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Legal Status and Assessment of Conservation Threats to Vipers (Reptilia: Squamata: Viperidae) of the Western and Central Balkans

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***Abstract.*—Vipers display high specific and sub-specific diversity in the Balkans, but available atlases and red data books provide no precise data about legal status and conservation threats. The three viper species in the Balkans share several conservation problems: lack of systematic study and public interest, "historical and political burdens," lack of knowledge, superstitions and fear among people, increasing urbanization, habitat destruction, illegal collection, as well as lack of adequate (or no) legislation at the country level. Here we present an overview of legal status of vipers across five countries (Croatia, Serbia, Bosnia and Herzegovina, Montenegro, and the Former Yugoslav Republic of Macedonia) and present precise information about particular conservation problems. Moreover, we propose conservation priorities and measures for each viper species in each country based on already standardized analyses. We calculated an overall index of relative environmental sensitivity. *Vipera ursinii* was indicated as a species in serious threat of decline (mean score value of 1.9) and *V. berus* as species possibly vulnerable to decline (score 1.2). *Vipera ammodytes* was indicated as species with low risk of decline (0.7). Based on these scores and previously published distribution data, we made an analysis of Important Viper Areas to indicate areas of special concern.**

Key Words.—Balkan Peninsula; conservation; legislation; vipers; Viperidae

Introduction

Vipers display high sub specific diversity in the Balkans, with two subspecies of the European Adder (*Viperus berus berus* and *V. b. bosniensis*; Ursenbacher et al. 2006), two subspecies of Meadow Vipers (*V. ursinii macrops* and *V. u. graeca*; Ferchaud et al. 2012), and three subspecies of Nose-horned Vipers (*V. ammodytes ammodytes*, *V. a. montandoni* and *V. a. meridionalis*; Tomović 2006; Ursenbacher et al. 2008; Fig. 1). Vipers are venomous and relatively secretive snakes (O'Shea 2011) and these could be the main reasons that they were relatively poorly studied in the Balkans. The available atlases and red data books provided no precise data about distribution, conservation status, and threats of the viper species in the Balkans and there are many gaps in distribution maps (for example see Gasc et al. 1997; Janev-Hutinec 2006). Moreover, most existing records are old. Implicitly, conservation measures, priorities, and strategies can not be established without precise and contemporary distributional data. Jelić et al. (2012a) recently published new and revised distributions for all three vipers. Data from Croatia, Bosnia and Herzegovina, Montenegro, Serbia and the Former Yugoslav Republic (FYR) of Macedonia were pooled to create informative distribution maps and to assess the highly important areas for conservation of the vipers. Here we discuss particular conservation problems and propose conservation priorities and measures for each viper species in each country of the Western and Central Balkans. All three vipers share several conservation problems: lack of systematic study and public interest, "historical and political burdens," lack of knowledge, superstitions and fear by people (recently elaborated for snakes in general in Ballouard et al. 2013), increasing urbanization, habitat destruction, illegal collection, and lack of adequate (or any) legislation in different countries. In this sense, vipers face similar problems already stated for reptiles in general (Gibbons et al. 2000; Böhm et al. 2013).

Materials and Methods

We investigated all available legislation and conservation related literature in Croatia, Serbia,

Figure 1. The three vipers assessed for vulnerability in Croatia, Serbia, Bosnia and Herzegovina, Montenegro, and Macedonia: top) Nose-horned Viper (*Viperus ammodytes*), middle) Adder (*V. berus*; black phase), bottom) Meadow Viper (*V. ursinii*). (Photographed by Dušan Jelić)

Bosnia and Herzegovina, Macedonia, and Montenegro. We used distributional data from Jelić et al. (2012a) and plotted records in the 10 × 10 km UTM (Universal Transverse Mercator) grid system. We excluded edge grid cells that covered our study area with < 10% of its surface from the analysis (i.e., covering the Adriatic Sea or border areas with surrounding countries), leaving 2,811 cells to be considered.

