The distribution of meadow and steppe vipers (Vipera graeca, V. renardi and V. ursinii): a revision of the New Atlas of Amphibians and Reptiles of Europe

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In some cases, species’ distributions have not been accurate and some geographical areas were not accounted for in the New Atlas of Amphibians and Reptiles of Europe (NA2RE), a project performed by the Mapping Committee of the Societas Europaea Herpetologica (SEH). The distribution of species within the Vipera ursinii-renardi group were presented jointly as a single taxon (“Vipera ursinii/renardi”), without differentiation between the meadow viper V. ursinii, the steppe viper V. renardi, and the recently described Greek meadow viper Vipera graeca. Here we present a revised 50×50 km resolution distribution map of this group with new records, eliminating putative or erroneous records and extinct populations. Additionally, we filled several spatial gaps in the distribution of V. renardi in Eastern Europe by incorporating recent regional overviews, previously considered ambiguous or inaccessible to most researchers, due to language barriers.

Key words: Biogeography, mapping, NA2RE, snake, threatened species, Viperidae.

The New Atlas of Amphibians and Reptiles of Europe (hereafter NA2RE; Sillero et al., 2014a,b) was created to present and provide accurate knowledge on the spatial distribution of amphibians and reptiles in Europe. It is the most comprehensive and up-to-date spatial database of European herpetofauna. However, exact distributions of some species groups remain unresolved (but see Wielstra et al., 2014). Species groups have often been the subject of continuous taxonomic studies and rearrangements; thus, species status of some lineages, borders of area, extent of
overlaps, and potential hybrid zones are often unknown or unrecognised (e.g. Gvoždík et al., 2010).

The distribution of viper species of the ursinii-renardi group (sometimes referred as the Acridophaga subgenus), have been jointly presented as a single taxon in NA2RE “Vipera ursinii/renardi”, including records of both the meadow viper V. ursinii and steppe viper V. renardi. The latter was not accepted previously as a full species by the Societas Europaea Herpetologica (SEH) (footnote 9 on table 3 in Sillero et al., 2014a), despite that species delimitation between V. ursinii and V. renardi had been proved or discerned (Nilson & Andrén, 2001; Ferchaud et al., 2012; Gvoždík et al., 2012). Further mitochondrial and nuclear DNA evidences also support the species status of these lineages (Zinenko et al. 2015; Mizsei et al., 2017). A recent taxonomic change has also influenced the current known distribution of this group, as the Greek meadow viper Vipera graeca, a former subspecies of V. ursinii, was elevated to the species level (Mizsei et al., 2017). Additionally, most of the distribution within the former Soviet Union is poorly understood because of the lack of accessible observation records. In fact, V. renardi, which is more common in lowland steppes, is more widespread than previously depicted in the NA2RE (e.g. Zinenko et al. 2015). Most published occurrence records are hard to find or overlooked, as they are often harboured in regional publications and written in local languages. Here, we have compiled these observations to update the map.

We revised the presence records of the group, differentiating V. ursinii, V. renardi and V. graeca in the NA2RE data (Supplementary Material) cell by cell. We have (i) identified cells with species’ presence (=1); (ii) confirmed species’ presence with available data in published or unpublished sources; (iii) added new species’ presence when we had available data for a cell previously showing species’ absence (=0); (iv) deleted species’ presence (1→0) when there was no evidence of presence (mainly by erroneous identification of species and locations); (v) changed status of cells to historical where there was no observations for the last 25 years, and provided the date of last observations; and finally (vi) we added a comment to each cell where changes were implemented. We determined the species according to recent molecular studies on meadow and steppe vipers (Ferchaud et al., 2012; Zinenko et al., 2015; Mizsei et al., 2017). Following the results of Ferchaud et al. (2012) and Zinenko et al. (2015), we treated Vipera lotiei (Nilson et al., 1995) as V. renardi s.l.

