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Preliminary data on the population characteristics of *Vipera ursinii moldavica* from "Dealul lui Dumnezeu" (Iaşi County, Romania) with notes on conservation

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Abstract. Dealul lui Dumnezeu is one of the Moldavian sites (the other one is Valea lui David) from where the Moldavian meadow viper (*Vipera ursinii moldavica*) has been recorded in the past, and which is currently inhabited by a viper population. The Moldavian meadow viper is a species of European Community interest whose conservation requires the designation of special areas of protection according to European Union environmental regulations. The population of *Vipera ursinii moldavica* from Dealul lui Dumnezeu is comparable to the one previously studied from Valea lui David in regard to structure, morphology, assessment of environmental stress based on asymmetry observed during the measurement of bilateral traits, and local threats. Steppic plant communities and several other species (one orthopteran, four amphibian, three reptile, and four bird species) recorded from the study area are of Community interest and need strict protection or/and require the designation of special areas of protection.

Keywords: Dealul lui Dumnezeu, *Vipera ursinii moldavica*, population characteristics, protected habitats, protected species

Introduction

Meadow vipers (*Vipera ursinii*) form a group with a large, but at the same time highly fragmented distribution area that covers Europe, Western and Central Asia (Nilson & Andrén 2001). Most of the populations are relatively distant from each other or they are separated by natural barriers such as deep valleys, mountain chains or rivers. Their habitats consist of different types of meadows at various elevations (Nilson & Andrén 2001).

In Romania the complex is represented by *Vipera ursinii rakosiensis* in Transylvania (Méhelÿ 1894, Korsós et al. 1997, Ghira 2007, Török 2007) and *Vipera ursinii moldavica* in Moldavia (Nilson et al. 1993). The populations from the Danube Delta are considered similar to *moldavica* or that they represent a sister group of the Moldavian populations (Nilson & Andrén 2001). Consequently, the following studies adopt the deltaic populations as *moldavica* (Halpern et al. 2006, 2007) or mention their intermediate position and adopt them as *moldavica* (Edgar & Bird 2006). The classification of these populations into a group or another remains open to

debate (Kotenko 2000) whereas other studies simply do not mention the subspecific status (Török 2002, 2007).

In Western Moldavia (Romania) the subspecies, which was initially considered a hybrid between *Viera ursinii renardi* and *V. u. rakosiensis*, has been recorded from four counties: in Iaşi County, the species was identified in the Valea lui David Natural Reserve (Vancea & Ionescu 1954, Fuhn & Vancea 1961, Nilson et al. 1993), from Tomesti (Băcescu 1933, 1937) and from Avântu – Ursoaia (Românești) (Vancea et al. 1985). In Botoşani County the steppe viper was found near Călăraşi and Şendriceni (Vancea et al. 1985), and in Galați County near Tecuci (Băcescu 1941). There is an interesting record from Suceava County, from the Rarău Mountains (Vancea et al. 1985). Unfortunately, the only specimen from this location was lost from the collection of the Natural History Museum from Iaşi (Krecsák et al. 2003).

Recent studies (1999-2000) have demonstrated the existence of a relatively large population from Valea lui David (Krecsák & Zamfirescu 2001), and reconfirmed the population from Dealul lui Dumnezeu (Avântu - Ursoaia - Românești) (Krecsák & Zamfirescu 2002, Krecsák et al. 2003, Zamfirescu et al. 2007).

The species *Vipera ursinii* is one of the most threatened snakes of Europe (Korsós 1992, Edgar & Bird 2006) and the *moldavica* subspecies is one of the endangered subspecies of the *Acridophaga* complex (Nilson & Andrén 2001). With regard to the environmental regulations, the Moldavian meadow viper is a species of Community interest whose conservation requires the designation of special areas of protection (European Council Directive 92/43/EEC, transposed as Romanian Government Ordinance no. 57 from 20/06/2007), and is critically endangered according to the Red Book of Romanian Vertebrates (Iftime 2005) and the 2007 IUCN Red List of Threatened Species. At present the site studied herein does not have formal protection.

