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THE EFFECT OF ALTITUTDE ON THE PRESENCE OF PLANT SPECIES IN STANDS FOR JUNIPERUS L. PLANT SPECIES ON KOPAONIK

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ABSTRACT

In this paper we present an assessment of the altitude effect on the plant species presence in different plant communities – the species of *Juniperus* genus (*Juniperus communis* L., *Juniperus oxycedrus* L. and *Juniperus sibirica* Burgsdorf) on Kopaonik Mountain. Two juniper species (*Juniperus communis* and *Juniperus oxycedrus*) were recorded at altitudes ranging from 420 m to 1420 m, while the third species *Juniperus sibirica* was found at an altitude of 2100 m. It was determined that the plant communities with the presence of species of the *Juniperus* genus differ in botanical terms at different altitudes. It was found that there are plant species in certain communities that are present only at some altitudes, while others were present at almost all altitudes. The species of *Hypericum perforatum* L. is recorded in all of plant communities surveyed that proves its best adaptation to the conditions at different altitudes.

Keywords: Kopaonik Mountain, altitude, botanical composition, plant communities, *Juniperus* L., *Hypericum perforatum* L.

1. INTRODUCTION

Mountain regions are ideal for describing and studying the environmental responses of plant communities (Naqinezhad et al., 2009).

Kopaonik Mountain is located in the central part of the Balkan Peninsula and extends from northwest to southeast (NW-SE), between 20° 35' and 21° 18' of east longitude and 42° 43' and 43° 23' of north latitude. On the western side, Kopaonik massif is separated from geologically similar Rogozna and Golija with the valleys of the Ibar and Sitnica rivers. From the north, Kopaonik is separated with the valley of Jošanica River from the identical geological massif of Željina Mountain, and the whole area (Kopaonik-Željin) is bounded with the depression of the Morava River basin. From the South and Southwest the Lab River separates Kopaonik from Kosovo depression basin. The upper parts of the Rasina and Toplica rivers can be geographically regarded as the eastern border of Kopaonik massif (Gavrilović, 1979).

In terms of structure and morphology, the largest part of Kopaonik, especially its western part belongs to the so-called zone of internal Dinarides that was formed during the Alpine orogeny. The eastern parts of the Kopaonik massif are integral parts of the Serbian-Macedonian mass, and their basic geomorphological characteristics originated from hercin orogenesis, which means that they were morphologically shaped before the western part (Vasović, 1988).

Kopaonik mountain is extremely complex in geological terms. It is composed of three basic types of rocks: sediments, igneous and metamorphic rocks.

Kopaonik is characterized by multiple types of soil resulting by interaction of the relief, climate and vegetation over a longer period of time.

At lower altitudes, up to 1000 m, siorezem, organogenic and siliceous soil, as well as Hum siliceous soil dominate. Siorezems are extremely shallow soil up to 20 inches deep. It can be found on steep slopes of sparse forests or poor pastures. Humus siliceous soil is a special type of fertile soil and it is formed at neutral, basic and acidic siliceous rocks. This type of soil is of relatively low productivity. Forests and pastures develop on it.

Brown and sour brown soils are dominant at altitudes above 1000 m. They are formed on acid silicate rocks, slightly inclined slopes and plateaus. Acid brown soil can be relatively deep, while on the prominent ridges and slopes it can be more shallow and prone to erosion. Kopaonik land is suitable for forests and pastures development.

Kopaonik has great elevation gradient, starting from the base, to its highest peaks. It can be divided into six high altitude climatic zones:

1. The first zone is dominated by thermophilic oak forests of *Quercum frainetto* species. This is the zone with dry, warm and mountain climate of sub-Mediterranean character. It stretches from the foothills up to 750m on the northern, and up to 1050 m on the southern exposures. The average temperature of this zone is about 11^{o}C, and the average annual percipitation is about 787mm of rainfall.
2. The second zone is a zone of gradual transformation into mountain climate. The presence of sessile oak forests, ie. vegetation type *Quercum petrae-cerris* is characteristic. It is located at an altitude of 1050 -1150 m in the southern and 750-1000 m in the northern exposures. The average annual temperature of this zone is about 7.2 ^{0}C, and the average annual precipitation is about 800 mm of rainfall.
3. The third zone is a zone of lower and middle temperate mountain climate. Vegetation is represented by beech and beech-fir forests of *Fagion moesiacae* type. The zone extends at an altitude of 1150-1550 m, on the southern and 1000-1500 m on the northern exposures. The average annual temperature of this zone is about 5^{0}C, the mean annual precipitation is about 827 mm of rainfall.
4. The fourth zone represents the area where the mountain climate is sharper and vegetation is dominated by pure spruce forests from *Vaccinioo-Piceion* type. It stretches between 1550 and 1750 m above sea level on the southern and 1500 and 1700 m on the northern exposure.

