

Sympatric area and ecology of some *Tulipa* species in the West Balkan Peninsula

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Abstract: Seven taxa of *Tulipa* grow in the Republic of Kosovo, out of which, three are stenoendemic species (*T. luanica*, *T. kosovarica* and *T. serbica*), one is local endemic species (*T. scardica*), whereas species *T. gesneriana* and species *T. sylvestris* which is represented with two subspecies (*T. sylvestris* subsp. *australis* and *T. sylvestris* subsp. *sylvestris*), have wider distribution. The paper deals with the 5 taxa; two are endemic species (*T. luanica*, *T. kosovarica*) and 3 taxa (*T. gesneriana*, *T. sylvestris* subsp. *australis* and *T. sylvestris* subsp. *sylvestris*) that are distributed in a sympatric area in serpentine substrate in the Deva locality, in the south of Kosovo, close to the border with Albania. Species of *T. kosovarica* forms three small populations in the serpentine substrate in the central part of Kosovo, while species of *T. luanica* have been found in the limestone substrate in the Pashtriku Mt (S. Kosovo). In the serpentines of Deva, populations of the two endemic species of tulips, as well as *T. gesneriana* and two subspecies of *T. sylvestris*, have been recorded. The presence of two endemic species as well as *T. gesneriana* and *T. sylvestris* subspecies in an area of only 18 km², makes this place particular importance center of distribution for tulips in the Western Balkans.

Keywords: endemic, Kosovo, serpentines, taxa, *Tulipa*.

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Introduction

The Balkan Peninsula is very rich in terms of floristic composition. According to STEVANOVIĆ (2005) and STEVANOVIĆ et al. (2007), there are somewhere between 2600–2700 Balkan endemics (species and subspecies), out of which 300 taxa belong to the obligate endemic serpentinophytes (STEVANOVIĆ et al. 2003) and 170 Balkan endemic geophytes from the class Liliatae (TAN et al. 2007). Within the Balkan peninsula, in spite of its small territorial area (10.908 km²), the Republic of Kosovo is very rich in its floristic and vegetation aspect, due to its continental and modified sub-Mediterranean climate, topography and geology. The total number of vascular plant species is estimated as ca. 2800–3000 (MILLAKU et al. 2013) and comprise diverse floristic elements, in particular the Balkan endemics and paleo-endemics. According to the Kosovar Ministry of Environment, the biodiversity ‘hot-spots’ are the Sharri mountains in the southwest, the Albanian Alps (Bjeshkët e Nemuna) in the northwest, and the Koritniku and Pashtriku mountains, both situated in the south of Kosovo. A high percentage of the endemic plant taxa are found also exclusively on the serpentines of Kosovo, which are situated in the north, central and southern parts of Kosovo. In the Sharri Mountains and in the Albanian Alps of Kosovo there have been 12 endemic plant species recorded (REXHEPI 1982), while according to STEVANOVIĆ (1996) are 15 local endemics.

The global centre of distribution for tulips is considered to be the mountain range of Pamir and Tian Shin in central Asia (BOTSCHANTZEVA 1982), while in the Balkan peninsula the richest countries with tulip species are Greece, with eight species (*Tulipa australis* Link, *Tulipa celsiana* DC., *Tulipa cretica* Boiss. and Heldr., *Tulipa goulimyi* Sealy and Turrill., *Tulipa hageri* Heldr., *Tulipa orphanidea* Boiss. ex Heldr., *Tulipa saxatilis* Sieber ex Spreng. and *Tulipa agenensis* DC.); Bulgaria, with four species (*Tulipa orphanidea*, *Tulipa celsiana*, *Tulipa hungarica* Borbás and *Tulipa sylvestris* M.Bieb.); Macedonia, with four species (*Tulipa biflora* Pall., *Tulipa polychroma* Stapf., *Tulipa sylvestris* subsp. *australis* (Link) Pamp. and *Tulipa scardica* Bornm.); and Serbia, with three species (*Tulipa sylvestris*, *Tulipa hungarica* and *Tulipa undulatifolia* Boiss.).

