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CONTENTS

Preface

Bibliography (monograph articles):

- Mandžukovski D.
**THE LIFE AND WORK OF PROF. DR. RADOŠLAV RIZOVSKI (16.IX 1935 – 20.VII 2008)
80 YEARS SINCE THE BIRTH OF AND OVER 40 YEARS OF EDUCATIONAL AND SCIENTIFIC
ACTIVITY** 1
-

Original Scientific Articles:

- Baričević D., Vukelić J., Puača M., Šapić I.
**A PHYTOCOENOLOGICAL STUDY OF FORESTS OF HUNGARIAN OAK AND TURKEY OAK
(QUERCETUM FRINETTO-CERRIDIS /RUDSKI 1949/ TRINAJSTIĆ ET AL. 1996) ON THE
NORTHWEST BORDER OF ARRIVAL (NATURE PARK PAPUK, CROATIA)** 7
- Dimitrov M., Natcheva R., Ganeva A., Gyurova D.
PLANT BIODIVERSITY OF SPHAGNUM-DOMINATED MIRES IN VITOSHA NATURE PARK 15
- Kutnar L., Eler K.
**PLANT SPECIES DIVERSITY AND INVASIBILITY OF (PERI-)URBAN FORESTS OF
LJUBLJANA, SLOVENIA** 30
- Melovski Lj., Hristovski S.
**FIRST RECORDS FOR SEVEN SPECIES AND ONE HYBRID FOR THE FLORA OF THE
REPUBLIC OF MACEDONIA** 36
- Nikolov I., Dimitrov M.
BOREO-MONTANE FOREST PHYTOCOENOSES IN CENTRAL STARA PLANINA MTS. 43
- Novaković-Vuković M., Milošević R.
**ANALYSIS OF FLORISTIC COMPOSITION OF MOUNTAIN BEECH FOREST ON LIMESTONE
AND SERPENTINE IN SERBIA** 55
- Pedashenko H., Vassilev K., Bancheva S., Delcheva M., Vladimirov V.
**FLORISTIC AND VEGETATION DIVERSITY IN KONGURA RESERVE (SOUTH-WEST
BULGARIA)** 59
- Teofilovski A., Nikolov Z., Mandžukovski D.
JUNCUS FILIFORMIS L. (JUNCACEAE), A NEW SPECIES IN THE FLORA OF MACEDONIA 71
- Vassilev K., Gavrilova A.
**FLORA, HABITATS AND VEGETATION OF CHAMDZHA MANAGED RESERVE, CENTRAL
BALKAN RANGE** 74
- Vukelić J., Šapić I., Baričević D.
**FLORISTIC-VEGETATIONAL VARIABILITY OF THE ASSOCIATION EPIMEDIO-
CARPINETUM BETULI (HORVAT 1938) BORHIDI 1963 IN THE NORTH OF CROATIA** 88
-

Instructions to Authors

ANALYSIS OF FLORISTIC COMPOSITION OF MOUNTAIN BEECH FOREST ON LIMESTONE AND SERPENTINE IN SERBIA

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ABSTRACT: The paper is floristic composition comparative research of mountain beech forests on serpentine in southwestern Serbia, and beech forests on limestone in eastern Serbia. The analysis showed that there are significant differences in the floristic composition. On the serpentine bedrock a low count of plant species was recorded, Jacquard's similarity index of studied stands had a very low value. Within phytocoenological relevés made on limestone bedrock, the most typical species of beech forests appear as isolated, while in the beech forests on serpentine, xerophyl species characteristic to the order *Erico - Pinetalia* and *Quercetalia pubescentis* were observed, in addition to "fagetal" species. In the spectrum of life forms on both the geological substrate hemicryptophytes dominated, and phanerophytes and nanophanerophytes of serpentine had the significant presence, as a result of warmer climate in southwestern Serbia. In geofloristic spectrum, a group of submediterranean floral elements, which are connected with Balkan floral elements, is as twice as numerous in the mountain beech forest on serpentine than on limestone, which is another indicator of southwestern Serbia's exposure to submediterranean influence.

Keywords: beech, serpentine, limestone, southwest Serbia, eastern Serbia.

