

Habitats of *Vipera berus nikolskii* in Ukraine

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Abstract. In one of the best-known parts of its distribution range (eastern and central Ukraine), *Vipera berus nikolskii* inhabits ecotones of broad-leaved forests connected with river banks. Sometimes, normally close to such forests and particularly towards the southern border of its range, *V. b. nikolskii* occurs in flood-plain deciduous forests or bogs inside pine forests on sandy, alluvial river terraces. Exceptionally, *V. b. nikolskii* can also exist on steppe slopes with bushes and sparse trees. Common syntopic species recorded were *Anguis fragilis*, *Lacerta agilis*, *Natrix natrix* and *Coronella austriaca*; more rarely encountered were *Zootoca vivipara* and *L. viridis*, and extremely rare was *Viper renardi*. The structural components of the *V. b. nikolskii* habitats had much in common with those of *V. b. berus*, however, there is great overlap between the preferred habitats of these two subspecies. Differences in habitat selection may reflect different habitat availability within their ranges, but despite their general habitat overlap they remain ecologically separated in the contact zones. This could be interpreted as competitive exclusion with a subsequent shift of their ecological optima. Alternatively, *V. b. nikolskii* could have had a temporal advantage in persisting in broad-leaved forests and better abilities to colonize new territories as compared with *V. b. berus* which on contrast might have arrived later on from more northern and western Pleistocene refugia.

Introduction

Nikolsky's viper was described as a full species – *Vipera nikolskii* Vedmederja, Grubant et Rudaeva, 1986 – but is now considered as a subspecies of the Common Adder, *V. berus nikolskii*, distributed in the forest-steppe zone of Eastern Europe from Moldova to Tatarstan (Milto & Zinenko 2005). Differences between the habitats of *Vipera berus berus* Linnaeus, 1758 and *V. b. nikolskii* were mentioned already in the first paper on the taxonomic status of *V. b. nikolskii* (Grubant et al. 1973), but until now only very sparse data have been published. They concern the connection with broad-leaved forests of the right banks of rivers in Eastern and Central Ukraine (Grubant et al. 1973; Vedmederja et al. 1986; Strelkov 1997) and other parts of its range: Moldova (Tsurkanu 2006), southwestern Ukraine (Tabachishin & Shljakhtin 2003), various regions in Russia (Bozhansky 2001; Tabachishin et al. 2003; Sokolov 2005) and in the whole range (Milto & Zinenko 2005); connection to different biotopes and landscapes between *V. b. berus* and *V. b. nikolskii* in contact zones (Loparev & Sytnik 2003; Sytnik & Loparev 2003; Loparev & Sytnik 2004; Zinenko 2004).

The aim of this paper is to give more detailed description of *V. b. nikolskii* typical habitats in Central and Eastern Ukraine, which are the best known parts of *V. b. nikolskii* range. Thus, the description will make the comparison of habitat preferences of *V. b. berus* and *V. b. nikolskii* possible.

Materials and methods

Data on habitat structure and biotopes were collected during 1997-2004 in Central and Eastern Ukraine and the adjacent Belgorod region of Russia in a forest-steppe zone. Descriptions of the habitats in Lubny vicinities in the Poltava region were given by a personal report of O. M. Rudyk, in Slavjanogorsk vicinities in Donetsk region – by a personal report of T. I. Kotenko and literature, vicinities of Staritsa village in Volchansk district in Kharkiv region and Kochetok vicinities in Chuguev district in Kharkiv region – by personal reports of V. M. Pashkov and D. G. Strelkov. Specimens from all these localities are stored in the Museum of Nature at V. N. Karazin's Kharkiv National University (MNKNU, Kharkiv) and the Zoological Museum of National Museum of the Natural History (ZNMNH, Kyjiv) of Ukraine National Academy of Sciences. Data on the habitats of 30 populations of *V. b. nikolskii* were investigated, 23 are to the east of the Dnipro in Ukraine, 5 – to the west, 2 – in the Belgorod region of Russia. Data on the distribution and structure of forest were obtained from vegetation and forests maps of Ukraine and literature (Andrienko 1977; Marynych et al. 1982; Isachenko & Shljapnikov 1989).