In this context, Kosovo is highly specific due to the fact that there are seven taxa of genus *Tulipa* present: *Tulipa luanica* Millaku, *Tulipa kosovarica* Kit Tan, Shuka and Krasniqi, *Tulipa serbica* Tatic and Krivošej, *Tulipa scardica* Bornm., *Tulipa gesneriana* L. and *Tulipa sylvestris* L. subsp. *australis* and *T. sylvestris* L. subsp. *sylvestris* (Fig. 1). The *Tulipa* genus is represented with two stenoendemic species: *Tulipa kosovarica* and *Tulipa serbica*, found only in the serpentines of Kosovo. Also in the same habitat are *T. gesneriana* and the two subspecies *Tulipa sylvestris* L. subsp. *sylvestris* and *Tulipa sylvestris* subsp. *australis* (Link) Pamp. In the Pashtriku Mt (Southern Kosovo) in calcareous substrate a new stenoendemic species from the genus *Tulipa* has been discovered: *Tulipa luanica* Millaku (MILLAKU & ELEZAJ, 2015). During the period 2013–2016, in the serpentines of southern Kosovo, starting from Pashtriku Mt up to Qafa e Prushit–Deve, a region very rich with populations of four *Tulipa* species

has been found (*T. kosovarica*, *T. gesneriana*, *T. luanica* and *T. sylvestris* with two subsp.: *T. sylvestris* subsp. *australis* and *T. sylvestris* subsp. *sylvestris*).