The study population, although recently reconfirmed (Krecsák & Zamfirescu 2002), has never been studied thoroughly. Therefore, our aim was to provide preliminary data about the population, and hence to lay down the basis for potential comparisons with the *ursinii* populations from Moldavia. Such approaches have been separately mentioned by different authors in relatively few papers, for the *V. u. moldavica* population of Valea lui David (Krecsak & Zamfirescu 2001, Krecsák et al. 2003), for the *V. ursinii* populations of the Danube Delta (Halpern *et al.* 2006, 2007), for *V. u. rakosiensis* (Újvári & Korsós 1997, Újvári et al. 2000, Korsós, 2001, Halpern & Péchy 2002) and for highland populations of the *Acridophaga* group (Baron 1997, Tomović et al. 2004).

According to the legal framework, the mere presence of this species represents a strong argument for the establishment of a protected area. Hence, we aim to supply extensive information concerning the presence of the viper and other species that that would additionally emphasise the necessity of setting the area from Dealul lui Dumnezeu under official protection (Birds and Habitats Directives, RGO 57/2007).

Material and Methods

Field study was carried out in 2006-2007, in the area known as "Dealul lui Dumnezeu" (= God's Hill). "Dealul lui Dumnezeu" is located to the northwest of Iaşi, in the area limited by the localities Epureni, Avântu, and Ursoaia (Commune Românești). It is a valley with a general north – south orientation,

bordered by relatively steep slopes, especially to the east. The exact locality of the study site is not disclosed in this paper to protect the viper population that is present.

We surveyed the communities of plants, amphibians and reptiles, insects, and birds. No animal was harmed in any way during the field investigation; they were handled on the spot and released at the capture location. The phytosociologial assessment was performed according to the Braun-Blanquet methodology (1964). Animal community surveys consisted of visual observations along transects. The investigation of the viper population consisted of two five-hour surveys (in two different days) in each ten-day period from August to September 2006. The study zone comprised the main types of vegetation and covered the area from where viper individuals had been previously recorded in 2000 (Krecsák & Zamfirescu 2002). The individuals were found along 2.4 km, within an area of 33.3 ha. The morphological study of the individuals allowed the age-sex structure analysis (Fowler et al. 2000, Varvara et al. 2001), the morphological description, and the fitness assessment through the fluctuant asymmetry non-parametric index (Palmer & Strobeck 2003). For population sex and age structure we considered that the average length of a newborn viper is 13.6 cm, females shorter than 31.5 cm and males shorter than 24.5 cm are juveniles and that females reach sexual maturity at the age of 4 and males at age 3 (Baron 1992, 1997).

Results and Discussions

From the target area (Fig. 1) we recorded 8 Moldavian meadow viper individuals (Fig.2). The viper individuals were recorded in the following vegetation types: three in steppic xerophilous communities, two in nitrophilous communities with rare bushes, two in hygro-mesophilous communities and one hygrophilous communities.

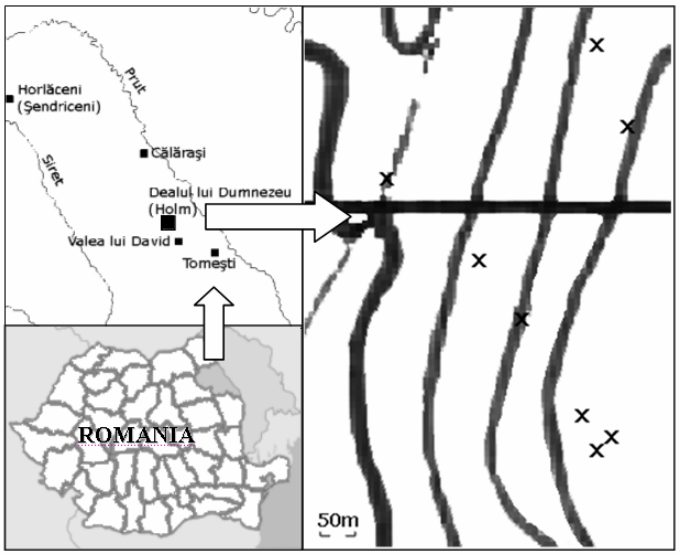

Figure 1. Location of the study area (square marks represent sites of *V. u. moldavica* records) and the distribution of the recorded Moldavian meadow viper individuals in the study area (the "x" marks represent the GPS locations of individuals on a topographic map)

The sex and age structure (Fig. 3) of the sample reveals that it contains five juveniles – three males and two females, and three adults – two males and one female. The morphological description of the Moldavian meadow vipers from Dealul lui Dumnezeu consisted of describing two metrical traits and 32 meristic traits (Tables 1, 2).

