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# *Rare and Endangered Geophyte Plant Species in Serpentine of Kosovo*

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**Abstract.** Our study documents information on rarity, geographical distribution, taxonomy and conservation status of 11 geophyte species in serpentine soils of Kosovo, already included in the Red Book of Vascular Flora of Kosovo. Kosovo's serpentine vegetation represents a diversity that yet has not been sufficiently explored. Large serpentine complexes are found in the northern Kosovo but also southern part of the country is rich in serpentines, therefore in endemics. Serpentine rocks and soils are characterized by low level of principal plant nutrients (N, P, K, Ca) and exceptionally high levels of Mg and Fe. Serpentines play particular importance for flora of the country due to their richness in endemic plant species. The following 11 plant species have been studied: *Aristolochia merxmuelleri*, *Colchicum hungaricum*, *Crocus flavus*, *Crocus kosaninii*, *Epimedium alpinum*, *Gentiana punctata*, *Gladiolus illyricus*, *Lilium albanicum*, *Paeonia peregrina*, *Tulipa gesneriana* and *Tulipa kosovarica*. Five out of eleven studied geophytes fall within Critically Endangered IUCN based threat category and five out of eleven are local endemics. *Aristolochia merxmuelleri* and *Tulipa kosovarica* are steno-endemic plant species that are found exclusively in serpentine soils. Information in our database should prove to be valuable to efforts in ecology, floristics, biosystematics, conservation and land management.

**Key words**: Kosovo, rare, serpentine, IUCN, geophyte.

## Introduction

Serpentine soils deriving from ultramafic rocks release toxic heavy metals into the environment (HERATH *et al.*, 2014). That is why plants growing in these soils experience reduced growth due to phytotoxicity of these metals. Serpentine soils are often shallow, rocky and vulnerable to drought. As a result of extreme physical and chemical conditions, serpentine soils support a high proportion of endemic plant species that are adapted to their harsh environment (KAZAKOU *et al.*, 2008; VICIC *et al.*, 2014). Serpentine soils itself represent a suitable model system for studying plant adaptation, speciation as well as species interactions (ANACKER, 2014). In the other hand geophyte plant species bear their perennating buds below the surface of the soil, being thus far more resistant to drought and the stressful environment of the serpentine soils. It is well known that Mediterranean basin has remarkable plant diversity (COWLING *et al.*, 1996) and in particular the presence of geophytes in large numbers in this area have long been noted (RAUNKIAER, 1934). Serpentine soils cover minor surfaces in the global level, comprising less than 1% of the earth's surface (COLEMAN & JOVE, 1992). Large

areas of Balkan Peninsula are covered by serpentine substrate, more than any other European part. More than 300 endemic taxa (species and subspecies) occur on serpentine in the Balkans (STEVANOVIC *et al.*, 2003). In the territory of Kosovo there have been found serpentine rocks (Fig. 1) which are very rich, from the aspects of flora and vegetation (REXHEPI, 1985; KRASNIQI & MILLAKU, 2007). Serpetine soils flora and vegetation in Kosovo has been investigated by many researchers so far, such as: BLECIC & KRASNIQI (1971), KRASNIQI (1972, 1987), HUNDOZI (1987), REXHEPI (1979, 1982a,b, 1997, 2000), REXHEPI & MILLAKU (1996), KRASNIQI & MILLAKU (2004), MILLAKU *et al.* (2007, 2011), PRODANOVIC *et al.* (2012). Plant taxa that inhabit serpentine soils and rocks are known as serpentinophytes. Additionally, according to VICIC *et al.* (2014) serpentine plant species have developed variety of physiological adaptations, one of them being selective heavy metal, Ca and Mg uptake and its translocation to the leaves. As described in variety of studies, serpentine soils have properties that are highly disadvantageous for most plants. As a crucial factor on plant survival on serpentine soils is considered the tolerance on heavy metals, especially to Ni. Also another known strategy of plants to cope with high levels of heavy metals is hyper accumulation (KAZAKOU *et al.*, 2008). There are however still some questions unclear to this date in regard to serpentine endemics and the existing competition level in serpentine soils (MOORE & ELMENDORF, 2011). Traits at a species level indicate however that endemics are typically slow-growing stress tolerators, rather than fast growing competitive dominants (ANACKER & HARRISON, 2012; FERNANDEZ-GOING *et al.*, 2012), in addition the stress tolerance traits of endemic species are consistent with a tradeoff of competitive abilities for serpentine tolerance traits, by which drought adaptation may come at the cost of fast growth rate (GRIME *et al.*, 2008). So far, variety of serpentine endemism studies has revealed much about the nature of plant endemism in general. In particular, serpentine research has highlighted the role of geology as a major environmental determinant of endemism through direct effects on topography and soil properties and indirect effects on habitat availability, degree of spatial isolation as well as microclimate (ANACKER, 2014).