Assessment of viper conservation threats.— We selected independent natural history and non-natural variables that are known to influence the survival of snake populations according to Fillipi and Luiselli (2000) and we altered them to fit our geographical requirements. We classified all the variables into four categories ranging from 0, least risk, to 3, highest risks. The categories themselves were based on average conditions for adults in the wild published elsewhere, or on personal experience of the authors. We used the following natural history and non-natural threat factors in the assessment of viper conservation threats: (1) Illegal trade (IT) opportunistic observations of legal and illegal pet shops in the years 1990–2008, where 0 = no trade; 1 = low trade; 2 = medium trade; 3 = high trade; (2) Maximal body size (BS; length), where 0 = < 50 cm; 1 = 51–90 cm; 2 = 91–130 cm; 3 = > 130 cm; (3) Distribution breadth (DB) in study area, where 0 = present in > 80% of the country; 1 = present in 50–80%; 2 = present in 20–50%; 3 = present in < 20% of the country; (4) Frequency of reproduction (FR), where 0 = annual; 1 = once every 2 y; 2 = once every 3 y; 3 = once every 4 y or longer; (5) Litter size (LS), where 0 = > 15 eggs or young; 1 = 10–15; 2 = 5–10; 3 = < 5; (6) Dietary breadth (FB) based on taxonomic orders of prey taken and percentage of main prey in the diet, where 0 = no specialization, no order > 30% of diet; 1 = low specialization, main prey 30–50% of diet; 2 = medium, main prey 50–70% of diet; 3 = highly specialized, main prey > 70% of diet; (7) Habitat breadth (HB) based on occurrence in four biogeographic regions of North-western and Central Balkans (Continental, Pannonian, Mediterranean, Alpine), where 0 = species found in all four regions; 1 = species found in three regions; 2 = species found in two regions; 3 = species found in only one region; (8) Habits (HT) categorized on the basis of the type of general phenology exhibited by the snakes in the wild, where 0 = species with fossorial-nocturnal activity; 1 = above ground-nocturnal activity; 2 = diurnal secretive activity; 3 = diurnal and obvious above ground activity; (9) Maximum age (MA) established on the basis of published data, where 0 = species with > 15 y maximum age; 1 = 10–15 y; 2 = 5–10 y; 3 = < 5 y; and (10) Adaptability to altered habitats (AH)

categorized on the basis of personal experience of the authors (1995–2011) and/or published data, where 0 = extremely adaptable species (found even in urban centers); 1 = adaptable species (found also in suburbia if small natural fields are available); 2 = minimally adaptable species (found at best in average sized natural woodlands); 3 = non-adaptable species (found only in large areas of natural habitat).

Determination of important viper areas.—To each UTM cell in the study area, we gave a score based on following criteria: (1) Number of viper species present in the general area (0–3); (2) SUM of mean scores of the index of threat for present species (0 –4); (3) Existence of syntopic relationships (number of species represented; 0–3); and (4) Conservation and legal protection status: number of legally protected species (0–3).

Statistical procedures.—We calculated mean values of 10 independent variables to determine threat levels for the three Viper species present in the analyzed part of the Balkans. Variable scores 0 and 1 were always associated with least or moderate risk, and scores 2 and 3 with high or extremely high risk. Specifically, we concluded that: (1) a mean score < 1 indicates that a species is in no risk of decline; (2) a mean score 1–1.7 indicates that a species is vulnerable to decline; and (3) a mean score > 1.7 indicates that a species is seriously exposed to decline or even extinction (Fillipi and Luiselli 2000). For important viper areas, we used four independent variables to calculate mean values for all 2,811 UTM cells in the western and central Balkans. We concluded that: (1) a mean score < 1.5 indicates an area of no significant importance; (2) a mean score 1.5–2.5 indicates an area of notable importance; and (3) a mean score > 2.5 indicates an area of special importance for the vipers.

Results

There is a huge discrepancy in the status of protection of vipers in the countries of the Western and Central Balkans (Table 1). For example, *V. ursinii* is strictly protected in Croatia, Serbia and FYR of Macedonia, while in both Montenegro and Bosnia and Herzegovina it is not protected at all. A similar, but less pronounced, situation is with the two other species of vipers. *Vipera berus* is strictly protected in Serbia, protected in Croatia, while in all other countries, it is not protected at all. *Vipera ammodytes* is protected only in Croatia, Serbia, and FYR of Macedonia. The mean scores of viper conservation threats varied from 0.7 for *Vipera ammodytes* to 1.9 for *V. ursinii*. *Vipera berus* had an intermediate mean score of

Table 1. Legislation dealing with protection of vipers in Croatia, Serbia, Bosnia and Herzegovina, Montenegro, and Macedonia.

