$  N. Beyond the edge of the area of “continuous” distribution the species was found at localities over the whole territory of the Czech Republic. Clusters of several localities were found in central Bohemia ( $50^\circ00'\text{--}50^\circ12'$  N,  $13^\circ40'\text{--}14^\circ30'$  E), and southern ( $48^\circ42'\text{--}49^\circ10'$  N,  $16^\circ40'\text{--}17^\circ00'$  E), central ( $49^\circ36'\text{--}49^\circ54'$  N,  $17^\circ50'\text{--}18^\circ10'$  E) and eastern Moravia ( $49^\circ36'\text{--}49^\circ54'$  N,  $17^\circ50'\text{--}18^\circ30'$  E).

The species distribution is patchy because most *C. nemoralis* populations live close to the anthropogenous biotopes. Only rarely they occupy sites away from interior of human settlements, particularly railroads, roadsides, isolated cemeteries (Honěk 1995a, b) or

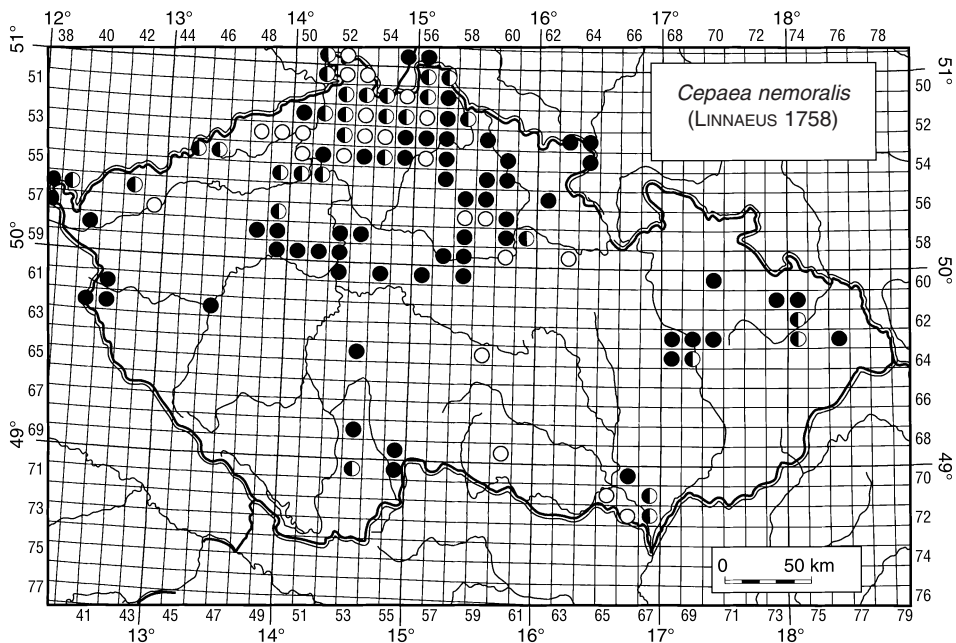


Fig. 1. Distribution of *Cepaea nemoralis* in the Czech Republic. Explanations: empty circle – distribution known in 1950, half circle – extended distribution up to 1989, full circle – extended distribution up to 2003.

banks of ponds (Dvořák 1998). A small living population was observed in the cellars of the castle of Skalná, in 1996–1999 (Dvořák 1999). This population became extinct after the reconstruction of the castle, and no specimen was found on February 4, 2003 (L. Dvořák, unpubl.). On the territory of the Czech Republic, *C. nemoralis* lives at low altitudes, mostly below 500 m a.s.l. The highest locality was Pavlův Studenec, at 730 m a.s.l.

### Spreading of species distribution in the past

The area where species was found increased since its first report by Uličný (1892–95), who established the presence in 5 quadrants of the mapping grid system. Until 1950 the species was known from several quadrants (Fig. 1). Between 1950 and 1989, several new localities were added. Flasar (1989) reported the species presence from dozens new quadrants, including the new data and earlier established localities verified after 1950. We added three unpublished quadrants established in early 1970's (see Appendix 1) into data belonging to the period before 1989 (Fig. 1). According to Honěk (1995b) and other collectors, occurrence of *C. nemoralis* was established in many new quadrants after 1989. Currently the species is thus known from more than 100 quadrants (Fig. 1).