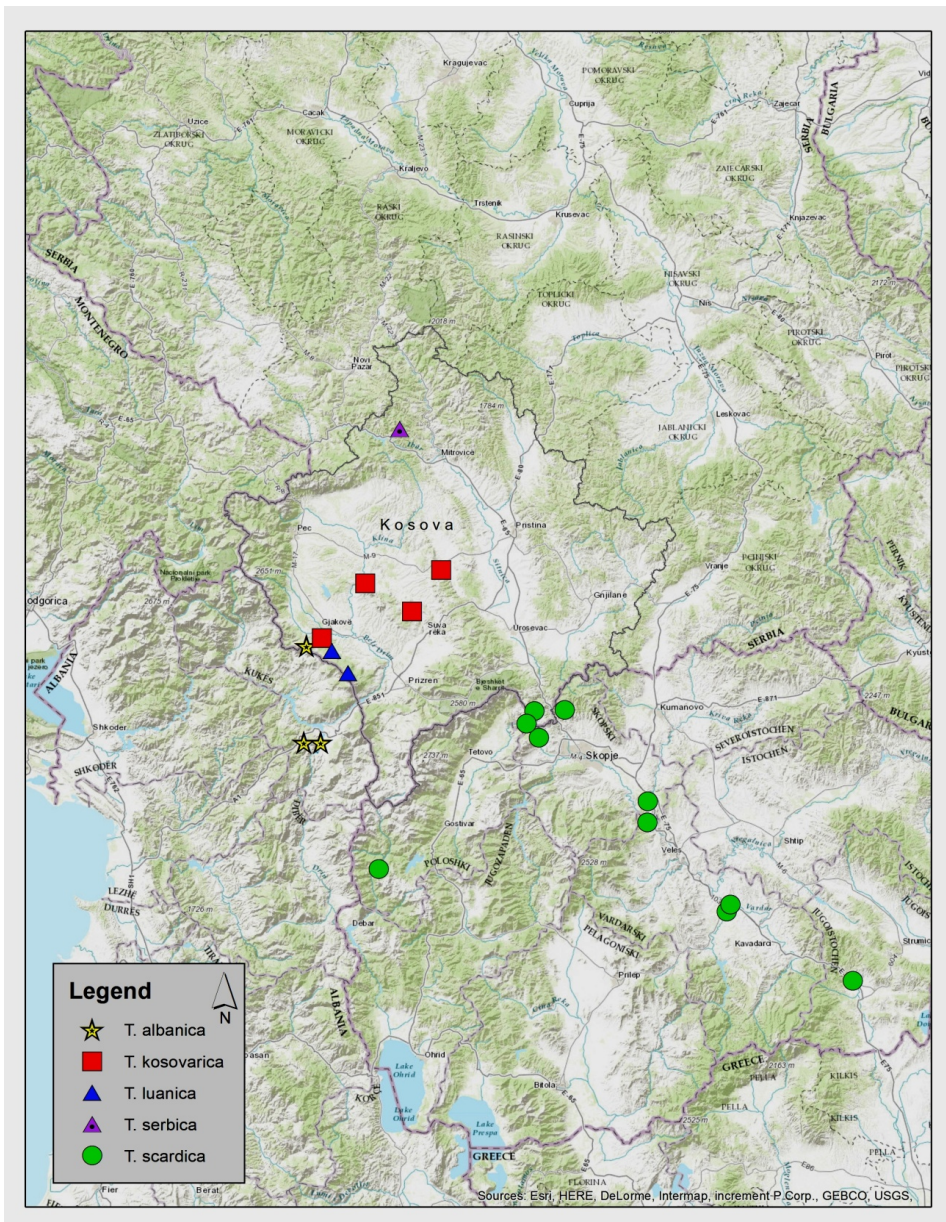


Fig. 1. Distribution of *T. albanica*, *T. gesneriana*, *T. kosovarica*, *T. luanica*, *T. serbica* and *T. scardica* in SE Europe.

Material and methods

During 2015 – 2016 all known populations of *Tulipa* species in Kosovo have been studied (in following localities: Mirusha, Guriç, Llapushnik, Krivenik, Pashtrik), except of *Tulipa serbica* populations, for which data are taken from literature sources (Mt Rogozna and Beli Laz – TATIĆ & KRIVOŠEJ (1997), STEVANOVIĆ (ed.) et al. (1999) and herbarium samples (Herbarium of the Faculty of Natural Sciences and Mathematics, University of Prishtina, Kosovo). Studies were based on field observations; the specimens were surveyed on their habitats, in particular during each species flowering time. Plant specimens were taken from populations for Herbarium deposition. Deeper analysis and comparisons between species were made on the lab. of botany in the Department of Biology, Prishtina University. Counting of the mature individuals was done using the random counting method (TILLÉ 2006). Ten measurements were made, each having 10 x 10 m²; all mature individuals inside of the circled area were counted and the average numbers were calculated. Determination of the plant species was made using adequate literature sources like: Flora Europaea (5 volumes, 1964 – 2001), using regional floras like: Flora of Albania (IV volumes, 1988-2000), Flora of Serbia (volume VII - 1975), Red Data Book of Vascular Plants of the Republic of Kosovo (MILLAKU (ed) 2013), as well as using other relevant books and keys.

General data about studied area

Locality Qafë Prush – Devë belongs to the western part of Balkan Peninsula, located in the South-West of Kosovo. From its west, it is bordered with serpentinite massif of Morina that continues towards the Albanian Alps of Kosovo; while from its east the Pashtriku Mt is located. Study area is characterized by sub-Mediterranean climate conditions which arrive the site through the Drini i Bardhë river valley. The average annual rainfall is 996 mm, while the lowest level of rainfall is during the months of June - September (only 137 mm) or only 13% of the annual rainfall amount (MILLAKU 2003). The average annual temperature is 9° to 13°C (AVDULLAHI et al. 2007). Locality Deva – Qafë Prush is part of the tectonic Mirditë - Gjakovë ophiolite belt (ELEZAJ & KODRA 2008). Based on Geological map of Kosovo in scale 1:200 000, terrain is composed of Middle Jurassic ophiolites, which are composed of peridotites, dunites, partly serpentinitised. Locality is composed by Lithosols like rendzina on serpentinite or brownised rendzina on serpentinite (NEJGEBAUER et al. 1961). The soil is very thin, consisting of very gravely / stony rock fragments that originated mainly from partially weathered rocks (Syrosem). In the mountainous areas, lithosols are endangered by erosion. They are less suitable for agriculture. Mainly, they are used as grassland or for forestry.