Country	*Vipera ammodytes*	*Vipera berus*	*Vipera ursinii*	Note
Croatia	Protected	Protected	Strictly protected	Croatian Nature Protection Act (National Gaazette 70/05, NN 139/08
	--; LC	LC; NT	EN; EN	Red list: Janev-Hutinec et al. 2006; Jelić et al. 2012
Bosnia and Herzegovina	--	--	--	No protection act
	--	--	--	No Red list
Serbia	Protected	Strictly protected	Strictly protected	Serbian Nature Protection Act (National Gazette 05/2010, 47/2011)
	--	--	--	No Red list
Montenegro	--	--	--	No protection act
	--	--	--	No Red list
Macedonia	Protected	--	Strictly protected	Macedonian Nature Protection Act (National Gazette 139/11)
	--	--	--	No Red list

1.2 (Table 2). These scores indicate that *V. ammodytes* can be considered a species with no risk of decline; *V. berus* is possibly vulnerable to decline; and *V. ursinii* is seriously exposed to decline or even extinction. The assessment of Important Viper Areas (IVA) indicated three especially important areas (Fig. 2): (1) massifs of southern Velebit, Poštak, Dinara, Ujilica, Troglav, Kamešnica, Cincar, Ljubuša, and Čvrsnica (Croatia-Bosnia and Herzegovina border); (2) massifs of Zelengora, Volujak, Ljubuša, Lebršnik, Korita, Durmitor, and Bjelasica (Bosnia and Herzegovina-Montenegro border); and (3) massifs of Šar Planina, Korab, Dešat, Bistra, Stogovo, Jablanica, and Galičica (Macedonia-Albania border).

Discussion

The lack of legislation dedicated to protection of viper species in Montenegro and Bosnia and Herzegovina is a major problem at both the regional and global level as it directly facilitates illegal trade (Ajtić 2008). Lack of protection is partly a result of historical and social conditions

Table 2. Scores for 10 variables affecting the survival of vipers in the study area. One asterisk for mean score indicates vipers are vulnerable to decline and two asterisks indicate seriously exposed to decline. The definition of attribute values for each species is given in Materials and Methods.

Variables	*Vipera ammodytes*	*Vipera berus*	*Vipera ursinii*
1. Illegal trade (IT)	2	0	1
2. Body size (BS)	1	1	0
3. Distribution breadth (DB)	1	2	3
4. Frequency of reproduction (FR)	0	1	1
5. Litter size (LS)	1	1	2
6. Dietary breadth (FB)	1	2	3
7. Habitat breadth (HB)	1	1	3
8. Habits (HT)	0	2	2
9. Maximum age (MA)	0	1	1
10. Adaptability to altered habitats (AH)	0	1	3
SUM	7	12	19
Mean score	0.7	1.2*	1.9**