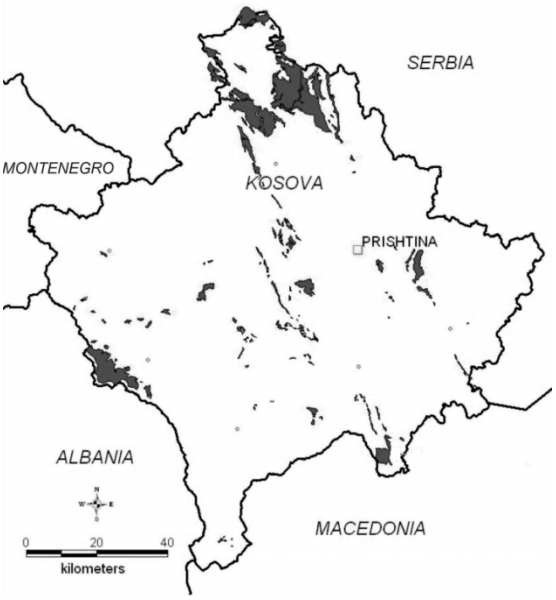


**Fig. 1**. Map showing distribution of serpentine massifs on Kosovo.

**Materials and Methods**

On the basis of material collected during the field work on the serpentines of Kosovo (2011-2013), we selected a group of plants significant to these sites that were additionally geophytes and rare plant species. Identification of collected plants was made according to Flora of Serbia (JOSIFOVIĆ, 1972, 1973; SARIĆ & DIKLIĆ, 1986), Flora of Albania (VANGJELI *et al.*, 2000), Flora Europaea (TUTIN *et al.*, 1964, 1967, 1976) while the nomenclature used was according to the databases of the Plant List (theplantlist.org).

For each species, while in the field we have filled up information forms with all the necessary data for assessment of threat category. In the same time we have taken plant samples and mount them in herbaria, based on standard measures (*all of them are recorded, labeled and placed in the Herbaria of*

*the Faculty of Natural Sciences, University of Prishtina*). We have taken photographs of the investigated plant species, recorded the GPS coordinates, counted the number of mature individuals, the main threats were recorded, we have measured the Area of Occupancy (AOO), the habitat type was noted, the geological – pedological composition, the altitude, as well as habitat degradation scale. Extent of Occurrence (EOO) was calculated later on, based on the compiled maps from the UTM coordinates. In order to assess the threat category of each species, we have been based in an explicit spatial approach, allowing insertion of certain obscurities in the entry data (IUCN 2012, MACE *et al*., 2008).

Based on possessed data, we have given a preliminary assessment, according to IUCN Red List and Criteria. Finally, the threat category has been given based on the software-program RAMAS - Red List Professional (AKÇAKAYA & ROOT, 2007). RAMAS Red List implements the IUCN criteria for classifying species into threat categories but in the meantime it allows for explicit incorporation of uncertainties in the input data. In other words, input data, such as the number of mature individuals, can be specified either as a number, or as a range of numbers, or a range of numbers plus a best estimate (MILLAKU *et al*., 2013).