The direction and rate of *C. nemoralis* spread could be seen from the distribution in different periods. Since before 1950, the species remained most abundant in the northern part of Bohemia (zone >50° N). But even here, the probability of finding a quadrant containing *C. nemoralis* locality increased nearly four times (Table 1). The probability of finding *C. nemoralis* in the central and southern zones of the country also increases, although in 2003 it remained 3.5–4.8 times smaller than in the north. The increase was greatest in central zone (49°–50° N) where the probability of finding *C. nemoralis* had

**Table 1.** Change in proportion of the geographic grid squares ( $\pm$  SE) where *C. nemoralis* was established before 1950, between 1950–1989, and after 1989 until 2003. The territory of the Czech Republic is divided into three latitudinal zones each of which includes N of  $1^\circ$  N  $\times$   $1^\circ$  E geographic degree rectangles (completely or in part).

Latitude	N	Before 1950	1989	2003
>50° N	6	0.066 $\pm$ 0.023	0.109 $\pm$ 0.042	0.248 $\pm$ 0.090
49–50° N	7	0.005 $\pm$ 0.005	0.011 $\pm$ 0.009	0.070 $\pm$ 0.019
<49° N	5	0.022 $\pm$ 0.022	0.041 $\pm$ 0.032	0.052 $\pm$ 0.043
Total	18	0.030 $\pm$ 0.011	0.052 $\pm$ 0.019	0.124 $\pm$ 0.038

increased 14.0 times since 1950. In contrast, in the southern zone (<49° N), the probability increased only 2.4 times. This is an indirect indication of the gradual spread of *C. nemoralis* distribution from north to south, first to the central then to the southern parts of the country. This spread of populations gradually smoothed the geographic differences in *C. nemoralis* distribution between the zones, which were substantial before 1989 but became no longer statistically significant in 2003 (Table 2).

**Table 2.** Significance of differences in proportion of the geographic grid squares occupied by *C. nemoralis* between the latitudinal zones dividing the Czech Republic.

	Effect				Error	
	df	MS	df	MS	F	p
1950	2	0.286	15	0.059	4.88	0.023
1989	2	0.379	15	0.103	3.69	0.050
2003	2	0.642	15	0.203	3.16	0.071

## DISCUSSION AND CONCLUSIONS

### The fact of spreading *C. nemoralis* area

We demonstrated an increasing number of localities occupied by *C. nemoralis* since its first finding at the territory of the Czech Republic, in 1890s (Uličný 1892–95). This trend was indicated by earlier data (Honěk 1995a), but in the last years the species area apparently spreads more rapidly than before. Does this spread only reflect an increasing amount malacological faunistic investigation or the area of *C. nemoralis* distribution really increases? With regard to a number of distinguished malacologists that investigated the territory of the Czech Republic before 1950 (see Ložek 1956 for review) it seems very improbable that the limited distribution established by earlier authors is an artefact caused by systematic overlooking of the species presence. Several authors intensively studied the area of central Bohemia (see comments in Ložek 1956) but did not mention the species presence, although its occurrence is very conspicuous. This indicates that the increasing number of localities where *C. nemoralis* was found could be attributed to an increase of the area of species distribution. *C. nemoralis* is apparently in the course of spreading, and the area of its distribution in the Czech Republic is expanding.

Human activity may be an important factor in the species dispersal. Honěk (1995a) suspected two means of *C. nemoralis* spread: railway transport and marketing of potted plants. This conjecture was based on a standard association between *C. nemoralis* populations and railway stations and cemeteries where potted plants were exposed.

In western Europe, *C. nemoralis* do not spread because of its origin area of distribution

and its occurrence on natural biotopes. The situation in the surrounding countries in central Europe is similar to the Czech Republic. The species probably spreads in southeast or east direction in Hungary (Domokos 1996, Nacsá 2003) and in Poland (M. Ozgo – pers. comm.), but no locality has been established in Slovakia.

