DOI: 10.5937/SustFor2490047S
UDK: 630*187(497.11Kosmaj)=111
Original scientific paper

PHYTOCOENOLOGICAL ANALYSIS OF SESSILE OAK AND TURKEY OAK FORESTS (*QUERCETUM PETRAEAE-CERRIDIS* B. JOVANOVIĆ 1979. S.L.) IN THE TERRITORY OF KOSMAJ

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Abstract. *Phytocoenological characteristics of the association of sessile oak and Turkey oak (Quercetum petraeae-cerridis B. Jovanović 1979. s.l.) in the territory of Kosmaj are presented in the paper. This phytocoenosis has large ecological amplitude on the researched territory, it is spread over a wide range of altitudes (phytocoenological relevés are from the altitudes ranging from 348 to 573 m), on all aspects (it appears more frequently on warmer aspects) and slopes from 8° to 28°. Bedrock on which this association appears is flysch, and the soils are eutric cambisol and dystric cambisol. Based on the floristic composition and habitat conditions the association is divided into two sub-associations: typicum and caricetosum silvaticae. According to the spectrum of range types the studied association Quercetum petraeae-cerridis B. Jovanović 1979. s.l. has Central European character, while according to the life-form spectrum it is of hemicryptophyte-phanerophyte character with an increased share of geophytes.*

Key words: Sessile oak and Turkey oak forest, sub-association, floristic composition, Kosmaj.

FITOCENOLOŠKA ANALIZA ŠUMA KITNJAKA I CERA (*QUERCETUM PETRAEAE-CERRIDIS* B. JOVANOVIĆ 1979. S.L.) NA PODRUČJU KOSMAJA

Abstract. *U radu su prikazane fitocenološke karakteristike zajednice kitnjaka i cera (Quercetum petraeae-cerridis B. Jovanović 1979. s.l.) na području Kosmaja. Ova fitocenoza na istraživanom području ima veliku ekološku amplitudu, rasprostranjena je u širokom dijapazonu nadmorskih visina (fitocenološki snimci su sa nadmorskih visina 348-573 m), na svim eskpozicijama (češće se pojavljuje na toplijim) i nagibima od 8°-28°. Geološka podloga na kojima se javlja ova zajednica je fliš, a zemljište eutrični kambisol i distrični kambisol. Na osnovu floorističkog sastava i stanišnih uslova izvršena je podela zajednice na 2 subasocijacije: typicum i caricetosum silvaticae. Prema spektru areal tipova proučena zajednica Quercetum petraeae-cerridis B. Jovanović 1979. s.l. ima srednjeevropski karakter, dok je prema spektru životnih oblika hemikriptofito-fanerofitskog karaktera, sa povećanim učešćem geofita.*

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Keywords: Šuma kitnjaka i cera, subasocijacija, floristički sastav, Kosmaj.

1. INTRODUCTION

It has been determined in Serbia that sessile oak is an aggregate which consists of three species (Jovanović, 2007): European sessile oak (*Quercus petraea* (Matt.) Liebl), Dalechampii oak (*Quercus dalechampii* Ten.) and Transilvanian sessile oak (*Quercus polycarpa* Schur.), which are named after the oldest described species of sessile oak (*Quercus petraea* agg. Ehrendorfer 1967). Sessile oak (*Quercus petraea* (Matt.) Liebl.) represents one of the most valuable tree species in Serbia, and larger complexes of sessile oak forests in Serbia are located on Fruška Gora, Avala, Kopaonik, Rtanj, Suva Planina, Majdanpečka Domena, Miroč, Deli Jovan, Stara Planina, Đerdap, Čemerno, Suvobor, Zlatibor, Stolovi, Kukavica and others. (Cvjetićanin *et al*., 2007). According to the data from the Second National Forest Inventory (2023) the total volume of sessile oak forests in the forest growing stock of the Republic of Serbia has been estimated to 32,062,038.23 m^3, which is why this species is on the third place in our country (share in the total volume is about 5.7%).