Results and discussion

Tulipa gesneriana L. (Liliaceae) is distributed in France, Switzerland, Spain, Italy, The Russian Federation, North Caucasus, and Turkey (Euro+Med 2006-2017).

The same species has been recorded in the serpentines of Deva (Fig. 2), in the south of Kosovo. *Tulipa kosovarica* has been discovered on serpentine substrates in open thermophilous woodland dominated by species *Quercus pubescens* Willd. and *Juniperus oxycedrus* L. in only two localities (Mirusha area and Guriq), in the southeast of Kosovo (SHUKA et al. 2012), while according to MILLAKU (ed., 2013) the species has been recorded also in serpentine substrate in dry grassland and open thermophilous woodland dominated by *Q. pubescens* in the Llapushnik locality, belonging to the Mountains of Drenica, in central Kosovo (Fig. 3).

Tulipa scardica, is distributed in the Vardar valley in Macedonia and Krivenik, southern Kosovo. *Tulipa kosovarica* and *T. scardica* have a limited number of mature individuals, and for this reason are listed in the Red List of the vascular Flora of the Republic of Kosovo, being protected and categorized as CR: Critically Endangered. During 2015-2016, the biggest population of *T. kosovarica* was found, in serpentines substrates of Deva Mt in the border line with Albania. The population of these species has been recorded at more than 5.000 mature individuals, distributed in the south of Kosovo, in the area between Qafë - Prush and Deva Mt, starting from 600 up to 900 m (a.s.l). In spite of recent findings about the distribution of this *Tulipa* species, we conclude that it shall again remain in the same category of threat as described by MILLAKU (ed., 2013), reason for this being the fact that species AOO (Area of Occupancy) is less than 10 km² and furthermore its populations are endangered by mines, rockers and constant zoo-anthropogenic activities. Some plant specimens were recorded also in the area inside of Albania along the borderline. *Tulipa luanica* has been recorded and described from the Pashtriku Mt (southern Kosovo), exclusively in calcareous substrate (MILLAKU & ELEZAJ 2015). During 2016, three subpopulations (a subpopulation is defined as an identifiable fraction or subdivision of a population – Subpopulation n.d.) of the same species were found in Pashtriku Mt in calcareous substrate and one population was recorded in the serpentines of the Qafa e Prushit and Deva Mt localities. The frequency of distribution of *T. luanica* on these habitats was seen to have a growing gradient from the eastern to the western part of the area. This is supported by the fact that the distribution centre of these species is Pashtriku Mt, which is bordered with the serpentines of Qafa Prushit - Deva. Additionally, except for the above-mentioned species of tulips (*T. gesneriana*, *T. kosovarica* and *T. luanica*), in the same area we have recorded the presence of *Tulipa sylvestris* subsp. *sylvestris* at an altitude from 800 to 900 m (a.s.l); and *Tulipa sylvestris* subsp. *australis* at an altitude of 500 to 900 m (a.s.l). In serpentines of the studied area (Qafë Prush-Devë) populations of the following five taxa from the genus *Tulipa* have been recorded: *T. gesneriana*, *T. kosovarica*, *T. luanica*, *T. sylvestris* subsp. *australis* and *T. sylvestris* subsp. *sylvestris*. The recorded species belong to the following plant associations: Polygalo–Genistetum hassertianae Blec. et al. 1969 (Fig. 4); Hyperico–Euphorbietum glabriflorae Rexhepi 1978, that belong to the Alliance Centaureo – Bromion fibrosi Bleč. et al. 1969; and Order Halascyetalia sendtneri H. Ritter – Studn. 1970, where the endemic species: *Genista hassertiana* (Bald.) Buchegger, *Euphorbia glabriflora* Vis. and *Halascya sendtneri* (Boiss.) Dörfner are the most prevalent species.