To revise the distribution we used literature sources (Sukhov, 1928; Bannikov et al., 1977; Nilson & Andrén, 2001; Vlasov & Vlasova, 2001; Dotzenko, 2003; Krečskák et al., 2003; Filippi & Luiselli, 2004; Ferri & Marconi, 2006; Ghira, 2007; Vedmederja et al., 2007; Zinenko & Bakiev, 2007; Ferri & Pellegrini, 2008; Seliunina, 2008; Kotenko & Kukushkin, 2008; 2009; Strugariu et al., 2011; Zamfirescu et al., 2012; Cogălniceanu et al., 2013; Debelo & Chibilyov, 2013; Frolova & Klimov, 2013; Jelić et al., 2013; Lyet et al., 2013; Bakiev et al., 2015; Pěchý et al., 2015; Tupikov & Zinenko, 2015; Zinenko et al., 2015; Bakiev et al., 2016; Mizsei et al., 2016); museum collections (The M. Shcherbak Zoological
Museum, National Museum of Natural History at the National Academy of Sciences of Ukraine, Kiev; The Museum of Nature at V. N. Karazin Kharkiv National University, Kharkiv, Ukraine); and records from our personal unpublished databases, and other unpublished sources (see acknowledgements). The date of each record was taken from the corresponding publication; in the case when no date was available in the text, we used the date of the publication for which it was referenced in. All records before 1992 (from 25 years ago) were considered as “historical”. After that point, with the maximum pressure from agriculture on steppic habitats of V. renardi and V. ursinii in the former USSR countries, there was temporary relief for steppic habitats, and a shift in the way of their management. Simultaneously, national Red data books and sometimes local monitoring programs started to gather

Figure 1: Revised distribution of meadow and steppe vipers in Europe.
current data about local species in newly established independent countries.

We added seven cells to the distribution of V. graeca from new populations recently discovered (Fig. 1). Furthermore, only one cell was confirmed and another one was deleted because observations suggest presence only in the neighbouring cell. We validated the presence of V. renardi in 42 cells, added 173 new cells based on published (N = 144 cells), and unpublished observations of the authors (N = 29 cells), listed 69 as historical, and deleted 6 cells (erroneous species identification in the literature; specification and correction of geographic coordinates of localities), most of them located in the north-eastern edge of the species’ distribution in Europe. However, we were unable to validate 56 cells where V. renardi is present in the NA2RE, but kept these cells as occupied in the database until these areas are further investigated. The distribution of V. ursinii (separated from the distribution of V. graeca and V. renardi) remained the same in most parts (33 cells), but we added 17 cells mainly in the Balkan Peninsula based on the comprehensive database of Jelić et al. (2013). We have changed the status of 17 cells to “historical”, mostly in Bessarabia (Ukraine, Romania, and Republic of Moldova), the eastern edge of the species range (V. ursinii ssp. moldavica). Most likely, all populations have gone extinct in these areas due to habitat alteration by agriculture. Last recorded observations of meadow viper there belong to the 1970’s, and only a few survived populations near Iasi and in the Danube Delta still existing (Krečsák et al., 2003). There are no known overlaps among the geographic ranges of the three species, thus, we consider them as allopatric; however, a contact zone may have historically existed between V. renardi and V. u. moldavica (see Fig. 1). Overall, we increased the known distribution of V. graeca by 87.5%, V. renardi by 63.8%, and V. ursinii by 34.0% in 50×50 km grid cells.

We assume that at this scale (50×50 km grids), further fieldwork may only slightly increase the currently known range of V. graeca and V. ursinii. However, it is possible to improve our knowledge of the distribution at finer scales, mostly in the reticulating mountain ranges in the Balkan Peninsula where these species live in isolated high alpine meadows that have been poorly explored. Due to the large distribution of V. renardi in Eastern Europe, which was mostly continuous in the past, there is potential for substantially extending the list of localities of these species and filling gaps in the known distribution, mostly in Southern Russia. Greater prevalence of “historical” observations (before 1992) in that region, indicates a need for contemporary surveys and consistent monitoring. Recent habitat loss, population size decrease, and population extinctions may be overlooked due to data deficiency. Northern isolated historical records in Russia may have resulted from range fluctuations in postglacial times (Zinenko & Bakiev, 2007), similarly to other reptile species in the region (Marosi et al., 2012); many of these populations are most likely to be extinct now.