In the whole Serbia, on warmer aspects in submontane region (as a transition between climazonal forest of Hungarian oak and Turkey oak and the lowest clima-regional belt of mountainous beech) xeromesophilous forests of sessile oak and Turkey oak appear – alliance *Quercion petraeae-cerridis* R. Lakušić & B. Jovanović 1980. (Tomić and Rakonjac, 2013). The association of sessile oak and Turkey oak (*Quercetum petraeae-cerridis* B. Jovanović 1979. s.l.) has been defined only in recent literature. Until then in the larger number of papers these forests had been treated as pure forests of sessile oak. In terms of characteristic assemblages, ecosystem stability and degradation processes, mixed forests of sessile oak and Turkey oak are very similar to sessile oak forests. Sessile oak and Turkey oak forest alternates with Hungarian oak and Turkey oak forests or is located between them, where it precedes pure sessile oak forests or beech forests (Cvjetićanin *et al.*, 2007). The association appears on different altitudes, from about 300 up to 1000 m, on warm aspects and larger slopes than Turkey oak forests. Bedrock is different, mostly acidic silicate rocks, but they occur also on limestones and serpentinites. Soils are developed, brown and leached, but very often also skeletal and eroded. Floristic composition of this association is similar to sessile oak forests, since besides the xerothermic species of *Quercetalia pubescentis* order, there are also some more mesophilic elements of sessile oak and even beech forests (Tomić and Rakonjac, 2013).

This association appears more frequently and is more widespread than monodominant Turkey oak forests. On some sites: Kopaonik (Rajevski and Borisavljević, 1956), Miroč and Crni Vrh (Glišić, 1976) and Rudnik (Gajić, 1961), where there are no typical sessile oak forests, these mixed associations, alternating with beech forests, build submontane belt. It occupies particularly large areas in Northwestern and Western Serbia, on Gučevo, Maljen, Cer, parts of Tara and Zlatibor (Vukićević, 1966; 1976), in submontane part of Kopaonik (Rajevski and Borisavljević, 1956), and it was found also on Pešter (Rakonjac, 2002; Rakonjac

et.al., 2008). This association occurs also on Fruška Gora, on somewhat lower altitudes, up to 400 m (Janković and Mišić, 1960; Jović *et al*., 1989), on Vršačke mountains (Pekanović, 1991), while in eastern Serbia it is represented only in fragments in National Park Đerdap (Jović, *et al.* 1997).

Since this phytocoenosis is widely spread in the protected area of Kosmaj, detailed research of this forest vegetation may serve as a starting point for planning of cultivation needs, as important factors in ensuring special purposes that these forests have.

2. MATERIAL AND METHODS

Kosmaj is a low (626 m) and according to its area relatively small mountain, greater part of which was placed under protection in 2005. The forest vegetation of the area of Kosmaj syntaxonomically belongs to deciduous oak and beech forests of the *Querco-Fagetea* class.

Figure 1 and 2. *Protected area Kosmaj*

According to the Thornthwaite climate classification subhumid wet climate – type C_2 dominates in the territory of Belgrade (Stajić, 2016). From a geological point of view Mount Kosmaj can be characterized as an isolated island massif of chalk flysch and limestone with a few breakthroughs of serpentinites and granitoids which also caused significant pedological diversity of Kosmaj.

For the analysis of floristic composition of the researched association 15 phytocoenological relevés were used, which were done according to the standard method of Braun-Blanquet (Braun–Blanquet,1964). Plant species were determined based on the literature sources: *Flora Srbije I-X* (Josifović *et al.* 1972-1977, Sarić *et al*. 1986; 1992; Stevanović *et al.* 2012), while nomenclature was harmonised with Euro+Med database of vascular flora of Europe (Euro+Med 2006 -). Names of syntaxons of forest vegetation are given according to Tomić and Rakonjac (2013). Spectra of floristic elements are done based on the systematization of plant-geographic elements according to Gajić (1980), and life-form spectra according to the method of Kojić *et al.* (1997).

3. RESULTS

3.1. Ecological conditions

On Kosmaj the forest of sessile oak and Turkey oak (*Quercetum petraeae-cerridis* B. Jovanović 1979. s.l.) has a large ecological amplitude, it is spread over a wide range of altitudes (phytocoenological relevés are from altitudes from 348 to 573 m), on all aspects (it occurs more often on warmer aspects) and slopes from 8° to 28°. These forests are most widespread on the slopes of Veliki Kosmaj, where they alternate with forests of Hungarian oak and Turkey oak (less often Turkey oak forests), where they precede mixed beech and sessile oak forests or pure beech forests.

Association of sessile oak and Turkey oak on Kosmaj occurs on flysch, and in terms of soils in this association eutric cambisol and dystric cambisol were found.