The conclusions concerning systematic position of the majority of the studied populations were based on the analysis of morphological variability in the redescription of *V. b. nikolskii* (Milto & Zinenko 2005) but intermediate hybrid populations were considered as belonging to one of the subspecies with closer affinity to these populations: populations in Kaniv vicinities on the right-bank of the Dnipro in Cherkasy region, in Novaja Sloboda vicinities Putivl' district, Sumy region and from vicinities of Sumy were considered as *V. b. nikolskii*; populations from the left bank of the Dnipro in Kaniv vicinities, left bank of Dnipro in Kyjiv vicinities and vicinities of Spadshchina in Putivl' district in Sumy region were considered as *V. b. berus* populations.

Results

V. b. nikolskii inhabits ecotones of open and closed biotopes with bushes (86.7%), pronounced slopes (80.0%), eroded areas (ravins, gullies – 53.3%), plenty

of dry vegetation (branches, grass – 63.3%) and fallen trees (53.3%), stubs (33.3%), rodents holes (20.0%) and southern and south-eastern or western expositions. Bare rocks are absent in Ukraine forest-steppe east from the Dnipro. Dry climatic conditions prevent the development of thick layer of moss, which is also common in habitats of *V. b. berus* in Central Europe (Völkl & Thiesmeier 2002). Instead, thick layers of dead leaves provide good thermoinsulation and are a suitable substrate for spring basking.

The range of *V. b. nikolskii* almost completely coincides with the forest-steppe and broadleaved deciduous forest zones in eastern and central Ukraine (the second one is very narrow and fragmented in eastern Europe). Localities of *V. b. nikolskii* (86.7% of the populations) are strictly connected with large areas of prevailing type of natural forests in the forest-steppe zone: broadleaved deciduous oak forests on the water sheds and upwarded right banks of the rivers Ingulets', Dnipro, Udaj, Khorol, Sejm, Psel, Vorskla, Siversky Donets' with tributaries (Fig. 1). For such forests the dominance of *Quercus robur*, *Tilia cordata*, *Acer platanoides* with presence of some other tree species (*Fraxinus excelsior*, *Ulmus* sp., *Malus sylvestris*, *Pyrus communis*, etc.) is typical. West of the Dnipro in Ukraine, *Carpinus betulus* is another main tree species in such forests, but east of the Dnipro it occurs only sporadically. As a rule, the understory is represented by *Corylus avellana*, *Swida sanguinea*, *Acer tataricus*, *Euonymus verrucosa*, including grasses and herbaceous plants like *Carex* sp., *Asarum europaeum*, *Aegopodium podagraria*, *Galium* sp., *Astragalus glycyphyllos*, *Stellaria* sp., *Poa nemoralis* etc. The forest edges are usually dominated by small trees (*Betula pendula*, *Malus sylvestris*) and bushes (*Crataegus* sp., *Euonymus verrucosa*, *Ulmus suberosa*, *Prunus spinosa*). In some localities of its central range (Krasnokuts'k district of Kharkiv region, Akhtyrka and Trostjanets' districts in Sumy region) and at the southern border of distribution (in Kharkiv, Donets'k and Lugans'k regions: Kotenko 1983; own data) *V. b. nikolskii* can also live in flood-plains, in ecotones of deciduous forests or in the ecotones between wet floodplain biotopes (wet meadows or *Alnus glutinosa* forest) and a sandy terrace. In addition *V. b. nikolskii* also inhabits small bogs with *Sphagnum* hummocks and *Betula pendula* within small depressions on sandy terraces inside dry pine or mixed forests. As a rule, such populations are situated near to large typical habitats. In the vicinity of the large forests on the right bank of the Siversky Donets' river in Donets'k region

Nikolsky's viper inhabits also the slopes with chalky bare rocks, steppe and dry meadow vegetation altered with bushes and forest with oaks and endemic *Pinus cretaea* (Kotenko 1983; Zinenko & Kotenko 2005; T. I. Kotenko, personal report). However, such habitats should be considered as secondary.