All three species are threatened by past and ongoing habitat loss and fragmentation. IUCN Red List Category of V. ursinii is Vulnerable (VU) globally (Joger et al., 2009), and V. renardi is VU in Europe re-
Snakes from the Red book of the Samara area: new places of finds. Samarskaya Luka: problems of regional and global ecology 25: 129-130.

Bakiev, A.G.; Garanin, V.I.; Gelashvili, D.B.; Gorelov, R.A.; Doronin, I.V.; Zaitseva, O.V.; Zinenko, O.I.; Klyonina, A.A.; Makarova, T.N.; Malenyov, A.L.; Pavlov, A.V.; Petrova, I.V.; Ratnikov, V.Yu.; Starkov, V.G.; Shiryeva, I.V.; Yusupov, R.Kh. & Yakovleva, T.I. (2015). The Vipers (Reptilia: Serpentes: Viperidae: Vipera) of the Volga basin. Part 1. Tolyatti, Kassandra. [in Russian]

Bannikov, A.G.; Darevsky, I.S.; Ishchenko, V.G.; Rustamov, A.K. & Shcherbak, N.N. (1977). Guide to Amphibians and Reptiles of the USSR. Moscow, Prosveshchenie. [in Russian]

Cogălniceanu, D.; Rozylowicz, L.; Székely, P.; Samohâl, C.; Stănescu, F.; Tudor, M.; Székely, D. & Iosif, R. (2013). Diversity and distribution of reptiles in Romania. ZooKeys 341: 49-76.

Cox, N.A. & Temple, H.J. (2009). European Red List of Reptiles. Luxembourg, Office for Official Publications of the European Communities.

Debelo, P.V. & Chibilyov, A.A. (2013). The Amphibians and Reptiles of the Ural-Caspian region. Natural diversity in the Ural - Caspian region series. Vol. 3. Yekaterinburg, Ural branch of Russian Academy of Sciences.

Dotsenko, I.B. (2003). Catalogue of the collections of Zoological Museum, NSNHM, NAS of Ukraine. The snakes. Kiev, NSNHM.

Ferchaud, A.-L.; Urenbacher, S.; Cheylan, M.; Luiselli, L.; Jelić, D.; Halpern, B.; Major, Á.; Kotenko, T.; Keyan, N.; Crnobrnja-Isailović, J.; Tomović, L.; Ghira, I.; Ioannidis, Y.; Arnal, V. & Montgomer, C. (2012). Phylogeography of the Vipera ursinii complex (Viperidae): mitochondrial markers reveal an east–west disjunction in the Palaearctic region. Journal of Biogeography 39: 1836-1847.
Ferri, V. & Marconi, M. (2006). Vipera di Orsini, *Vipera ursinii* (Bonaparte, 1835), In R, Sindaco; G., Doria; E., Razzetti & F., Bernini (eds.) Atlante degli anfibi e dei rettili d’Italia / Atlas of Italian Amphibians and Reptiles. Societas Herpetologica Italica, Edizioni Polistampa, Firenze, pp. 606-611.

Ferri, V. & Pellegrini, Mr. (2008). Vipera di Orsini, *Vipera ursinii* (Bonaparte, 1835), In L., Di Tizio; Mr., Pellegrini; N., Di Francesco & M., Carafa (eds.) Atlante dei Rettili d’Abruzzo. Ianieri-Talea Edizioni, Pescara, pp. 184-189.

Filippi, E. & Luiselli, L. (2004). Ecology and conservation of the Meadow viper, *Vipera ursinii*, in three protected mountainous areas in central Italy. *Italian Journal of Zoology* 71: 159-161.

Frolova, E.N. & Klimov, A.S. (2013). Some morphological characters of the steppe viper (*Pelias renardi*) vicinity of museum-reserve “Divnogorye”. *Modern herpetology: problems and ways of their solutions. The first international conference of the young herpetologists of Russia and neighbouring countries. Saint-Petersburg*.

Ghira, I. (2007). Rediscovery of *Vipera ursinii rakosensis* in Transylvania. *Herpetologica Romana* 1: 77-81.