   The annual average temperature is around 4^{0}C and the average annual precipitation is about 857 mm of rainfall.
5. The fifth zone is in the zone of harsh subalpine climate. The vegetation type is made of communities of subalpine bushes of *Juniperion Vaccinion myrtilli*. They are located in the area between 1750 - 1950 m on the southern and 1700-1950 m on the northern exposures. The temperature of this zone on average is 3^{0}C, and the annual precipitation is 870 mm.
6. The sixth zone is a zone that is covered by pre alpine harsh climate. The vegetation of this pre alpine climate consists of the high mountain pastures and mountain pastures, from *Poion violaceae* type. They are located in the zone above 1950 m above the sea level. Annual temperatures prevailing in these areas rarely rise above 2^{0}C, while the average amount of annual precipitation is about 883 mm of rainfall.

2. THEORETICAL PART

Vegetation distribution in mountain landscapes is characterized by spatially heterogeneous environmental conditions concerning climate, soil and geology as well as frequency and intensity of disturbance (Karkaj et al., 2012).

One important factor is altitude which has a strong influence on the vegetation structure. Impact of altitude to floristic composition have been considered as the subject of numerous studies ((Lomolino, 2001), (Naqinezhad et al., 2009), (Karkaj et al., 2012)). Altitudinal gradients are regarded as the most powerful ecological element which affects the natural vegetation structure.

Altitude presents an important orographic factor that affects the modification of various climates and soils, (Vasić et al., 2008) and therefore the species richness and the vegetation structure.

Temperature and relative humidity are the most important factors that determine the extent to which plants are present.

With increasing altitude the air becomes less thin and fresh, reflecting the solar radiation and temperature regime habitats. Proper temperature drops (for every 100 m above sea level, the temperature drops to 0,58^{0}C) (Vasić et al., 2008).

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With the sea level increase, the relative humidity also rises due to the ascending air currents that send water vapor high into the air (Vasić, 2012).

Plants that inhabit different altitudes are extremely efficient and cost-effectively customized to survive in a changing climate.

3. EXPERIMENTAL PART

3.1. Material and methods

The research in this paper was done in the period from 2015 to 2016. The list of flora is made up of the species given in an alphabetical order. The species presented in this paper include the plant communities in which species of Juniperus genus (*Juniperus communis, J. and J. oxycedrus sibirica*) were recorded at different altitudes (470 m, 630 m, 830 m, 1030 m, 1230 m, 1430 m, and 2100 m).

The plant material was determined using a Serbian flora key (Josifović, 1970-1986), and a nomenclature of plant species is customized to a flora of Europe (Tutin, 1964-1980, 1993) and IOPI databases (International Organisation for Plant Information).

3.1.1. Synthesis

The subject of study in this paper is the presence of plants at different altitudes in the plant communities with the appearance of the genus *Juniperus* species (*J. communis, J. oxycedrus* and *J. sibirica*). Two species of juniper (*Juniperus communis* and *Juniperus oxycedrus*) were found at altitudes from 420 m to 1420 m, while the third species, *Juniperus sibirica*, was found at an altitude of 2100 m. It should be noted that the species *Juniperus communis* and *Juniperus oxycedrus* could be found together up to 1420 m above sea level, but as the altitude increased these two species were less present because of the increasing negative anthropogenic impact on them (logging and deforestation).

Table 1. The presence of plant species in the plant communities with a dominance of species of the *Juniperus* genus.

	470m	**630m**	**830m**	**1030m**	**1230m**	**1430m**	**2100m**
Achillea millefolium L.	+	-	+	+	+	+	-
Acinos alpinus (L.) Moench	-	-	+	-	-	-	-
Agrimonia eupatoria Ledeb.	-	+	-	-	-	-	-
Agrostis stolonifera L.	-	-	-	-	-	+	+
Anagallis foemina Miller	-	-	+	-	-	-	-
Artemisia vulgaris L.	-	+	-	-	-	-	-
Asperula cynanchica L.	+	-	+	-	-	-	-
Astragalus onobrychis L.	-	-	+	-	-	-	-
Bupleurum veronense Turra	+	-	-	-	-	-	-
Calamintha vulgaris (L.) Druce	-	+	-	-	-	-	-
Campanula patula L.	-	-	-	-	-	+	-
Carduus acanthoides L.	-	+	-	-	-	-	-
Carlina vulgaris L.	-	-	-	+	-	+	-
Centaurea jacea L.	-	-	-	-	+	-	-
Centaurea scabiosa L.	-	+	-	-	-	-	-
Centaurea alba L. subsp. *splendens* (L.) Arcangeli	-	-	+	-	-	-	-
Centaurea biebersteinii DC.	+	+	-	+	-	-	-
Centaurium erythraea Rafin.	-	-	-	+	-	-	-
Cerastium caespitosum Gilib.	-	-	-	-	-	-	+
Chamaespartium sagittale (L.) P. Gibbs	-	-	-	-	+	-	-
Cirsium eriophorum (L.) Scop.	-	+	-	+	+	+	+
Cornus mas L.	-	+	-	-	-	-	-
Coronilla varia L.	+	+	-	-	-	-	-
Crataegus monogyna Jacq.	+	-	-	-	-	-	-
Cuscuta sp.	-	+	-	-	-	-	-