Fig. 2. *Tulipa gesneriana* L. with rose color of perianth segments.



Fig. 3. *Tulipa kosovarica* Shuka, Tan and Krasniqi, as recorded in sympatric area.



Fig. 4. Sympatric area – *T. kosovarica* Shuka, Tan and Krasniqi (A) and *T. luanica* Millaku (B) sharing their habitat with *Genista hassertiana* (Bald.) Buchegger and *Euphorbia glabriflora* Vis.

Population of *T. kosovarica* was found under the endemic community: Ass. Polygalo-Forsythietum europaeae Blec. et Krasniqi 1972 and Ass. Astero-Juniperetum oxycedri Rexhepi 1990, which belongs to the Alliance Prunotennele – Syringion Fukarek 1979 and the Order Quercetalia pubescentis Br.Bl. 1932. The individuals of *T. kosovarica* and *T. gesneriana* have been recorded also in open thermophilous woodland (Habitat type G1.7a Temperate and submediterranean thermophilous deciduous woodland – JANSSEN et al. 2016), dominated by the *Q. pubescens*, while the individuals of *T. luanica* have been recorded also within the thermophilous woodland, dominated by *Ostrya carpinifolia* Scop. and endemic *Dioscorea balcanica* Košanin. The population of the *T. kosovarica* dominates the habitat in comparison to the *T. luanica* and *T. gesneriana*, which have far fewer mature individuals present. The *T. kosovarica* species has been recorded also on dry grasslands, which are dominated by *Stipa pulcherrima* K. Koch. (Fig. 5). Data concerning locality, exposition, altitude, vegetation type, substrate, number of population(s) and subpopulation(s), number of mature individuals as well as conservation status are presented in Table 1. The main threats affecting these plant species are mines and mining activities, wild and human induced fires as well as collection from natural habitats.



Fig. 5. *Tulipa kosovarica* Shuka, Tan and Krasniqi on dry grasslands, where *Stipa pulcherrima* K.Koch is dominant.

New findings

According to SHUKA et al. (2012), the description of the leaf morphology for *T. kosovarica* states that the margins of the leaf are ciliolate in basal 2/3. After carefully analyzing more than 100 specimens of the species, we found that 55% of the specimens had leaf margins ciliolate throughout and only 45% had leaf margins ciliolate in basal 2/3. The perianth color of *T. kosovarica*, as described by SHUKA et al. (2010) is cerise–magenta, while in the studied sympatric area except described specimens according to SHUKA et al. (2010) are found some individuals with white perigon segment (Fig. 6) – for which we conclude that it represents a new form – *Tulipa kosovarica* f. *alba* Millaku. Within the sympatric area, natural hybrid individuals between *T. kosovarica* and *T. gesneriana* were recorded (*Tulipa kosovarica* Shuka, Tan & Krasniqi x *Tulipa gesneriana* L.) that shared inherited morphological traits deriving from the pollination process. The two individuals had half of their perigon base colored in yellow (an inherited trait from *T. gesneriana*) and the other half of the perigon base colored in white (an inherited trait from *T. kosovarica*) (Fig. 7). Other natural hybrid specimens were recorded also with other shared characteristics, sharing traits from *T. luanica* and *T. gesneriana* (*Tulipa luanica* Millaku x *Tulipa gesneriana* L.). On these particular specimens, the perigon base was colored in yellow, just as it is in *T. gesneriana*, while the perigon itself was colored in pink. The pollen grains had violet colors that were obvious traits of *T. luanica*. These data on natural hybrid species of tulips found in this area of Balkans are of importance, because it is known that it plays a crucial role in evolution, a feature that tends to be prone to certain families and genera of plants (ELLSTRAND et al. 1996).

Tab. 1. Specific information for each tulip species population.