Figure 2. *Vipera ursinii moldavica* – adult male (photo Ş. R. Zamfirescu).

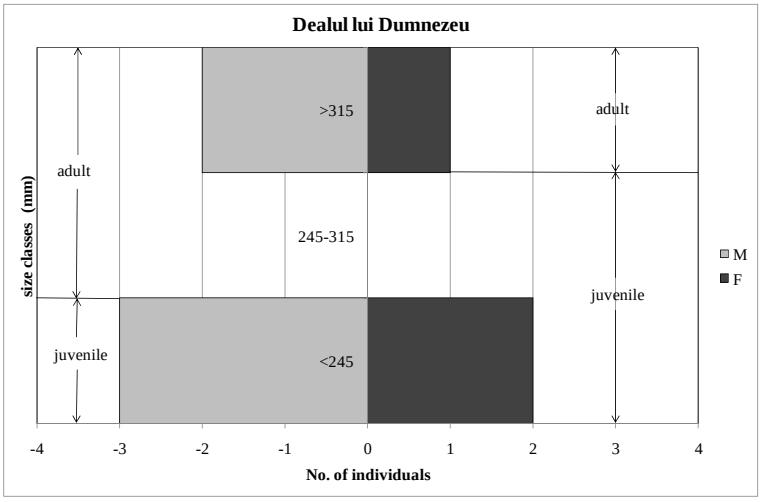

Figure 3. Sex and relative age structure of the Moldavian meadow viper sample from Dealul lui Dumnezeu (M-males, F-females)

Table 1. Descriptive statistics of the female vipers; n = 3 (SVL – snout to vent length, TL – tail length, L – left side, R – right side).

Trait	Mean	Standard Error	Standard Deviation	Sample Variance	Min.	Max.	Confidence Level (95.0%)
SVL	283.667	95.649	165.669	27446.333	153.000	470.000	411.545
TL	33.000	12.342	21.378	457.000	16.000	57.000	53.105
Rostral	1.000	0.000	0.000	0.000	1.000	1.000	0.000
Apical	1.000	0.000	0.000	0.000	1.000	1.000	0.000
Frontal	1.000	0.000	0.000	0.000	1.000	1.000	0.000
Parietal	2.000	0.000	0.000	0.000	2.000	2.000	0.000
Prefrontal	8.000	1.000	1.732	3.000	6.000	9.000	4.303
Nasal L.	2.333	0.333	0.577	0.333	2.000	3.000	1.434
Nasal R.	2.333	0.333	0.577	0.333	2.000	3.000	1.434
Loreal L.	4.000	0.577	1.000	1.000	3.000	5.000	2.484
Loreal R.	3.667	0.882	1.528	2.333	2.000	5.000	3.795
Cantal L.	2.000	0.000	0.000	0.000	2.000	2.000	0.000
Cantal R.	2.000	0.000	0.000	0.000	2.000	2.000	0.000
Inframaxilar L.	1.000	0.000	0.000	0.000	1.000	1.000	0.000
Inframaxilar R.	1.000	0.000	0.000	0.000	1.000	1.000	0.000
Parafrontal L.	3.000	0.577	1.000	1.000	2.000	4.000	2.484
Parafrontal R.	2.667	0.333	0.577	0.333	2.000	3.000	1.434
Nazo-rostrale L.	1.000	0.000	0.000	0.000	1.000	1.000	0.000
Nazo-rostrale R.	1.000	0.000	0.000	0.000	1.000	1.000	0.000
Preocular L	3.667	0.333	0.577	0.333	3.000	4.000	1.434
Preocular. R.	3.333	0.333	0.577	0.333	3.000	4.000	1.434
Postocular L.	2.667	0.333	0.577	0.333	2.000	3.000	1.434
Postocular R.	2.667	0.333	0.577	0.333	2.000	3.000	1.434
Subocular L.	3.000	0.000	0.000	0.000	3.000	3.000	0.000
Subocular R.	3.000	0.000	0.000	0.000	3.000	3.000	0.000
Supraocular L.	1.000	0.000	0.000	0.000	1.000	1.000	0.000
Supraocular R.	1.000	0.000	0.000	0.000	1.000	1.000	0.000
Supralabial L.	8.333	0.333	0.577	0.333	8.000	9.000	1.434
Supralabial R.	8.667	0.333	0.577	0.333	8.000	9.000	1.434
Sublabial L.	9.000	0.577	1.000	1.000	8.000	10.000	2.484
Sublabial R.	10.000	0.000	0.000	0.000	10.000	10.000	0.000
Anal	1.000	0.000	0.000	0.000	1.000	1.000	0.000
Subcaudal	30.667	0.882	1.528	2.333	29.000	32.000	3.795
Ventral	143.333	0.333	0.577	0.333	143.000	144.000	1.434