	470m	630m	830m	1030m	1230m	1430m	2100m
Cytisus jankae Velen.	-	-	+	-	-	-	-
Dactylis glomerata L.	-	-	-	-	-	-	+
Daucus carota L.	-	+	-	-	-	-	-
Dianthus cruentus Griseb.	-	-	+	-	-	-	-
Digitalis laevigata Waldst. & Kit.	-	+	-	-	-	-	-
Dorycnium herbaceum Vill.	-	+	-	+	-	-	-
Eryngium campestre L.	+	+	-	-	+	-	-
Euphorbia amygdaloides L.	-	-	-	+	-	-	-
Euphorbia cyparissias L.	+	-	-	-	+	-	-
Euphrasia stricta D. Wolff ex J. F. Lehm.	-	-	-	+	-	-	-
Fagus moesiaca (K.Maly) Czecz.	-	-	-	-	-	+	-
Fragaria vesca L.	+	+	-	-	+	+	+
Galium verum L.	-	-	-	+	+	-	-
Gentianella austriaca (A. & J. Kerner) J. Holub	-	-	-	-	-	-	+
Genista januensis Viv.	-	-	-	-	-	+	+
Geranium columbinum L.	-	-	+	-	-	-	-
Gnaphalium sylvaticum L.	-	-	-	-	-	+	-
Helianthemum nummularium (L.) Miller	-	+	-	+	+	-	-
Helleborus odorus Waldst. & Kit.	-	+	-	+	-	+	-
Hieracium hoppeanum Schult.	-	-	-	+	+	+	-
Hieracium pilosella L.	+	-	+	-	-	-	-
Hypericum perforatum L.	+	+	+	+	+	+	+
Juniperus communis L.	+	+	+	+	+	+	-
Juniperus oxycedrus L.	+	+	+	+	+	+	-
Juniperus sibirica Burgdsdorf.	-	-	-	-	-	-	+
Lathyrus sp.	-	+	-	-	-	-	-
Leontodon hispidus L.	-	-	+	+	+	+	-
Linaria vulgaris Miller	-	+	-	-	-	-	-
Linum catharticum L.	-	-	-	-	+	-	-
Linum hologynum Rchb.	-	-	-	-	+	-	-
Lotus corniculatus L.	-	+	-	-	-	+	-
Luzula luzuloides (Lam.) Dandy & Wilmott	-	-	-	-	-	+	-
Medicago prostrata Jacq.	-	-	+	-	-	-	-
Nardus stricta L.	-	-	-	-	-	+	-
Onobrychis viciifolia Scop.	+	-	-	-	-	-	-
Ononis spinosa L.	+	+	-	-	+	-	-
Petrorhagia prolifera (L.) P. W. Ball & Heywood	-	+	-	-	-	-	-
Petrorhagia saxifraga (L.) Link	+	-	+	+	-	-	-
Phleum phleoides (L.) Karsten	-	-	-	-	+	-	-
Picris hieracioides L.	+	+	-	-	-	-	-
Pimpinella saxifraga L.	-	-	-	-	+	-	-
Plantago lanceolata L.	+	-	-	-	+	-	-
Plantago media L.	-	+	-	+	+	-	-
Poa cenisia All.	-	+	-	-	-	-	-