Gvoždík, V.; Jandzik, D.; Cordos, B.; Rehák, I. & Kotlík, P. (2012). A mitochondrial DNA phylogeny of the endangered vipers of the *Vipera ursinii* complex. *Molecular Phylogenetics and Evolution* 62: 1019-1024.

Gvoždík, V.; Jandzik, D.; Lymerakis, P.; Jablonski, D. & Moravec, J. (2010). Slow worm, *Anguis fragilis* (Reptilia: Anguidae) as a species complex: Genetic structure reveals deep divergences. *Molecular Phylogenetics and Evolution* 55: 460-472.

Jelić, D.; Ćirić, R.; Sterijovski, B.; Crnobrnja-Isoailovic, J.; Leilo, S. & Tomović, L. (2013). Distribution of the genus *Vipera* in the western and central Balkans (Squamata: Serpentes: Viperidae). *Herpetozoa* 25: 109-132.

Joger, U.; Crnobrnja-Isoailovic, J.; Vokrin, M.; Corti, C.; Sterijovski, B.; Westerström, A.; Kreccsák, L.; Pérez Mellado, V.; Sá-Sousa, P.; Cheylan, M.; Pleguezuelos, J. M. & Sindaco, R. (2009). *Vipera ursinii*. The IUCN Red List of Threatened Species 2009: e.T22997A9406628. Retrieved on 11/05/2016.

Kotenko, T.I. & Kukushkin, O.V. (2009). Steppe viper, *Vipera renardi* (Christ.), In I. A., Akimov ed.) *The Red Data Book of Ukraine. Animals*, Kiev, Globalkonsulting.

Kotenko, T.I. & Kukushkin, O.V. (2008). Steppe viper, *Vipera renardi* (Christ.), - a species of the Red Data Book of Ukraine. Kiev, Registration of Animals under Red Data Book of Ukraine.

Krečsák L.; Zampirescu S. & Korsős Z. (2003): An updated overview of the distribution of the Moldavian steppe viper (*Vipera ursinii moldavica*) Nilson, Andren et Joger, 1993. *Russian Journal of Herpetology* 10: 199-206.

Lyet, A.; Thuiller, W.; Cheylan, M. & Besnard, A. (2013). Fine-scale regional distribution modelling of rare and threatened species: bridging GIS Tools and conservation in practice. *Diversity and Distribution* 19: 651-663.

Marosi, B.; Zinenko, O.I, Ghira, I.V.; Crnobrnja-Isoailovic, J.; Lymerakis, P.; Sos, T. & Popescu, O. (2012). Molecular data confirm recent fluctuations of northern border of dice snake (*Natrix tessellata*) range in Eastern Europe. *North-Western Journal of Zoology* 8: 374-377.

Mizsei, E., Szabolcs, M., Dimaki, M., Roussos, S.A., Ioannidis, Y. (in press): *Vipera graeca*. The IUCN Red List of Threatened Species.

Mizsei, E.; Jablonski, D.; Roussos, S.A.; Dimaki, M.; Ioannidis, Y.; Nilson, G. & Nagy, Z.T. (2017). Nuclear markers support the mitochondrial phylogeny of *Vipera ursinii-renardi* complex (Squamata: Viperidae) and species status for the Greek meadow vipers. *Zoetaxa* 4227: 75-88.