### Direction of spreading

In the Czech Republic the distribution in northern Bohemia apparently continues *C. nemoralis* distribution in eastern Germany and southwest Poland. The populations of northern Moravia are probably contiguous with those found in Upper Silesia. The absence of geographic barriers and frequent communication between people on both sides of the boundary may favour initial spread of the species into the territory of the Czech Republic.

Between 1950 and 2003 the species area spreaded from northwest to southeast. Any other directions of spreading and origin of isolated populations in the south and east of the Czech Republic are difficult to trace. The connection with populations of Western Europe is difficult. Along the western and southwestern boundary of the Czech Republic indigenous populations are separated from the populations of Germany and Austria by mountain ranges (Ore Mts., Český Les Mts., and the Bohemian Forest). Of course, some populations might cross these barriers (e.g. those established along the Eger river or those found near Tachov). Some localities in south Bohemia and Moravia could be contagious with those of Upper Austria. However, we suppose that most of the dispersed populations originated by random drift between indigenous populations assisted by human activities.

### ACKNOWLEDGEMENTS

The authors would like to thank all colleagues who have provided their unpublished data, namely to O. Ditrich, M. Hrabáková, L. Juříčková, M. Malcová, M. Maňas, M. Mergl, P. Kment, J. Straka, A. Rafajová, P. Tučková, B. Urbánková, V. Vávra, J. Hlaváč and V. Vrabec. The authors also thank M. Horský for excerpt of the dates from the National Museum in Prague (curator K. Neumanová) and from the Silesian Regional Museum in Opava (curator B. Beneš). Other thanks belong to J. Hlaváč for preparing of Fig. 1. The work of A. Honěk was supported by grant no. M 01-01-03 of the Ministry of Agriculture of the Czech Republic.

### REFERENCES

- Currey, J. D., Cain, A. J. (1968): Studies on *Cepaea* IV. Climate and selection of banding morphs in *Cepaea* from the climatic optimum to the present day. – Philosophical Transactions of the Royal Society of London B 253: 483–489.
- Domokos, T. (1996): Javaslat a még nem védett közép-európai montán Gastropodák, valamint a *Cepaea nemoralis* és a *Cepaea hortensis* fajok védettségre [Proposal for reservation of Central European mountain gastropods, as well as *Cepaea nemoralis* and *Cepaea hortensis*]. – Malakológiai Tájékoztató, 15: 53–59. (In Hungarian).
- Dvořák, L. (1998): Páskovka hajní (*Cepaea nemoralis* L.) v jižních Čechách [*Cepaea nemoralis* in Southern Bohemia]. – Sbor. Jihočes. Muz. v Čes. Budějovicích, Přír. Vědy 38: 18. (In Czech).
- Dvořák, L. (1999): Malakofauna sklepů, štol a jeskyní západních Čech a oblasti Šumavy [Molluscs of cellars, galleries and caves of West Bohemia and of the Bohemian Forest Region]. – Silva Gabreta, 3: 141–154. (In Czech).
- Dvořák, L., Ditrich, O., Juříčková, L. (2003): New records of three ruderal snail species (Mollusca: Gastropoda) in South Bohemia. – Sbor. Jihočes. Muz. v Čes. Budějovicích, Přír. Vědy, 43: 111–113.
- Flasar, I. (1989): Die Verbreitung der Schwarzmündigen Bänderschnecke *Cepaea (Cepaea) nemoralis* (L., 1758) in der Tschechoslowakei (Gastropoda, Stylommatophora: Helicidae). – Malakologische Abhandlungen, Staatliche Museum für Tierkunde in Dresden, Band 14, 13: 111–117.
- Flasar, I. (1998): Die Gastropoden Nordwestböhmens und ihre Verbreitung. – Heldia, München, 3: 1–210.
- Hlaváč, J. Č., Horský, M., Beran, L., Dvořák, L., Juříčková, L., Vrabec, V. (2002): Měkkýši Českého lesa – I.