Open biotopes in habitats of *V. b. nikolskii* can be more diverse than forest biotopes. Before the human transformation they consisted of dry and wet grasslands. Within cultural landscapes adders still can be abundant in ecotones of previously described forests with fields, gardens, rural building areas and pastures. Inside forests the open sites are represented by the banks of forest lakes and ponds, upper swamps, glades, clearings, and road margins.

Syntopic reptile species usually are the sand lizard (*Lacerta agilis exigua* Eichwald, 1831 or *Lacerta agilis chersonensis* Andrzejowski, 1832 – in 76,7% of all cases) and the grass snake (*Natrix natrix* L., 1758 - 60.0% of all cases). The Slow-worm, *Anguis fragilis colchicus* Linnaeus, 1758 and Smooth snake, *Coronella austriaca* Laurenti, 1768 are common (73.3% and 26.6% respectively) in the typical habitats of *V. b. nikolskii*. These four species form a specific assemblage for such biotopes. The Common Lizard, *Zootoca vivipara* (Jacquin, 1787) is only exceptionally syntopic with Nikolsky's viper (13.3%), due to its absence in deciduous water-shed forests within the investigated region. On the slopes of the right bank of the Dnipro, in the ecotones of oak-hornbeam forest with bushes, the Green lizard, *Lacerta viridis*, Laurenti, 1768 is another species syntopic with Nikolsky's viper (6.7% of all cases, but present in two of tree investigated populations of *V. b. nikolskii* on the right bank of the Dnipro). Among amphibians, usually Crested newts, *Triturus cristatus* (Laurenti, 1786), Common toads, *Bufo bufo* (Linnaeus, 1758), Tree-frogs, *Hyla arborea* (Linnaeus, 1758) and Moor frogs, *Rana arvalis* Nilsson, 1842 inhabit the same forest tracts as *V. b. nikolskii*.

Discussion

The habitats of Nikolsky's viper are characterized by the presence of ecotones, a mosaic structure, well warmed substrate with good thermo-insulating properties, open sunny places, and also eroded slopes. The connection with broad-leaved forests on watersheds and the right banks of the rivers in East-European upwarded forest-steppe and broad-leaved forest landscapes appears also very clear. Habitats of Nikolsky's viper in floodplain forests, in bogs in small depressions on alluvial sandy

Figure 1. Localities of *V. b. berus* and *V. b. nikolskii* in the central and eastern Ukraine.



terraces of the rivers or in comparatively dry slopes with bushes and sparse trees are rare and probably colonized from adjacent typical habitats. The type of the open biotope in *V. b. nikolskii* habitat is more variable than forest type and apparently is less important.

Our data have revealed significant differences in frequency of the occupied biotopes between *V. b. berus* and *V. b. nikolskii*. Thus, the typical plain habitats of *V. b. berus* in Central and Western Europe are edges of raised bogs and fens, heaths, sparse wet coniferous forests and wet mixed forests (Benson 1999; Völkl & Thiesmeier 2002). Almost the same set of biotopes exists in habitats of *V. b. berus* in European Russia and Byelorussia (Belova 1976; Pikulik et al. 1988; Bozhansky & Orlova 2001), Northern Ukraine (Grubant et al. 1973; own data). These habitat differences are present in the contact zone of *berus* and *nikolskii* and lead to a partial spatial separation (Loparev & Sytnik 2003, 2004; Sytnik & Loparev 2003; Zinenko 2004). Subspecies also differ in the preferred hibernation places: winter shelters in *V. b. nikolskii* were observed in dense oak-maple forest on eroded slopes with fallen trees and stubs (Gaidary vill., Zmijiv dist., Kharkiv reg.) and in old glades with *Corylus avellana* bushes inside dense oak-forest (Kharkiv vicinities, Strelkov D. G.,

pers. comm.). Typical winter shelters of *V. b. berus* (see Bozhansky & Orlova 2001; Völkl & Thiesmeier 2002) are not used by *V. b. nikolskii* according to our observations.