3.2. Floristic composition

In phytocoenological table (Table 1) 15 relevés are presented from different parts of Kosmaj, where the association of sessile oak and Turkey oak was found. The floristic composition of this association is diverse, since plants from thermophilic and mesothermal oak forests and also mesophilic types of beech forests occur. The stands originate from sprout forest. The canopy is in some cases sparsely closed, in stands that are more degraded and it ranges from total (0.7) to dense (0.9).

In the tree layer, in addition to dominant edifiers, sessile oak (*Quercus petraea* (Matt.) Liebl) and Turkey oak (*Quercus cerris* L.) there are also: Field maple (*Acer campestre* L.), Hungarian oak (*Quercus farnetto* Ten.), European hornbeam (*Carpinus betulus* L.), beech (*Fagus sylvatica* L.), sweet cherry (*Prunus avium* L.), Manna ash (*Fraxinus ornus* L.), field elm (*Ulmus minor* Mill.), European ash (*Fraxinus excelsior* L.), common hawthorn (*Crataegus monogyna* Jacq.), European wild pear (*Pyrus pyraster* (L.) Burgsd.), Eurasian aspen (*Populus tremula* L.).

Shrub layer is floristically diverse (24 present species in total). Shrub canopy varies from very opened (0.1) to well developed (0.9). The most present species are Manna ash (*Fraxinus ornus* L.), field maple (*Acer campestre* L.), field elm (*Ulmus minor* Mill.) and common hawthorn (*Crataegus monogyna* Jacq.). They are followed by: *Cornus mas* L., *Prunus avium* L., *Prunus spinosa* L., *Cornus sanguinea* L., *Rosa canina* L., *Carpinus betulus* L., *Ligustrum vulgare* L., *Pyrus pyraster* (L.) Burg., *Crataegus oxyacantha* L., *Sambucus nigra* L., *Corylus avellana* L., *Quercus petraea* (Matt.) Liebl), *Fraxinus excelsior* L., *Euonymus verrucosus* Scop., *Populus tremula* L., *Cotoneaster integerrimus* Medik., *Euonymus europaeus* L., *Acer pseudoplatanus* L., *Quercus farnetto* Ten., *Quercus cerris* L.

Degree of coverage of ground flora ranges from 0.3 to 1.0. In the ground flora layer there are typical species such as: *Brachypodium sylvaticum* (Huds.) Beauv., *Mycelis muralis* (L.) Dum., *Lonicera caprifolium* L., *Helleborus odorus* Waldst. & Kit. ex Willd., *Crataegus monogyna* Jacq. i *Tamus communis* L. They are followed by: *Geranium robertianum* L., *Circaea lutetiana* L., *Rubus canescens* DC., *Rosa canina* L., *Euphorbia amygdaloides* L., *Calamintha vulgaris* L., *Quercus cerris* L., *Alliaria petiolata* (M.Bieb.) Cavara & Grande, *Acer campestre* L., *Geum*

urbanum L., *Fallopia convolvulus* (L.) Á. Löve, *Prunus avium* L, *Fragaria vesca* L. and others.

Based on the floristic composition and habitat conditions the association *Quercetum petraeae-cerridis* B. Jovanović 1979. s.l. was divided into two sub-associations: *typicum* and *caricetosum silvaticae*.

Table 1. *Phytocoenological table of the association Quercetum petraeae-cerridis*