Mizsei, E.; Úveges, B.; Vági, B.; Szabolcs, M.; Lengyel, S.; Pfiegerle, W.P.; Nagy, Z.T. & Tóth, J.P. (2016). Species distribution modelling leads to the discovery of new popula-
tions of one of the least known European snakes, Vipera ursinii graeca, in Albania. Amphi-
bia-Reptilia 37: 55-68.
Nilson, G. & Andrén, C. (2001). The Meadow and Steppe Vipers of Europe and Asia - The Vipa-
ra (Acradophaga) ursinii complex. Acta Zoologica Academiarum Scientiarum Hungaricae 47: 87-267.
Nilson, G.; Tuniyev, B. S.; Andrén, C. & Orlov, N. (1995). Systematics of the vipers of the Cau-
casus: Polymorphism or sibling species? Asian Herpetological Research 6: 1-16.
Péchy, T.; Halpern, B.; Sós, E. & Walzer, C. (2015). Conservation of the Hungarian meadow-
viper Vipera ursinii rakosiensis. International Zoo Yearbook 49: 89-103.
Seliunina, Z.V. (2008). Reptiles of the Black sea biosphere reserve in 1990-2005. Kiev, Re-
gistration of Animals under Red Data Book of Ukraine.
Sillero, N.; Campos, J.; Bonardi, A.; Corti, C.; Creemers, R.; Crochet, P.-A.; Cynobera
Isalovitc, J.; Dinoél, M.; Felcita, G.F.; Gon-
çalves, J.; Kuzmin, S.; Lymberakis, P.; de Pous,
P.; Rodríguez, A.; Sindaco, R.; Svebroeck, J.;
Toxopius, B.; Vierits, D.R. & Vences, M. (2014a). Updated distribution and biogeogra-
phy of amphibians and reptiles of Europe. Amphibia-Reptilia 35: 1-31.
Sillero, N.; Oliveira, M.A.; Sousa, P.; Sousa, F. & Gonçalves-Seco, L. (2014b). Distributed data-
base system of the New Atlas of Amphibians and Reptiles in Europe: the N2ARE project.
Amphibia-Reptilia 35: 33-39.
Strugariu, A.; Zamfirescu, S.R.; Ghergel, I.; Sahlean, T.C.; Moraru, V. & Zamfirescu, O. (2011). A preliminary study on population characteristics and ecology of the critically endangered meadow viper Vipera ursinii in the Romanian Danube Delta. Biologia 66: 175-
180.
Sukhov, G.F. (1928). Materials to the herpetofauna of Poltava region. Proceedings of Poltava state 
Museum 1: 251-256.
Tufikov, A.L. & Zinenko, O.I. (2015). Distribution of the steppe viper Vipera renardi (Reptilia, 
Viperidae) in Kharkiv region. Visnyk of Dnipropetrovsk University. Biology, Ecology 23:
172-176.
Vedmederja, V. I.; Zinenko, O.I. & Goncharenko,
L. A. (2007). Catalogue of collections of the Museum of Nature at V. N. Karazin’s Kharkiv National 
University. Snakes (Reptilia: Serpentes). Kharkiv.
Vlasov, A.A. & Vlasova, O.P. (2001). Reintroduc-
tion of the steppe viper (Vipera ursinii renardi) in forest-steppe nature reserves of the Central Chern-
ossmje. Questions of herpetology. Proceedings of the First meeting of A. M. Nikolsky Herpetological Society. pp. 57-58. Moscow, 
Puschino.
Wielstra, B.; Sillero, N.; Vörös, J. & Arntzen, W. (2014). The distribution of the crested and 
marbled newt species (Amphibia: Salamandridae: Triturus) – an addition to the New Atlas of Amphibians and Reptiles of Europe. Amphibia-Reptilia 35: 371-381.
Zamfirescu, S. R.; Strugariu, A.; Zamfirescu, O. & Ghergel, I. (2012). In situ confirmation of the occurrence of the critically endangered Moldavian meadow viper (Vipera ursinii mol-
davica) in the Ciret Vale (Iasi county, Ro-
mania). North-Western Journal of Zoology 8: 378-
381.
Zinenko, O.I. & Bakiev, A.G. (2007). About Change of the Northern Boundary of Distribution of the Steppe Viper, Vipera renardi (Reptilia, Viperidae), in European Russia. Vestnik Zoologii 41: 478.
Zinenko, O.; Stümpel, N.; Mazanava, L.; Bakiev, 
A.; Shryav, K.; Pavlov, A.; Kotenko, T.; 
Kukushkin, O.; Chikin, Y.; Dusebayeva, T.; 
Nilson, G.; Orlov, N.L.; Tuniyev, S.; Anan-
jeva, N.B.; Murphy, R.W. & Joger, U. (2015). 
Mitochondrial phylogeny shows multiple independent ecological transitions and northern dispersion despite of Pleistocone glaciations in meadow and steppe vipers (Vipera ursinii and Vipera renardi). Molecular Phyloge-
genetics and Evolution 84: 85–100.