**Results and Discussion**

From 11 geophyte plant species that have been analyzed, we have the following results in regard to their IUCN based threat category in Kosovo: *Aristolochia merxmuelleri* Greuter & E.Mayer, *Colchicium hungaricum* Janka, *Crocus flavus* Watson., *Tulipa kosovarica* Shuka, L. Tan, K. & Krasniqi, E., and *Tulipa gesneriana* L. all belong to the "Critically Endangered (CR)" threat category (Fig. 2). This is mainly as a result of low number of mature individuals found in the corresponding habitats. We have two geophyte plant species categorized as "Endangered (EN)": *Crocus kosanini* Pulevic and *Fritillaria messanensis* subsp. *gracilis* (Ebel) Rix. their area of occupancy was less than 300 km$^2$ (Fig. 3). Other two geophyte plant species: *Epimedium alpinum* L. and *Paeonia peregrina* Mill. have been categorized as "Vulnerable (VU)" due to the fact that a decrease in the number of mature individuals has been noticed as a result of human settlements and activities (Fig. 4). While two last geophyte species that we have investigated: *Gentiana punctata* L and *Lilium albanicum* Griseb. have been categorized as "Least Concern (LC)" due to the fact that they are abundant at the given moment, though they can be threatened in the near future (Fig. 5).

As serpentine soils derive from ultramaphic rocks formed from hydrative and metamorphic transformation of rocks from the earth's mantle (CHIARUCCI *et al*., 2007), they do give rise to an unusual and sparse plant associations that are tolerant to extreme soil conditions, including lack of essential plant nutrients (as nitrogen, potassium and phosphorous) (FRAZELL *et. al,* 2009). There are plenty of known examples of serpentine soils and distinctive ecologic plant communities associated with them (ALEXANDER *et al*., 2007).

In our study, we have analyzed eleven geophyte plant species that are found in serpentine soils, with few exceptions being found also in calcareous or silicate substrate (Table 1) and tried to correlate their scarcity, their life form and therefore their threat status to their habitat soils. As known, plants growing in these soils must tolerate calcium deficiency, drought, poor-quality soils, exposure to heavy metals and full sun. Geophytes in the other hand have their underground storage organs, chiefly for storing water and energy (carbohydrates) enabling them to survive in these extreme environment conditions. Out of 11 studied geophyte plant species five are Balkan endemics and one is stenoendemic (*Tulipa kosovarica* Shuka, L. Tan, K. & Krasniqi, E.). While, regarding their conservation status, from these eleven investigated geophytes we have five "Critically Endangered (CR)", two "Endangered (EN)" geophyte plant species, two "Vulnerable (VU)" geophyte plant species and two geophyte plant

species that have been categorized as "Least Concern (LC)" due to the fact that they are widespread and we have abundant data on their situation.

**Table 1.** Species distribution and correlating data.

| Pop. code | Species | Locality(ies) name | Altitude (m) | Geographical substrate | Ecological conditions of species habitat |
|---|---|---|---|---|---|
| 001 | *Colchicum hungaricum* Janka | Gadime, Guranë | 650 up to 700 | Serpentine, Calcareous | Limited dispersal area and very low number of mature individuals. |
| 002 | *Crocus flavus* Watson | Guranë | 692 | Serpentine | Very low number of mature individuals. |
| 003 | *Aristolochia merxmuelleri* Greuter & E.Mayer | Mirushe | 470 | Serpentine | One population with limited dispersal area. |
| 004 | *Tulipa gesneriana* L. | Krevenik | 583 | Serpentine | One population with limited dispersal area. |
| 005 | *Tulipa kosovarica* Shuka L, Tan K, Krasniqi E. | Mirushe, Llapushnik, Guriq | 650 up to 900 | Serpentine | Three populations with very low no. of mature individuals. |
| 006 | *Crocus kosaninii* Pulevic | Kaçanik, Brezovice, Blinaje, Guranë | 600 up to 2000 | Serpentine | Extreme limited dispersal areal in four populations. |
| 007 | *Fritillaria messanensis subsp. gracilis* Rix. | Lumëbardh i Pz., Vrellë, Syne, Rusoli, Maja e Vjellakut, Gryka e Rugovës | 440 up to 1900 | Serpentine, Calcareous | Each of 3 bigger populations in Kosovo is characterized with low no. of mature individuals. |
| 008 | *Lilium albanicum* Griseb. | 34 localities in Albanian Alps of Kosovo and Sharri Mountains | 684 up to 2479 | Serpentine, Calcareous | Despite of distribution, its populations are always characterized with low. no. of mature individuals. |
| 009 | *Gentiana punctata* L. | 31 localities in Albanian Alps of Kosovo & Sharri Mt. | 1000 up to 2445 | Serpentine, Silicate | Species populations are widely distributet. Stable. |
| 010 | *Paeonia peregrina* Mill. | Gllarevë, Gërmi, Gazimestan | 570 up to 765 | Serpentine, Calcareous | Species is characterized with stable populations though their habitats are subject of human activity. |
| 011 | *Epimedium alpinum* L. | Bokat e Morinës | 500 up to 1100 | Serpentine | Limited dispersal area. |