Table 2. Descriptive statistics of the male vipers; n = 5 (SVL – snout to vent length, TL – tail length, L – left side, R – right side).

Trait	Mean	Standard Error	Standard Deviation	Sample Variance	Min.	Max.	Confidence Level (95.0%)
SVL	272.800	61.276	137.017	18773.700	150.000	459.000	170.129
TL	41.400	9.698	21.686	470.300	21.000	69.000	26.927
Rostral	1.000	0.000	0.000	0.000	1.000	1.000	0.000
Apical	1.000	0.000	0.000	0.000	1.000	1.000	0.000
Frontal	1.000	0.000	0.000	0.000	1.000	1.000	0.000
Parietal	2.000	0.000	0.000	0.000	2.000	2.000	0.000
Prefrontal	5.400	1.077	2.408	5.800	2.000	8.000	2.990
Nasal L.	2.400	0.245	0.548	0.300	2.000	3.000	0.680
Nasal R.	2.000	0.000	0.000	0.000	2.000	2.000	0.000
Loreal L.	3.600	0.510	1.140	1.300	2.000	5.000	1.416
Loreal R.	3.200	0.860	1.924	3.700	0.000	5.000	2.388
Cantal L.	2.000	0.000	0.000	0.000	2.000	2.000	0.000
Cantal R.	1.800	0.200	0.447	0.200	1.000	2.000	0.555
Inframaxilar L.	1.000	0.000	0.000	0.000	1.000	1.000	0.000
Inframaxilar R.	1.000	0.000	0.000	0.000	1.000	1.000	0.000
Parafrontal L.	2.200	0.490	1.095	1.200	1.000	4.000	1.360
Parafrontal R.	2.400	0.510	1.140	1.300	1.000	4.000	1.416
Nazo-rostrale L.	1.000	0.000	0.000	0.000	1.000	1.000	0.000
Nazo-rostrale R.	1.000	0.000	0.000	0.000	1.000	1.000	0.000
Preocular L	3.600	0.245	0.548	0.300	3.000	4.000	0.680
Preocular. R.	3.600	0.245	0.548	0.300	3.000	4.000	0.680
Postocular L.	3.600	0.245	0.548	0.300	3.000	4.000	0.680
Postocular R.	3.200	0.490	1.095	1.200	2.000	4.000	1.360
Subocular L.	3.000	0.000	0.000	0.000	3.000	3.000	0.000
Subocular R.	3.200	0.200	0.447	0.200	3.000	4.000	0.555
Supraocular L.	1.000	0.000	0.000	0.000	1.000	1.000	0.000
Supraocular R.	1.000	0.000	0.000	0.000	1.000	1.000	0.000
Supralabial L.	8.200	0.200	0.447	0.200	8.000	9.000	0.555
Supralabial R.	8.200	0.200	0.447	0.200	8.000	9.000	0.555
Sublabial L.	9.600	0.245	0.548	0.300	9.000	10.000	0.680
Sublabial R.	10.000	0.447	1.000	1.000	9.000	11.000	1.242
Anal	1.000	0.000	0.000	0.000	1.000	1.000	0.000
Subcaudal	39.000	0.632	1.414	2.000	37.000	41.000	1.756
Ventral	140.400	0.579	1.294	1.675	139.000	141.500	1.607

Bilateral traits were used to assess the asymmetry of the individuals. The asymmetry nonparametric index for the sample is 2.875. Only one individual displayed no asymmetry of the bilateral characteristics; for all the others, the asymmetry ranged from 1 to 6 traits.