Does *V. b. nikolskii* prefer other biotopes or are these differences caused by a different set of available biotopes in the region?

Habitats overlap in the two *V. berus* subspecies. *V. b. nikolskii* can live in very humid habitats characteristic for *V. b. berus*, like edges of raised bogs and wet meadows or on the hummocks in shallow water in relict bogs of sandy alluvial terraces depressions (North-West of Kharkiv region – V. I. Vedmederja, personal report; own observations), though in our opinion such habitats are secondary. Vice versa, *V. b. berus* can, however, at least elsewhere inhabit similar habitats as *V. b. nikolskii*: e.g. ecotones of broad-leaved forest and bare rocks and heath (Southern Sweden: Andren & Nilson 1981). Thus, the observed habitat differences could be caused by other sets of available biotopes in the subspecies areas: heaths are completely absent, bogs, natural coniferous and mixed forests are extremely rare and marshes have a small area and are not numerous in forest-steppe zone of central and eastern Ukraine.

The range of *V. b. nikolskii* has different climatic characteristics when compared with that of *V. b. berus*: less annual precipitation (430-550 mm), a larger temperature range (average temperature of January: 7-8°C, average temperature of July 19-21°C) and primary equal balance between precipitation and evaporation (Marynych et al. 1985). However, a shift to more humid habitats in the region, known in the southern part of the range in *Zootoca vivipara* (Korshunov & Zinenko 2003) or *Lacerta agilis* (Sand Lizard, Jablolkow 1976) does not occur. On the contrary, the rareness of syntopy with *Zootoca vivipara* and *Lacerta viridis* to the west of Dnipro reflects the preference of more warm and dry biotopes by *V. b. nikolskii*. On the contrary, only in 3 of 14 populations of *Z. vivipara* in the Kharkiv region *V. b. nikolskii* was recorded (Zinenko, unpubl.).

The separation of the subspecies in different biotopes and landscapes in the contact zone of *V. b. berus* and *V. b. nikolskii* (Loparev & Sytnik 2003, 2004; Sytnik & Loparev 2003; Zinenko 2004) could be interpreted as competitive exclusion, due to a shift of ecological optima and possible active preferences of different habitats (ecological displacement). But the hybridization in a contact zone (Zinenko & Ruzhilenko 2003; Zinenko 2004), with a wide mutual intergradation of morphological characters (Milto & Zinenko 2005), as well as some indications of gene flow at least from *V. b. berus* to *V. b. nikolskii* (Kalyabina-Hauf et al. 2004) show that these differences in ecology and habitat preferences do not lead to the isolation of taxa. Moreover, wide introgression could also reduce ecological isolation of subspecies because of emerging of hybrids with intermediate morphological but also ecological characters.

Another explanation of subspecies habitat separation in a contact zone could be the history of colonization. Originally connected with refugia of broad-leaved forests in upwarded landscapes, *V. b. nikolskii* thus had advantages in colonization time. The Common Adder has dispersed from refugia in Central Europe (Carlsson 2003, Kalyabina-Hauf 2004) across newly formed and homogenous biotopes and has reached a forest-steppe zone when it was already inhabited by *V. b. nikolskii*, despite the comparatively higher dispersal capacities of *V. berus berus* (cf. *V. b. bosniensis* and *V. b. berus* in northern Italy: Kalyabina-Hauf et al. 2004; Ursenbacher et al. 2006).

Thus, *V. b. berus* and *V. b. nikolskii* have overlapping habitats. Together with the lack of reproductive isolation mechanisms it makes introgression possible.