1 INTRODUCTION

Beech is the most ubiquitous tree species in Serbia with the widest altitudinal distribution, arising from a broad ecological amplitude in regard to climatic factors (light and temperature), and edaphic factors (geological substrate and soil types), and slightly lower amplitude compared to the humidity of habitat [8]. It occurs in most parts of Serbia, except in the Pannonian Plain, with the exception of Fruška Gora and Vršac Mountains [2]. On the territory of Serbia beech forests cover 660,400 ha (29.3% of the total covered area), out of which is 64.7% is in government property [1]. Considering that the beech communities are widespread in almost all mountain massifs in Serbia, their soils were formed on different rocks which vary in textural characteristics, chemical and mineral composition, as well as in resistance and products created in their degradation process [5]. Within beech forests, several basic types of substrate can be defined, considering the importance of the parent substrate for the genesis and soil properties [6]: carbonate rocks, acidic and neutral silicate rocks and mafic silicate rocks. Beech forests have very diverse botanical composition, considering their prevalence and effect of orographic-edaphic factors, so they include a large number of phytocoenoses. One of them is a mountain beech forest (*Asperulo odoratae-Fagetum moesiaca* B. Jovanović in 1973., Syn. *Fagetum moesiaca montanum* B. Jovanović 1953.; *Fagetum montanum asperuletosum* B. Jovanović 1973), which represents a powerful climate-regional belt of vegetation on the territory of Serbia, as well as the most abundant and economically important type of beech forest and Serbian woodland in general [11]. Aim of the paper was to determine the extent of the differences in the floristic composition between mountainous beech forests on serpentine and limestones, which would contribute to a better knowledge of beech forests on different geological substrates, since these forests are of great importance for Serbia.

2 MATERIAL AND METHOD

The study of mountain beech forests floristic composition (*Asperulo odoratae-Fagetum moesiaca* B. Jovanović 1973) was based on 24 phytocoenological relevés that were obtained from literature. 14 phytocoenological relevés were sampled in the mountain beech forest on serpentine bedrock on Crni vrh near Priboj [12], another 10 were sampled in the mountain beech forest on Mount Ozren - Sokobanja, on a limestone substrate [3]. Syntaxonomic names follow [16]. CA vegetation data analysis was performed using the statistical software CANOCO 4.5 [9]. Indexes of diversity and equivalence (Shannon -Wiener diversity index and Evenness) were calculated in the program JUICE 7.0 [15]. Jaccard's similarity index of investigated stands was also calculated [10]. The spectrum of floral elements was made according to the systematization of phytogeographical elements [4], and spectrum of life forms [7].

3 RESULTS AND DISCUSSION

64 species were recorded in mountain beech forest on serpentine and 77 species in beech forest on limestone. The conclusion is that the beech forest on limestone is floristically richer than on the serpentine, although the analysis included a smaller number of phytocoenological relevés on limestone than in the serpentine [14] compared the vegetation of limestone and serpentine in Bosnia and came to the conclusion that the serpentine, unlike limestone, sees great uniformity in terms of growing vegetation and poorness in the number of species. It should be noted that the serpentine bedrock is very unfavorable for the development of the plant world, on which only plants that have managed to adapt to life on this inhospitable bedrock can survive. The same conclusion is reached by analyzing the floristic composition of beech forests on serpentine and limestones in Serbia. Floristic composition analysis of mountain beech forests on Pešter, on limestone and silicate bedrock, also showed greater floristic richness of this forest on limestone, but this phenomenon is explained by higher degradation and more open set of studied stands, which enables settlement to a large number of species [13].

Mountain beech forests on both serpentinite and limestone within studied stands occupy mainly same expositions - northern and northwestern. They are also located on similar inclinations - inclinations on serpentinite are in 5-40° range, while inclinations on limestone are in 0-30° range. Mountain beech forests on serpentinite are registered in 560-800 m elevation range, while stands on limestone are registered on elevations between 810-870 m. Based on all of the above-mentioned, it can be concluded that geological substrate is the primary factor that affects floristic composition in the studied stands of mountain beech forest on serpentinite and limestone. Jaccard's index of similarity of studied stands [10] is:

$$J = \frac{UV}{V + U - UV} = 0.24, \text{ where is}$$

UV- the number of common species,
 U, V- the number of species in mountain beech forest on serpentinite and limestone, respectively.

Jaccard's similarity index shows that although this is the same community, floristic similarity among the studied stands is low.