We associate the small sample size with the extreme drought conditions that affected the studied area, and to which the vipers seem to be sensitive. This presumption is indirectly supported by the fact that generally, the lack of habitat humidity is considered a threat for meadow viper populations (Corbett 2002, Halpern & Péchy 2002, Edgar & Bird 2005). Drought may indirectly affect viper thermoregulatory behaviour through the reduction of the grass layer cover. Consequently, as the body temperature of the lowland meadow vipers depends mostly on the grass layer temperature (Újvári & Korsós 1997, Zamfirescu & Krecsák 2002), in scarce vegetation conditions the only way thermoregulation can be achieved during hot days is by taking refuge in burrows, which results in a reduction in the number of individuals observed and, as a result, sample size.

In terms of habitat area, the study population is comparable to the one from Valea lui David (Krecsák et al. 2003). Both Moldavian populations are smaller than the ones from the Danube Delta: Perişor-Periteasca approximately 1200 ha (Török 1997) and Sfântu Gheorghe approximately 1000 ha (Török 2002).

The spatial structure of the population is rather random (statistical testing was not possible because of the small sample size), as the individuals were observed in various types of vegetation. Our observation is parallel with other findings noting that *Vipera ursinii ursinii* does not exploit the space uniformly, even if the available area is homogenous (Baron 1997).

The sex and age structure shows that the population is reproducing because both sexes and juveniles have been recorded. The absence of juveniles may lead to a constant decline of the population size (Halpern & Péchy 2002), which is not the case of the target population. An unbalanced sex-ratio is not necessarily an indicator of population decline. In Dabas-Gyón (Hungary) a *Vipera ursinii rakosiensis* population has been reported to persist even though it is dominated by large females that reproduce more often than small ones (Újvári et al. 2000). Female domination, also reported for *Vipera ursinii macrops* (Tomović et al. 2004), could be as well a result of observation bias as females are more apparent than males, the formers tending to spend more time basking towards the end of the activity period (Baron 1997). In our sample from Dealul lui Dumnezeu, recorded towards the end of the activity period, the males dominate numerically (Fig. 3), which differs from the above-mentioned situation. A possible explanation with regards to this matter refers to the influence of drought on viper individuals, which has already been previously discussed. Thus, we cannot infer that the sample sex-ratio applies for the whole population because of the small sample size. Further studies are needed for the assessment of a realistic population sex-ratio.

With regard to the morphological description (Tab. 1-2), the values are generally consistent with the previous descriptions of this subspecies (Fuhn & Vancea 1961, Krecsák & Zamfirescu 2001, Nilson & Andrén 2001). Some traits differ from the population

from Valea lui David (Krecsák & Zamfirescu 2001): more ventral (135.63±6.02 in ♂ and 137±7.78 in ♀ from Valea lui David) and caudal scales (36.13±3.04 in ♂ and 28.30±2.79 in ♀ from Valea lui David) in both sexes, more prefrontal scales in females (5.60±1.17 in ♀ from Valea lui David), and lower frequency of double apical scales in the population from Dealul lui Dumnezeu (28.57% of ♂ and 11.11% of ♀ from Valea lui David). If compared to the deltaic populations (Halpern et al. 2006, 2007), the morphological description is quite similar, except for the relatively higher frequency of double apicals (27.1% in Periteasca population and 8.5% in Sfântu Gheorghe population) and more loreal scales (sum of both sides Periteasca ♂: 8.5±1.3, Sfântu Gheorghe ♂: 10.2±2.0, Periteasca ♀: 9.7±1.8, Sfântu Gheorghe ♀: 10.5±2.4) than in the study population. The comparison of the study population to the closely related one should be repeated in the future and statistically tested.

Subtle morphological asymmetries of reptiles may indicate an endangered population (Újvári et al. 2002, Crnobrnja-Isailovic et al. 2005), and it can be related to environmental and/or genetic stress as it varies with location (Herczeg et al. 2005). In *Vipera ursinii macrops*, it has been discussed that some head scalation characters display post-embryonic ontogenetic variation which may be linked with environmental factors (Tomović et al. 2008). Sometimes the morphologic asymmetry is coupled with a functional one and with sex which may alter the reproductive success and defensive ability (Shine et al. 2005, Razzeti et al. 2007). Individual fitness in Dealul lui Dumnezeu population, assessed through fluctuant asymmetry, is comparable to that found in the Valea lui David population (Mann-Whitney $U_{8,35}$=111, p=0.757, unpublished data). Other studies approached the asymmetry just from the trait perspective and therefore population-wide asymmetry comparisons to similar groups are not possible. The most asymmetric trait was the sublabials. The same situation was previously described for the target population (Nilson & Andrén 2001). Although not mathematically quantified, the asymmetry was also reported from the Danube Delta populations (Halpern et al. 2006, 2007) and Valea lui David population (Krecsák & Zamfirescu 2001).