Association	***Quercetum petraeae-cerridis* B. Jovanović 1979. s.l.**															
Sub-association	*Typicum*												*caricetosum silvaticae*			Degree of presence
Facies													*rubosum*			
Locality	Kosmaj															
Relevé	2	5	11	12	16	18	20	40	41	90	91	24	6	51	44	
Size (m2)	900	900	900	900	900	900	900	900	900	900	900	900	900	900	900	
Altitude (m)	573	436	508	505	478	391	465	415	364	407	356	383	430	435	348	
Aspect	SE	SW	SE	S-SE	W	W-NW	W-SW	NW	N-NW	NW	NW	S	N-NE	NE	N-NW	
Slope (°)	21	8	20	23	20	20	28	15	13	14	11	11	14	20	27	
Bedrock	Flysch															
Soil	Eutric Cambisols											Dystric Cambisol	Eutric Cambisols			
Layer I																
Tree crown canopy	0,8	0,8	0,9	0,8	0,8	0,9	0,8	0,8	0,7	0,9	0,8	0,8	0,8	0,7	0,8	
Mean height (m)	22,0	22,0	23,0	22,0	20,0	25,0	22,0	14,0	18,0	20,0	20,0	14,0	24,0	23,0	20,0	
Mean diameter (cm)	28,0	20,0	25,0	20,0	25,0	35,0	37,0	20,0	22,0	25,0	30,0	20,0	17,0	30,0	23,0	
Spacing (m)	7,0	4,0	4,0	4,0	6,0	8,0	8,0	4,0	5,0	7,0	7,0	6,0	5,0	10,0	8,0	
Quercus petraea	3.1	3.1	5.5	3.1	3.1	2.1	3.1	4.4	3.1	5.5	5.5	5.5	2.1	3.1	2.1	V
Quercus cerris	3.1	3.1	1.1	3.1	4.4	4.4	3.1	1.1	4.4	1.1	1.1	1.1	5.5	4.4	4.4	V
Acer campestre	1.1	1.1	1.1		1.1	1.1				+.1						III
Quercus farnetto				1.1	1.1	+			1.1			+.1	+	+		II
Carpinus betulus				1.1	1.1		1.1						1.1		+	II
Fagus sylvatica					+		1.1						1.1	1.1	+.1	II
Prunus avium								2.1	+.1	1.1			+.1		+.1	II
Fraxinus ornus	2.1						+		+							I
Ulmus minor				2.1		1.1										I
Fraxinus excelsior			+											+.1		I
Crataegus monogyna		1.1														I
Pyrus pyraster														+.1		I
Populus tremula													+			I
Layer II																
Crown canopy	0,6	0,4	0,6	0,7	0,6	0,2	0,9	0,3	0,6	0,3	0,3	0,2	0,1	0,3	0,2	
Mean height (m)	3,0	4,5	3,0	3,5	2,0	3,0	4,0	2,5	3,0	1,5	3,0	2,0	3,0	3,0	1,0	
Fraxinus ornus	4.4	1.1	1.1	1.1	1.1	1.1	2.1			+.1	1.1	+.1	1.1	1.1	2.1	V
Acer campestre	1.1	2.1	2.1	2.3	4.4	3.1	3.3	1.1	1.1	1.1			1.1	1.1	1.1	V
Ulmus minor		1.1	2.1	2.1	1.1	1.1	1.1	1.1	1.1	2.1	1.1	1.1	1.1	1.1		V

Crataegus monogyna	1.1	2.1	1.1	2.1	3.1	2.1	3.1	3.1	3.1	2.1		1.1	1.1		1.1	V
Cornus mas	1.1	2.1	3.2		1.1	3.1	2.2			2.2		2.2			+	III
Prunus avium			1.1	1.1				3.1	1.1	1.1	2.3	+		+.1		III
Prunus spinosa		1.1	1.1					1.1	2.1		1.1	2.1			+	III
Cornus sanguinea				3.2	2.2			1.1		1.1	1.1		1.1		+.1	III
Rosa canina			1.1	2.3				2.2		+.1		2.1			1.1	II
Carpinus betulus				1.2	1.1							+			1.1	II
Ligustrum vulgare			1.1	3.3				2.3	4.4							II
Pyirus pyraster				1.1			1.1		1.1							I
Crataegus oxyacantha														1.1		I
Sambucus nigra			2.1							1.1				+		I
Corylus avellana								1.2							1.1	I
Quercus petraea				1.1								1.1				I
Fraxinus excelsior														2.1		I
Euonymus verrucosus					1.3											I
Populus tremula													1.1			I
Cotoneasterintegerrimus		1.2														I
Evonymus europaeus			1.1													I
Acer pseudoplatanus			1.1													I
Quercus farnetto												1.1				I
Quercus cerris												+.1				I
Layer III																
Cover	0,7	0,6	0,9	0,8	0,9	0,6	0,3	0,7	0,9	0,7	0,7	0,3	0,8	1,0	1,0	
Brachypodium syvaticum	3.3	2.2		2.1	3.3			3.2	3.2	1.2	1.2	2.2		1.2	2.3	IV
Mycelis muralis	3.1	1.1	3.1	2.1	1.1			1.1	2.1		1.1	2.1	2.1	1.1	3.1	IV
Lonicera caprifolium	1.2	2.3	1.1	2.3	2.3	1.1		3.3	2.3	1.2		1.2	1.1			IV
Helleborus odorus	1.1	2.1	1.1	1.1	1.1	2.1	2.1	1.1	1.1	1.1			1.1	1.1		IV
Crataegus monogyna	2.1	1.1	2.1	2.1	2.1	1.1			2.1	1.1	1.1	1.1	1.1			IV
Tamus communis		1.1	1.1	1.1	1.1	1.1	1.1	+.1	1.1	1.2		1.1	2.1			IV
Geranium robertianum		2.2	2.2					1.1	3.3	3.3	4.4		2.1		2.2	III
Circaea lutetiana			2.3				+	1.1	2.1	2.3	2.1			3.3	2.3	III
Rubus canescens	3.3	2.2		1.1	2.1				2.2			2.1			4.4	III
Rosa canina		1.1		3.3	3.3	1.1		2.1	1.1			2.3				III
Euphorbia amygdaloides	1.1		2.1	3.3	1.2	2.1	2.1						1.1		1.1	III
Calamintha vulgaris	2.1	2.1		1.1	2.1		+.1		1.1			1.1		1.1	2.2	III
Quercus cerris	3.1	1.1		1.1	2.1		2.1			1.1		1.1	1.1		1.2	III
Alliaria petiolate		2.2	1.1	1.1	2.1		2.1			2.3			3.1			III