Ordinate system (Fig. 1) shows that, although it is one plant community, phytocoenological relevés diverge depending of the geological basis. Within phytocoenological relevés made on limestone bedrock, in the negative part of the coordinate system, "fagetal" species appear as isolated: *Asperula odorata*, *Isopyrum thalictroides*, *Cardamine bulbifera*, *Anemone ranunculoides*, *Salvia glutinosa* and others. On the other hand, within the beech forests on serpentine, in addition to "fagetal" species, xerophyl species characteristic for *EricoPinetalia* and *Quercetalia pubescentis* orders: *Fraxinus ornus*, *Campanula patula*, *Polygonatum odoratum*, appear on the graph.

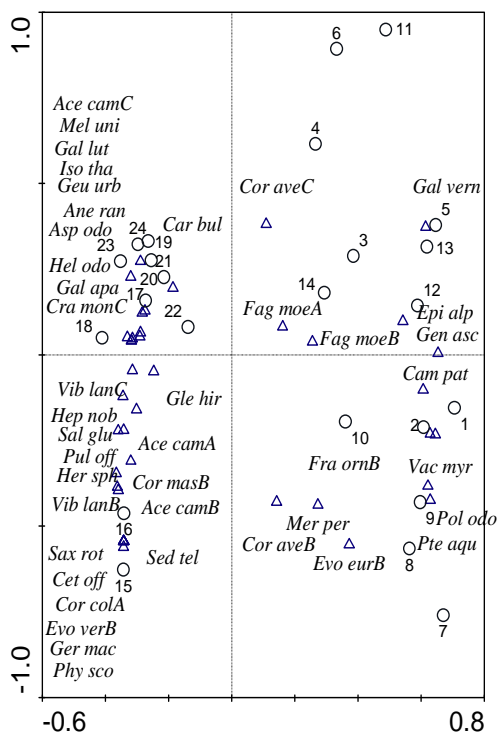


Figure 1: CA ordination biplot, fit range for the species 30-100%, 42 species (○-relevé representation, △-species representation; (1-14)- relevés on serpentinite; (15-24)- relevés on limestone

Species abbreviations: *Ace cam*-*Acer campestre*; *Mel uni*-*Melica uniflora*; *Gal lut*-*Galeobdolon luteum*; *Iso tha*-*Isopyrum thalictroides*; *Geu urb*-*Geum urbanum*; *Cor ave*-*Corylus avellana*; *Gal vern*-*Galium vernum*; *Ane ran*-*Anemone ranunculoides*; *Asp odo*-*Asperula odorata*; *Car bul*-*Cardamine bulbifera*; *Hel odo*-*Helleborus odoratus*; *Gal apa*-*Galium aparine*; *Cra mon*-*Crataegus monogyna*; *Fag moe*-*Fagus moesiaca*; *Epi alp*-*Epimedium alpinum*; *Gen asc*-*Gentiana asclepiadea*; *Vib lan*-*Viburnum lantana*; *Cam pat*-*Campanula patula*; *Gle hir*-*Glechoma hirsuta*; *Hep nob*-*Hepatica nobilis*; *Sal glu*-*Salvia glutinosa*; *Pul off*-*Pulmonaria officinalis*; *Her sp*-*Heracleum sphondilium*; *Cor mas*-*Cornus mas*; *Fra orn*-*Fraxinus ornus*; *Vac myr*-*Vaccinium myrtillus*; *Mer per*-*Mercurialis perennis*; *Pol odo*-*Polygonatum odoratum*; *Sax rot*-*Saxifraga rotundifolia*; *Sed tel*-*Sedum telephium*; *Pte aqu*-*Pteridium aquilinum*; *Evo eur*-*Evonymus europaeus*; *Cet off*-*Ceterach officinarum*; *Cor col*-*Corylus colurna*; *Evo ver*-*Evonymus verrucosa*; *Ger mac*-*Geranium machrorrhizum*; *Phy sco*-*Phyllitis scolopendrium* (the abbreviations following the species denotes A-tree layer, B-shrub layer, C-ground flora layer)

Shannon Wiener index (Table I) shows significant differences between the studied stands. This index has a much higher value in the mountain beech forest on limestone than on serpentinite, which is logical if we consider the number of recorded species, which is larger in the stands on limestone. On the other hand, Evenness index shows approximately equal value (Table I), provided that it's slightly higher in the mountain beech forest on limestone. Based on Evenness index it can be concluded that plant species do not have regular spatial distribution. As species that reduce the value of this index, we can mention the ones that are characterized by great number and coverage in a certain number of relevés: *Asperula odorata*, *Allium ursinum*, *Geranium machrorrhizum*, *Cardamine bulbifera* etc.