- Vybrané lokality v severní části (západní Čechy) [Molluscs of the Český Les Mts – I. Selected localities in the northern part (Western Bohemia)]. – *Silva Gabreta*, 8: 205–228. (In Czech).
- Hlaváč, V. F. (1940): Nový výskyt druhu *Tachea nemoralis* L. v zemi České [New finding of *Tachea nemoralis* L. in Bohemia]. – *Časopis Národního Musea, řada přír.*, 114: 228–229. (In Czech).
- Honěk, A. (1995a): Geographic distribution and shell colour and banding polymorphism in marginal populations of *Cepaea nemoralis* (Gastropoda: Helicidae). – *Malacologia*, 37 (1): 111–122.
- Honěk, A. (1995b): Distribution and shell colour and banding polymorphism of the *Cepaea* species in Bohemia (Gastropoda: Helicidae). – *Acta Soc. Zool. Bohem.*, 59: 63–77.
- Juříčková, L. (1995): Měkkýší fauna Velké Prahy a její vývoj pod vlivem urbanizace [Molluscan fauna in the territory of Prague agglomeration and its development in urban influence]. – *Natura Pragensis – studie o přírodě Prahy*, 12: 1–212. (In Czech).
- Juříčková, L. (1998): Měkkýší Hradce Králové [Molluscs of Hradec Králové (East Bohemia, Czech Republic)]. – *Acta Musei Reginaehradecensis, series A – scientiae naturales*, 26: 101–172. (In Czech).
- Kerney, M. P., Cameron, R.A.D., Jungbluth, J.H. (1983): *Die Landschnecken Nord- und Mitteleuropas*. – Verlag Paul Parey, Hamburg und Berlin, 384 pp.
- Kolouch, L. R. (1997): Měkkýší (Mollusca) lokality „Na Plachtě“ v Hradci Králové [Molluscs in the locality “Na Plachtě”, Hradec Králové]. – *Acta Musei Reginaehradecensis, series A – scientiae naturales*, 25: 69–74. (In Czech).
- Ložek, V. (1956): Klíč československých měkkýšů [Key of Czechoslovak Mollusca]. – Vydavatelstvo Slovenskej Akademie Ved, Bratislava, 437 pp. (In Czech).
- Nacsá, K. (2003): Adatok Nagymágoos (DS 55, 56, 65, 66) és környéke malakofaunájához [Contribution to the knowledge of the malacofauna of Nagymágoos and its environs (DS 55, 56, 65, 66)]. – *Malakológiai Tájékoztató*, 21: 83–92. (In Hungarian).
- Petrbok, J. (1940): Monografická studie českých měkkýšů rodu *Tachea* a *Eulota* [Monograph of the Czech molluscs of the genera *Tachea* and *Eulota*]. – *Rozpravy II. Třídy České Akademie* 50 (13): 1–30. (In Czech).
- Petrbok, J. (1954): *Tachea nemoralis* Linné v Podmoklech [*Tachea nemoralis* Linne in Podmokly]. – *Časopis Národního Musea, řada přír.*, 123: 225. (In Czech).
- Slavík, A. (1868): Monografie českých měkkýšů zemských i sladkovodních [Monograph of Czech Land and Water Molluscs]. – *Archiv pro přírodovědecké prozkoumání Čech*, I (4): 79–135. (In Czech).
- Uličný, J. (1892–95): Měkkýší čeští [Czech molluscs]. – F. Šimáček, Praha, 208 pp. (In Czech).