Species	Locality	Exposition	Altitude (m a.s.l.)	Vegetation type	Substrate	No. of populations /subpopulations	No of mature individuals	Area of occupancy (AOO)
<i>Tulipa kosovarica</i>	Mirushë, Guriç, Llapushnik, Qafë - Prush, Devë	North	420 660 732 550	Thermophilous woodland & Dry grasslands	Serpentine	4	ca. 5000	20 km ²
<i>Tulipa luanica</i>	Pashtrik, Qafë - Prush, Devë	North / East	1000 540	Thermophilous woodland & Dry grasslands	Limestone Serpentine	1 / 3	ca. 4000	10 km ²
<i>Tulipa scardica</i>	Krivenik	North	980	Thermophilous woodland	Serpentine	1	ca. 100	< 1 km ²
<i>Tulipa gesneriana</i>	Qafë - Prush, Devë	North	540	Thermophilous woodland	Serpentine	1	ca. 200	<10 km ²
<i>Tulipa sylvestris</i> subsp. <i>australis</i>	Spread in all serpentines of Kosovo	In all expositions	530 810	Thermophilous woodland, Xerophilous meadows & Dry grassland	Serpentine	> 30	uncountable	ca 900 km ²
<i>Tulipa sylvestris</i> subsp. <i>sylvestris</i>	Morinë, Golesh, Qafë - Prush, Devë	North, East	645 975	Dry grasslands, Thermophilous woodland	Serpentine	< 10	uncountable	ca 300 km ²
<i>Tulipa serbica</i>	Beli Laz, Mt Rogozha	North	900 950	Xerophilous meadows	Serpentine	2	ca. 2000	98 km ²



Fig. 6. *Tulipa kosovarica* Shuka, Tan and Krasniqi individuals with perianth segment colored in cerise-magenta and *Tulipa kosovarica* f. *alba* Millaku with white color of perianth segment.



Fig. 7. Hybrid specimen (*T. kosovarica* x *T. albanica*).

Discussion

Based on the conducted research, we have noticed that the genus *Tulipa* is present almost entirely in the serpentines of the south of Kosovo (Deva locality) in one small area, including the following species: *T. kosovarica*, *T. gesneriana*, *T. luanica* and *T. sylvestris*, with the two subspecies *T. sylvestris* subsp. *australis* and *T. sylvestris* subsp. *sylvestris*.

The population of the *T. kosovarica* in the sympatric area (Qafë Prush–Deva) has a considerably larger number of mature individuals compared to the populations of the species in Mirusha, Llapushnik and Guriq, which were recorded earlier by MILLAKU (ed., 2013) and SHUKA et al. (2012). The population of *T. luanica* and *T. gesneriana* in the sympatric area have a very low number of mature individuals compared to the population of the species in Pashtriku Mt (MILLAKU & ELEZAJ 2015). Within the sympatric area, spontaneous natural hybridization between the species: *T. kosovarica* x *T. gesneriana* as well as fewer hybrid species between *T. kosovarica* x *T. luanica* has been recorded.

While the climatic and ecological conditions are more or less the same, we consider that the *T. kosovarica* species can be distributed further in similar habitats in the serpentines of the northern Albania.

The species *T. gesneriana*, *T. kosovarica* and *T. scardica* are protected by law in Kosovo, enlisted in the Red List of Vascular Flora of the Republic of Kosovo (AMMK 2016); The populations of the species *T. luanica* and *T. serbica* should be protected and their size monitored.

We conclude that for *Tulipa* species of Kosovo and the Balkans the molecular analysis are of crucial importance to be conducted. Only that way we would be able to gain more accurate taxonomic definitions, taking into account also the species high variability. Results show that Kosovo is the home of three stenoendemic species of tulips (*T. kosovarica*, *T. luanica* and *T. serbica*), one local endemic (*T. scardica*) and three taxa: *T. gesneriana* and *T. sylvestris* (*T. sylvestris* subsp. *sylvestris* and *T. sylvestris* subsp. *australis*), which have a broad range of distribution. This presence of seven taxa of *Tulipa* in Kosovo makes it an important regional and global habitat of the native species of the genus *Tulipa*.

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