Table I: Indices of the diversity and evenness of mountain beech forest at the study sites

	Average Shannon-Wiener index	Average Evenness index
serpentinite	1.37	0.55
limestone	2.24	0.60

The life form spectrum (Fig. 2) reveals significant differences. Hemicryptophytes are dominant in mountain beech forest on limestone and serpentinite, which is a common occurrence in temperate zone climatic conditions, with the fact that they are about 10% more numerous on limestone than on serpentinite. On the other hand, phanerophytes have significant presence on serpentinite, a lot larger than on limestone (37.5%: 27.3%). Considering that the analysis of the spectrum of life forms shows plant species relation to the climate of a region, we can conclude that this phenomenon is due to a warmer climate in southwestern Serbia. Geophytes also have strong presence both in the beech on the serpentinite and on limestone (20.41%: 19.47%), which was expected, considering very mesophilic nature of beech

forests. Other life forms have approximately equal presence on both the geological substrata.

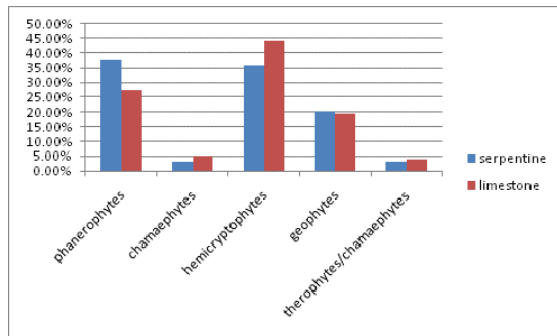


Figure 2: The spectrum of life forms for the community of mountain beech on limestone and serpentinite

Analysis of geofloristic spectrum (Fig. 3) also shows significant differences between the studied stands. In both cases, the most common as collective is Central European floral element. A group of species with wide ecological amplitude (Eurasian areal type) is the second most common on limestone. The biggest differences are reflected in the presence of a collective group of sub-Mediterranean floral elements, which are connected with Balkan floral elements. This group is as twice as numerous in the mountain forest of beech on serpentinite than on limestone, which is another proof that this community is more xerophilous on serpentinite than on limestone. Larger presence of group of subatlantic floral elements on limestone than on the serpentinite is indicator of more mesophilic conditions on limestone.

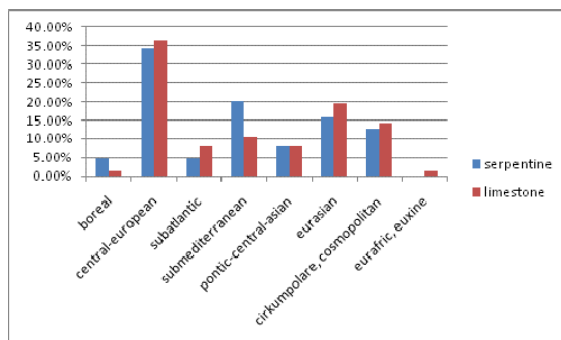


Figure 3: Spectrum of floral elements for the community of mountain beech on limestone and serpentinite

4 CONCLUSIONS

The paper is based on a comparison of the floristic composition of mountain beech forests (*Asperula odoratae-Fagetum moesiaca* B. Jovanović 1973) on limestone and serpentinite, based on 14 phytosociological relevés made in the mountain beech forest on serpentinite on Crni Vrh, close to Priboj, and 10 relevés made on limestone in Ozren-Sokobanja. The analysis showed significant differences. Jaccard's index of similarity on studied stands is 0.24, indicating a very low floristic similarity in studied stands. CA floristic data analysis showed relevés grouping into two groups, depending on the geological substrate. Within phytocoenological relevés made on limestone bedrock,

typical species of beech forests appear as isolated: *Asperula odorata*, *Isopyrum th alicroides* *Cardamine bulbifera*, *Anemone ranunculoides*, *Salvia glutinosa* and others. On the other hand, within beech forests on serpentinite, in addition to "fagetal" type, xerophilous species characteristic to the order *Erico - Pinetalia* and *Quercetalia pubescentis*: *Fraxinus ornus*, *Campanula patula*, *Polygonatum odoratum* are also visualized on the graphics.

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