	470m	630m	830m	1030m	1230m	1430m	2100m
Polygala comosa Schkuhr	-	+	-	+	+	-	-
Potentilla arenaria Borkh.	+	+	+	-	+	-	-
Potentilla argentea L.	+	-	-	-	-	-	-
Potentilla heptaphylla L. subsp. *australis* (Krašan ex Nyman) Gams	-	-	-	+	-	-	-
Primula veris L.	-	-	-	+	-	-	-
Prunella laciniata (L.) L	-	-	-	+	+	-	-
Prunella vulgaris L.	-	-	-	+	-	-	-
Pteridium aquilinum (L.) Kuhn.	-	-	-	+	-	-	-
Ranunculus bulbosus L.	-	-	-	-	+	-	-
Rubus praecox Bertol.	+	-	-	-	-	-	-
Rubus ideaus L.	-	+	-	-	-	-	-
Rumex acetosella L.	-	-	-	-	-	+	-
Rumex crispus L.	-	-	+	-	-	-	-
Rumex sanguineus L.	-	-	-	-	-	-	+
Scabiosa argentea L.	-	+	-	-	-	-	-
Salvia amplexicaulis Lam.	-	+	-	-	-	-	-
Salvia verticillata L.	+	-	+	-	-	-	-
Sanguisorba minor Scop.	+	+	-	+	-	-	-
Scabiosa columbaria L.	-	-	-	+	-	+	+
Sedum sexangulare L.	-	+	-	-	-	-	-
Senecio squalidus L. subsp. *rupestris* (Waldst. & Kit.) Greuter	-	-	-	-	+	+	-
Silene sendtneri Boiss.	-	-	-	-	-	+	-
Stachys annua (L.) L.	-	-	+	-	-	-	-
Stachys recta L.	-	-	+	-	-	-	-
Stachys scardica (Griseb.) Hayek	-	-	-	+	-	-	-
Stellaria graminea L.	-	-	-	-	-	+	+
Taraxacum officinale Weber	-	-	-	-	-	-	+
Teucrium chamaedrys L.	+	+	-	-	-	-	-
Teucrium montanum L.	+	-	+	+	-	-	-
Thymus sp.	+	+	-	+	+	-	+
Trifolium ochroleucon Hudson	-	-	-	+	-	-	-
Trifolium patens Schreber	-	-	-	+	-	+	-
Trifolium pratense L.	-	+	+	-	-	+	+
Tussilago farfara L.	-	-	-	-	-	-	+
Verbascum sp.	-	-	+	-	-	+	+
Viola tricolor L.	-	-	+	-	-	-	-
Xeranthemum annuum L.	+	+	-	-	-	-	-

4. RESULTS AND DISCUSSION

It was found that there are plants species present only at certain altitudes, while others are present at almost all altitudes as it can be observed from the table (Table. 1).

Plant species that occur only at one altitude are:*Acinos alpinus* (830 m), *Agrimonia eupatoria* (630 m), *Anagallis foemina* (830 m), *Artemisia vulgaris* (630 m), *Astragalus onobrychis* (830 m), *Calamintha vulgaris* (630 m), *Centaurium erythraea* (1030 m),

Comus mas (630 m), *Dactylis glomerata* (2100 m) and other.

Plant species that occur only at two altitudes: *Agrostis stolonifera* (1430 m and 2100 m), *Asperula cynanchica* (470 m and 830 m) *Carlina vulgaris* (1030 m and 1430 m), *Coronilla varia* (470 m and 630 m), *Dorycnium herbaceum* (630 m and 1030 m), *Euphorbia cyparissias* (470 m and 1230 m) *Prunella laciniata* (1030 m and 1230 m), *Salvia verticillata* (470 m and 630 m) and other.

Plant species that can be seen at more than two altitudes are: *Achillea millefolium* (470 m, 830 m, 1030 m, 1230 m and 1430 m), *Cirsium eriophorium* (470 m, 1030 m, 1230 m, 1430 m and 2100 m), *Fragaria vesca* (470 m, 630 m, 1230 m, 1430 m and 2100 m), *Leontodon hispidus* (830, m, 1030 m, 1230, m, 1430 m), *Ononis spinosa* (470 m, 630 m and 1230 m) and other.

It was noted that the plant species *Hypericum perforatum*, is recorded in all of plant communities surveyed that proves its best adaptation to the conditions at different altitudes.

5. Conclusion

In this paper we showed that plant species inhabit habitats of different altitudes and the plants respond differently related to various soil factors in investigated communities. Some plants are adapted on various types of land and climate, such as *Hypericum perforatum*. Other species have adapted to live in the narrow range of temperature and humidity, and therefore inhabit only small areas where they ‘he been specialized on certain properties of the soil at different altitudes of the mountain. Plant as: *Acinos alpinus (830), Agrimonia eupatoria*(630), *Anagallis foemina Mili (830)* live in habitats on certain altitude, while *Agrostis alba* (1430 и 2100), *Carlina vulgaris*(130 и 1430) and *Achillea millefolium* (470,1030, 1230 и1430), *Cirsium eriophorum* (470, 1030, 1230 и1430) can be found on two or more different altitudes.

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