## APPENDIX

### *C. nemoralis* distribution – unpublished data

- |   |   |
|---|---|
| 5254: Stráž pod Ralskem, alder woodland near the pond, May 17, 1995, L. Dvořák.   | 5352: Blíževedly, introvillan, August 7, 2004, P. Kment.  |
| 5256: Janov nad Nisou, affluent of the Lužická Nisa River, 2001, L. Juříčková; Liberec, Štefánikovo náměstí square, April 13, 2003, L. Dvořák; Liberec, Truhlářská Street, April 14, 2003, L. Dvořák. | 5738: Lužní Potok creek by Pstviny, village ruins, August 5, 2003, L. Juříčková.  |
| 5257: Janov nad Nisou, intravillan, 2001, L. Juříčková.   | 5848: Lišany, Pražská Street, roadside, July 7, 2002, A. Honěk.   |
| 5354: Mimoň, by the wall near the park, May 16, 1995, L. Dvořák.  | 5852: Bořanovice, a descent, summer 2002, B. Urbánková.   |
| 5450: Žalhostice, railroad 200 m NW the railroad station, October 10, 1999, P. Šmarďa (det. M. Horsák).   | 5853: Podolanka, by the patch between the fields, October 21, 2000, M. Hrabáková. Praha 10–Horní Počernice, garden, 2003, J. Straka.                              |
| 5638: Růžové Údolí by Hranice, alder woodland with willow in the creek alluvial in the village, August 5, 2003, L. Juříčková.   | 5949: Ploskov, grounds of an estate, September 22, 2003, L. Dvořák et P. Tučková; Luby, ruins easterly of a village, September 22, 2003, L. Dvořák et P. Tučková. |
|   | 5951: Praha-Ruzyně, Stochovská street, roadside, June 4, 1999, A. Honěk.  |

- 5952: Praha, Budějovická underground station – SKY club Brumlovka env., March 24, 2001, V. Vrabec. May 7, 2003, L. Dvořák; Praha 11-Jižní Město II, building ground of the SIP, September 7, 2001, V. Vávra (det. J. Hlaváč); Praha 11-Jižní Město I, Květnového Vítězství Street 1554, school garden, October 10, 2002, V. Vávra (det. J. Hlaváč).
- 5957: Kolín, garden of the house opposite the private grammar school, 1996, V. Vrabec.
- 5958: Chvaletice, garden of the house Nr. 231, 1996 and 1997, A. Rafajová.
- 6052: Praha-Lahovičky, garden in grounds of Autobenex company, N of inflow of Berounka River to Vltava River, February 7, 2004, J. Hlaváč.
- 6054: Vyžlovka, garden alpinum, June 23, 1996, A. Honěk; motorway D1, 17 km from Prague, grassy dike, July 22, 2003, L. Juříčková.
- 6056: Zásmyky, intravillan, February 2, 1992, V. Vrabec.
- 6070: Bruntál, garden in Žlutý Kopec street, behind the tunnel, 1998, P. Tučková.
- 6173–74: Pustá Polom, May 1998, L. Gembal, coll. Silesian Museum Opava.
- 6240: Pavlův Studenec, remnants of the ancient village, July 5, 1999, A. Honěk.
- 6246: Plzeň-Bory, Bettinger street, ruins, 1998, M. Mergl.
- 6368: Střeň, intravillan near the house Nr. 78, March 25, 2003, M. Mañas.
- 6369: Olomouc-Černovír, nearby the allotted gardens, March 8, 2003, M. Mañas.
- 6370: Hlubočky, side ditch in a valley of Trnava stream, autumn 1992, M. Mañas.
- 6376: Frýdek-Místek, bushes in S part of Místek in the 1. máje street, July 10, 2003, L. Dvořák.
- 6468: Slatinice, cemetery entrance, April 26, 2001, A. Honěk.
- 6469: Olomouc, Heyrovského street fore the garages, November 5, 1994, M. Mañas; Olomouc-Nové Sady, housing estate, April 26, 1999, M. Mañas; Olomouc-Slavonín, allotted gardens, July 25, 2002, M. Malcová.
- 7066: Hustopeče, behind the bus station nearby the hospital, June 2003, M. Straka (det. M. Horský).
- 7167: Podivín, side ditch, August 14, 1975, O. Ditrich; Ladná, railroad nearby the station, July 2, 1973, O. Ditrich.
- 7266: Lednice, castle park, May 15, 1971, July 9, 1972, July 2, 1973, August 14, 1975, O. Ditrich.
- 7267: Břeclav, the Thaya River alluvium, September 3, 1973, O. Ditrich; Poštorná, the Thaya River alluvium, April 8, 1974, O. Ditrich.