**Fig. 2** – Critically endangered (**CR**) plant species. **1**. *Colchicum hungaricum* Janka., **2**. *Crocus flavus* Watson, **3**. *Aristolochia merxmuelleri* Greuter & E. Mayer, **4**. *Tulipa gesneriana* L., **5**. *Tulipa kosovarica* Shuka L, Tan K, Krasniqi E.


**Fig. 3** - Endangered (**EN**) plant species. **1**. *Crocus kosaninii* Pulevic., **2.** *Fritillaria messanensis subsp. gracilis* Rix.

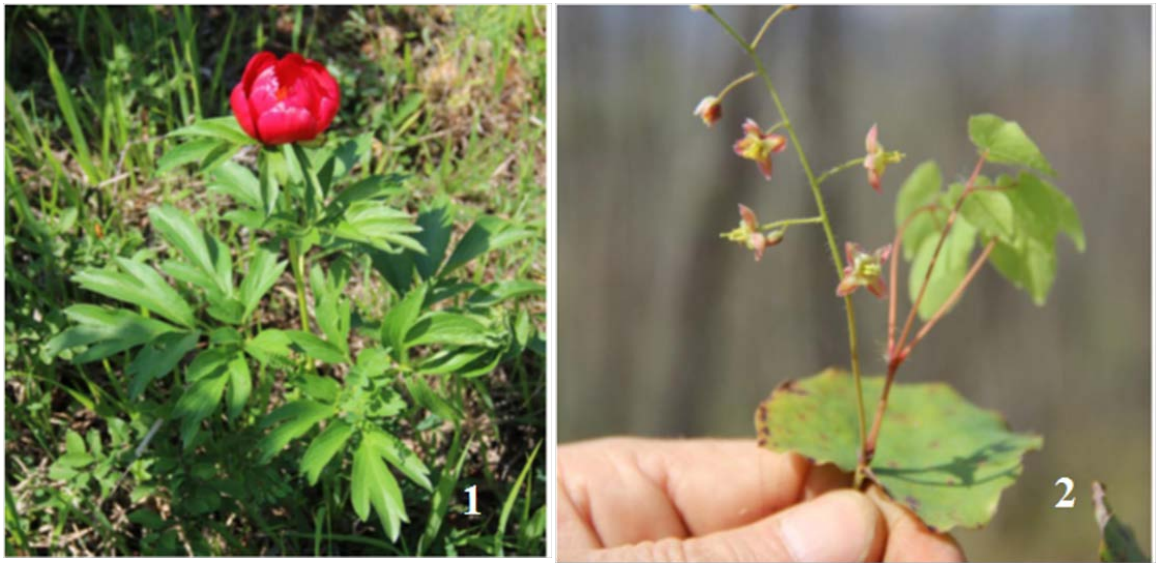


**Fig. 4 -** Vulnerable (**VU**) plant species. **1**. *Paeonia peregrina* Mill. **2**. *Epimedium alpinum* L.


**Fig. 5** – Least Concern (**LC**) plant species. **1**. *Lilium albanicum* Griseb., **2**. *Gentiana punctata* L.

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