Separation between different biotopes and landscapes in a contact zone most likely is caused by postglacial colonization history, but by different habitat selection and competitive exclusion due to ecological differences of subspecies can be considered as secondary factors.

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References

- Andren, C., Nilson, G. (1981): Reproductive success and risk of predation in normal and melanistic color morphs of the adder, *Vipera berus*. Biol. Journ. Linn. Soc. **15**: 235-246.
- Andrienko, T.L., Bilyk, G.I., Bradis, E.M., Golubets', M.A., Makhaeva, L.V., Rubtsov, M.I., Tkachenko, V.S., Sheljag-Sosonko Ju., R. (1977): Geobotanicheskie raionovannaya Ukrayins'koyi RSR [Geobotanical division of Ukrainian SSR]. Kyjiv, Naukova Dumka [in Russian].
- Belova, Z.V. (1976): Prostranstvennaya struktura populatsii obyknovnoĭ gadyuki (*V. berus* L.) [Spatial structure of the Common Adder population (*V. berus* L.)]. Ecol. **1**: 71-75 [in Russian].
- Benson, P.A. (1999): Identifying individual adders, *Vipera berus*, within an isolated colony in East Yorkshire. British Herpetol. Soc. Bull. **67**: 21-27.
- Bozhansky, A.T. (2001): Gadyuka Nikol'skogo, *Vipera nikolskii* Vedmederja, Grubant et Rudaeva, 1986 [Nikolsky's Viper, *Vipera nikolskii* Vedmederja, Grubant et Rudaeva, 1986]. In: Krasnaya Kniga Rossijskoj Federatsii. Zhivotnye [Red Data Book of the Russian Federation. Animals], p. 348 – 349. Moscow, Astrel' [in Russian].
- Bozhansky, A.T., Orlova, V.F. (2001): On the terminology of the Common Adder (*Vipera berus*) in spring(sic) period. In: Voprosy Gerpetologii, p. 34-35. Pushchino-Moscow [in Russian].
- Carlsson, M. (2003): Phylogeography of the Adder, *Vipera berus*. Acta Universitatis Upsaliensis. Comprehensive summaries of Uppsala Dissertations from the Faculty of Science and Technology 849. Uppsala.
- Grubant, V.N., Rudaeva, A.V., Vedmederja, V.I. (1973): O sistematičeskoj prinadležnosti černoĭ formy obyknovnoĭ gadyuki [On the systematical position of black morph of Common Adder]. In: Voprosy gerpetologii, p. 68-71. Leningrad, Nauka [in Russian].
- Isachenko, A.G., Shljapnikov, A.A. (1989): Priroda mira: Landshafty [Nature of world: Landscapes]. Moscow, Mysl' [in Russian].
- Kalyabina-Hauf, S., Schweiger, S., Joger, U., Mayer, W., Orlov, N., Wink, M. (2004): Phylogeny and systematics of adders (*Vipera berus* complex). Mertensiella **15**: 7-16.
- Korshunov, A.V., Zinenko, A.I. (2003): Peculiarities of biotopical distribution of the Common Lizard *Lacerta vivipara* in the periphery of its range (Kharkiv region). In: Biodiversity and Role of Zoocenosis in Natural and Anthropogenic Ecosystems, p. 206-207. Dnipropetrovsk: Dnipropetrovsk National University [in Russian].
- Kotenko, T.I. (1983): Reptilii levoberežnoĭ stepi Ukrainy [Reptiles of Left-bank steppe of Ukraine]. PhD Thesis. Kiev [in Russian].
- Litvinov, N., Ganshchuk, S. (2005): Environment and body temperatures of reptiles in Volga-Ural region. In: Herpetologia Petropolitana, p.