The local threats of the viper population are represented mainly by the human activities. The area is relatively remote and inaccessible which is the reason why the human impact resumes to grazing (sheep) and manual mowing. These two activities affect the viper population mainly indirectly. Actually, the locals have a hostile attitude towards the vipers and usually try to kill them while guarding the sheep or mowing. At the bottom of the valley, especially on flat areas, there are small agricultural patches.

In this regard, we consider that the human activities are not particularly dangerous for the vipers and its habitats, as long as they are kept at a traditional scale. Over-grazing, mechanised mowing and land ploughing are recognised as major threats for the lowland meadow viper populations, because they destroy the vegetation layer, compact the soil, destroy borrows, and directly kill the snakes (Újvári et al. 2000, Kammel 2001, Korsós 2001, Krecsák & Zamfirescu 2001, Krecsák et al. 2003, van Roon et al. 2006). On the contrary, these activities may be used as management techniques against vegetation ruderalisation (Collins et al. 1998). Although limited,

agricultural activities that employ ploughing are dangerous for the vipers and habitats, and therefore should be banned in the area.

In addition to the presence of the Moldavian meadow viper, there are some other arguments in favour of the protection of the Dealul lui Dumnezeu area

During our research we identified some plant communities that define priority natural habitat types of Community interest whose conservation requires the designation of special areas of conservation (Directive 92/43/EEC, RGO 57/2007): 6240 Sub-Pannonic steppic grasslands (Ass. *Taraxaco serotinae - Festucetum valesiacae*), 62CO Ponto-Sarmatic steppes (Ass. *Jurineo arachnoideae-Stipetum lessingianae*).

Among orthopterans, the most important recorded species is *Saga pedo* (Fig. 4), which is a species of Community interest and in need of strict protection (Directive 92/43/EEC, RGO 57/2007). It is also an important indicator for the good condition of the steppic habitat (Báldi & Kisbenedek 1997).

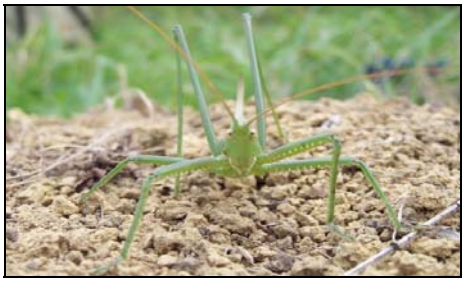

Figure 4. *Saga pedo* (Dealul lui Dumnezeu) (photo S. R. Zamfirescu)

In the wet areas of the investigated site we observed several amphibian species, of which the most relevant for the purpose of this paper are: *Triturus cristatus* and *Bombina bombina,* requiring the designation of special protection areas; *Epidalea (=Bufo) viridis* and *Hyla arborea,* in need of strict protection (Directive 92/43/EEC, RGO 57/2007).

Apart from the Moldavian meadow viper, other important reptiles recorded from the study area are: *Lacerta viridis*, *Lacerta agilis* and *Coronella austriaca*, which are strictly protected (Directive 92/43/EEC, RGO 57/2007).

Some of the recorded bird species are strictly protected, requiring the designation of special areas of protection: *Lanius collurio*, *Lanius minor*, *Anthus campestris* and *Ciconia ciconia*. (Directive 79/409/EEC, RGO 57/2007).

If compared to the Valea lui David Natural Reserve, which is emblematic of the Moldavian meadow viper and steppic habitats, the area of Dealul lui Dumnezeu is 59.6% similar to the former as indicated by the value of the Sørensen Coefficient based on species and plant communities presence (Zamfirescu et al. 2007).

Dealul lui Dumnezeu represents the north-western limit of a larger area (bordered towards south-east by Valea lui David) that includes several steppic patches, which are potential habitats for Moldavian meadow viper populations that have not been discovered yet, but which will be considered for further research.

We consider that the area from Dealul lui Dumnezeu, which has a great scientific importance, fulfils the requirements of the environmental regulations and therefore deserves to be set under official protection.

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