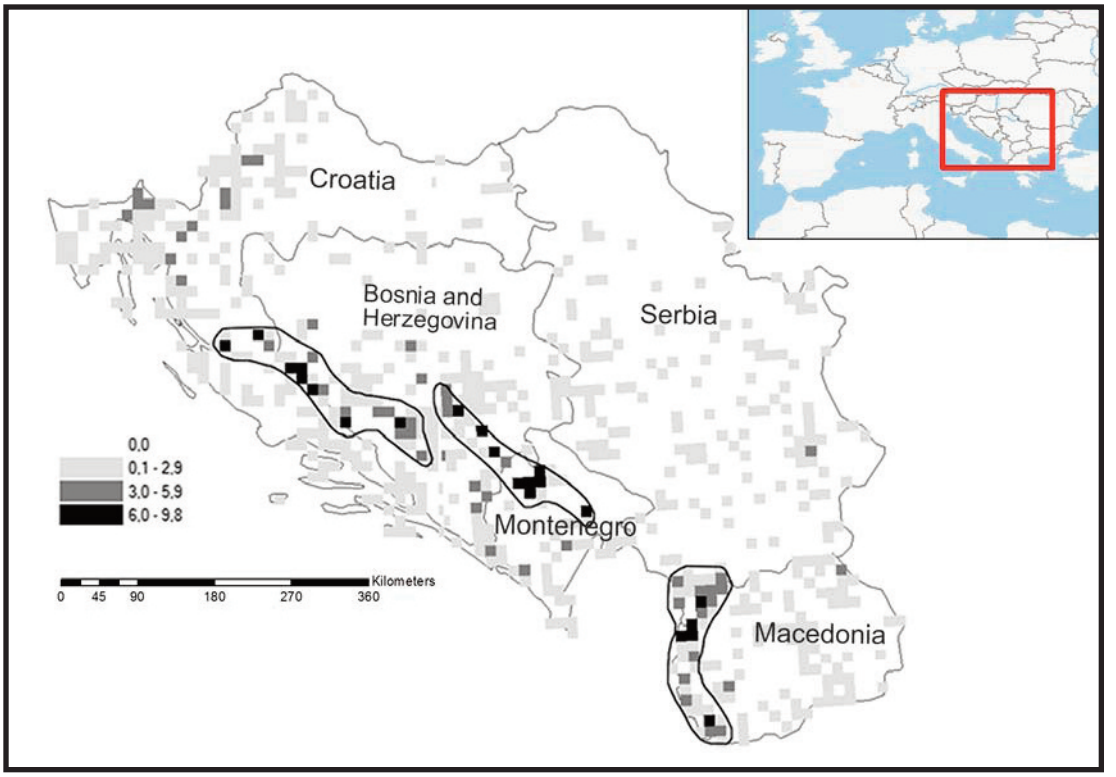

Figure 2. Important Viper Areas (IVA) in the western and central Balkans. Map represents main score indicating areas of special importance for the vipers (white = low vulnerability, black = high vulnerability) based on four selected criteria for each UTM 10 × 10 km cell. Inset map shows the area of Europe studied. The legend shows the range of scores we used.

in these countries and a general negative attitude towards venomous snakes. Even in countries where vipers are protected (Croatia, Serbia, and Macedonia), there still are strong negative attitudes and vipers are killed on sight. Illegal killing and harming of protected species is never prosecuted and education has been shown to be a much more efficient tool. It is of international importance that all the countries in the region cooperate and coordinate legislation for the formal protection of vipers, as well as focusing on cooperative education. The conservation scores we obtained indicate that *V. ammodytes* can be considered as species with no risk of decline, but that *V. berus* is possibly vulnerable to decline and *V. ursinii* is seriously exposed to decline or even extinction. These results confirm our observations in the field, and represent a good starting point for protection of *V. ursinii* and *V. berus* in all five countries. The analysis of conservation threats that we used is crucial because it takes in account species biology and ecology (e.g., reproduction type and frequency, fecundity, specialization in microhabitat use or preferred climatic conditions) as opposed to a more traditional use of only size of distribution area and observed threats (e.g., habitat degradation, illegal trade, harvesting).

We suggest that in Bosnia, Herzegovina, and Montenegro, *V. ursinii* should be strictly protected due to its status in international legislation (Habitat directive – Annex II and IV, Bern Convention – Appendix I, CITES – Appendix I), because of a high score of 1.9 in our analysis of conservation threats, and the realistic threats posed to the species in the countries of concern (e.g., killing, high illegal trade risk). We suggest that both *V. berus* and *V. ammodytes* should be protected because of international legislation (only *V. ammodytes* is on the Bern Convention – Appendix II). Although *V. ammodytes* scored only 0.7 in our analysis of conservation threats, there are four distinct genetic clades that exist in the study area (Ursenbacher et al. 2008) and these clades may warrant protection to conserve genetic diversity (especially in Montenegro).