- 179–182. Ananjeva, N., Tsinenko, O., Eds., St. Petersburg.
- Loparev, S.A., Sytnik, A.I. (2003): A case of joint inhabitation of populations of *Vipera berus* and *V. "nikolskii"* within the one area and some features of their ecology. *Nature reserves in Ukraine*. 9, 1: 56-57 [in Russian].
- Loparev, S.O., Sytnik, O.I. (2004): Ekologo-prostorove spivisnuvannya dvoh form gadyuk *Vipera berus*-complex v raioni seredn'ogo Dnipro [Ecological and spatial coexistence of two morphs of adders *Vipera berus* complex in the Middle Dnipro region]. In: *Suchasni problemy zoologichnoi nauky*, p. 101-103. Kyjiv, Kyjiv University [in Ukrainian].
- Marynych, A.M., Lan'ko, A.I., Shcherban', M.I., Shyshchenko, P.G. (1982): Fyzyczna geografiya URSR [Physical geography of USSR]. Kyjiv, Vyshcha shkola [in Ukrainian].
- Piculik, M.M., Bakharev, V.A., Kosov, S.V. (1988): Reptilii Belorussii [Reptiles of Byelorussia]. Minsk, Nauka i tekhnika [in Russian].
- Prytkaya yashcheritsa. Monograficheskoe opisanie vida [Sand lizard. Monographic description of species] (1976):. Jablokov A. V., Ed., Moscow, Nauka [in Russian].
- Ruzanova, I.E., Tabachishin, V.G. (2000): Peculiarities of the Nikolsky's viper thermobiology in the North of the Lower Volga area. *Modern Herpetology*. 1: 72-75 [in Russian].
- Strelkov, D.G. (1996): Gadyuka Nikol'skogo kak ob'ekt laboratornogo sodержaniya [Nikolsky's viper as the object of laboratory keeping]. *Nauchnye issledovaniya v zoologicheskikh parkakh*. 2: 116-120 [in Russian].
- Sytnik, A.I., Loparev, S.A. (2003): Case of coexistence (sic) of *Vipera berus* and *V. nikolskii* populations and characteristic features of their ecology. Programme and abstracts. 12th Ordinary General Meeting Societas Europaea Herpetologica (SEH): 157. Saint Petersburg.
- Tabachishin, V.G., Tabachishina, I.E., Zavalov, E.V. (2003): Modern habitats and some ecological aspects of the forest-steppe viper in the north of the Lower Volga region. *Povolzhskii Ecol. Journ.* 1: 82-86 [in Russian].
- Tabachishin, V.G., Zavalov, E.V. (2003): Forest-steppe viper distribution in the south of the Podolsk [Podol'e] height. *Povolzhskii Ecol. Journ.* 2: 202-203 [in Russian].
- Tsurkanu V. (2006): On the systematic status of common adder *Vipera berus* (Linnaeus, 1758) in Moldova. Academician Leo Berg – 130. Collection of Scientific Articles: 159-163. Bendery, Eco-TIRAS.
- Urnenbacher, S., Carlsson, M., Helfer, V., Tegelström, H., Fumagalli, L. (2006): *Molecular Ecology* 15:3425-3437
- Vedmederja, V.I., Grubant, V.N., Rudaeva, A.V. (1986): K voprosu o nazvanii chernoï gadyuki lesostepi evropeïskoï chasti SSSR [On the name of the black adder in the forest-steppe zone of the European part of the USSR]. *Vestnik Khark. Univ.*, 288, 83-85 [in Russian].
- Zinenko, A.I., Ruzhilenko, N.S. (2003): About the systematic belonging of viper inhabiting the Kaniv Natural Reserve. *Nature reserves in Ukraine*. 9, 1: 51-55 [in Russian].
- Zinenko, O.I., Kotenko, T.I. (2005): Gadyuka Nikol'skogo, lesostepnaya gadyuka – *Vipera berus (Pelias) nikolskii* Vedmederja, Grubant et Rudaeva, 1986 [Nikolsky's viper, forest-steppe viper – *Vipera berus (Pelias) nikolskii* Vedmederja, Grubant et Rudaeva, 1986]. *Nature reserves of Crimea: Nature protection, biodiversity, ecodiversity*. Part 2: 139-142 [in Ukrainian].