The conservation status of the vipers is much worse than legislation indicates. A National Red List of endangered species exists only in Croatia (*V. ursinii* is considered as Endangered B1+2ab(iii, iv); *V. berus* as Near threatened B2b(ii, iii); Jelić et al. 2012b), so there is urgent need for the same conservation status in other countries of the western and central Balkans. We strongly urge that our suggestions above should be taken into consideration in future national legislation and red list assessments. Reading et al. (2010) indicated that snakes are in worldwide decline and that special measures should be taken for their conservation. Designating areas of special importance for endangered species is one of the recognized actions to improve their conservation status. We strongly recommend to the policy makers in the countries within the study area that three Important Viper Areas should be recognized and be included in different types of legally protected areas (national and nature parks; NATURA 2000). Croatia is the first in line country to join the EU and therefore started the preparation of NATURA 2000 network by designating SCI (Site of Community Importance). During the course of the negotiations, Croatia suggested that *V. ursinii macrops* should be raised to the level of "priority taxa" in Habitat Directive`s Annex II. This change will mean that Croatia, and all other Balkan countries joining the EU after it, should include 80% of their *V. ursinii macrops* habitats in NATURA 2000 SCI protected areas. Normally, for Annex II species, at least 50% of their habitats should be included in NATURA 2000. We recognized three Important Viper Areas (IVA) that should be taken into account when setting national and regional protected areas. All three areas are spread across the borderline areas (Croatia-Bosnia and Herzegovina; Bosnia and Hrzegovina-Montenegro and FYR of Macedonia-Albania), which amplifies the importance of regional cooperation.

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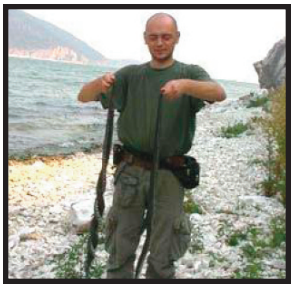

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Suvad Lelo began his career as a Technical Assistant of the Institute for Genetic Engineering and Biotechnology, Sarajevo in 1994. Since 1996 he has worked in the Department of Biology of the Faculty of Science and Mathematics, University of Sarajevo (1996 - Assistant, 2000 - Senior Assistant, 2005 - Assistant Professor, 2009 - Associate Professor, 2013 - Full Professor). So far he has authored or co-authored 97 scientific papers (29 in journals followed by international databases), 57 conference announcements, and 14 books. He has also participated in the managing of nine international and 13 domestic projects. He was a mentor for 26 graduate students, four master's theses, and one doctoral dissertation. He is the founder and president of the Association for the Inventory and Protection of Animals for which he prepared a preliminary list of fauna of Bosnia and Herzegovina totaling more than 12,000 listed species. Suvad is also the founder of the local journal Contributions Fauna of Bosnia and Herzegovina and was its Editor in Chief for the first 4 y, and in the second term was Deputy Editor. He participated in the drafting of two ordinances under the Nature Protection Act. By a decision of the Federal Minister of Physical Planning and Environment, he has been appointed as a member of the expert committee to review the Environmental Impact Study of highways in Bosnia and Herzegovina. (Photographed by Samir Đug).

Ljiljana Tomović works as an Associate Professor of Vertebrate Morphology, Systematics, and Phylogeny at the University of Belgrade, Faculty of Biology. She graduated from the Faculty of Biology at the University of Belgrade, where she also completed an M.S. and Ph.D. on *Vipera ammodytes* systematics and biogeography. She was a mentor or member of the commission for 19 graduate students, four Master's theses, and seven Ph.D. dissertations. She has been studying vipers (*Vipera ammodytes, V. berus,*and *V. ursinii*) in the central part of the Balkan Peninsula since 1993. Her specialties are herpetology, morphology, systematics, population ecology, and ethology. She participated in three international and seven national projects. So far, she has authored or co-authored 32 scientific papers in indexed journals. Since 2005, the main focus of her work has been population studies of *Vipera ursinii* in Macedonia, Montenegro, and Bosnia and Herzegovina, and since 2007, population studies of *Testudo hermanni*, *Natrix tessellata*, *Natrix natrix*, and *Vipera ammodytes* in the central part of the Balkans. Ljiljana is a member and one of the founders of the Serbian Herpetological Society "Milutin Radovanović." (Photographed by Dragan Arsovski).