Acer campestre		1.1			2.1	1.1	2.2	1.1	1.1				1.1	1.1		III
Geum urbanum		1.1			2.1			2.2	1.1		1.1		1.1	1.1	1.1	III
Fallopia convolvulus		1.1	1.1			1.1	1.1			1.2	1.2			+.1		III
Prunus avium		1.1		1.1		1.1		2.1			1.1	1.1	+			III
Fragaria vesca	1.1				1.1		1.1			1.1		+	1.1		1.1	III
Galium aparine		1.1	1.1		+.1				1.2	1.2	1.1			+.1		III
Galeopsis speciosa		+	2.3						1.1	2.1	1.1		1.1		+	III
Rubus hirtus								3.3		3.3	2.3		4.4	3.3	2.3	II
Glechoma hirsuta		2.3	3.3		1.2	4.3	1.2							2.2		II
Quercus petraea	2.1				1.1		1.1			2.3	4.3	3.1				II
Lysimachia punctata	3.3	2.1		2.3								+.1		2.3	+.1	II
Ajuga reptans	1.2			+	1.1	2.3							1.2			II
Cornus mas	1.1	1.1	2.1	3.3		1.1	1.1									II
Lapsana communis			1.1		1.1			1.1			2.1				2.1	II
Rumex acetosella			1.1		1.1	+			1.1				1.1	3.3		II
Melica uniflora	1.2		3.3		3.3	3.2	3.2									II
Fraxinus ornus	3.1	2.1		1.1		1.1	2.1									II
Ligustrum vulgare	+.2			2.3					2.3	1.1	1.2					II
Clematis vitalba									2.3	1.1	1.1		1.1		1.1	II
Stachys silvatica						1.1			1.1				+	2.3	1.1	II
Viola odorata				+		1.1	1.1		1.1				1.1			II
Cynanchum vincetoxicum	2.3			1.1	1.1		1.2		+.1							II
Hypericum perforatum	2.1			1.1	1.1							1.1		1.1		II
Viola hirta						1.1	1.2	1.1				+				II
Cornus sanguinea				3.3				2.1					1.1	1.1		I
Stenactis annua	+.1								+.1			1.1		1.1	+.1	II
Carex sylvatica													2.2	2.2	3.2	I
Carpinus betulus	1.1						1.1						1.1			I
Poa nemoralis	2.2											3.2			1.2	I
Carex Pilosa					3.3									1.2	2.3	I
Moehringia trinervia		2.3								1.2			2.2		+.2	I
Hedera helix						1.1						1.1			1.1	I
Dryopteris filix-mas									+.1	1.1			+.2		1.2	I
Hypericum hirsutum	1.1				1.1										+.1	I
Campanula patula	1.1				+.1										1.1	I
Veronica chamaedrys								1.1					+.1		1.2	I
Cardamine bulbifera							3.1						3.1			I

Urtica dioica			1.1						+					3.3		I
Scrophularia nodosa		+												1.1	3.1	I
Aremonia agrimonoides	1.1						1.2	2.2								I
Rumex sanguineus		2.1								1.1	1.1					I
Ulmus minor						1.1	1.1			1.1						I
Lychnis coronaria				1.2	1.1							+				I
Viola alba	1.1	+.1											+.1			I
Sambucus nigra			2.1										+.1			I
Rubus caesius			1.1				2.2									I
Evonymus europaeus			2.1			1.2										I
Lamium maculatum			1.1											3.3		I
Prunella vulgaris	1.1				1.2											I
Euphorbia cyparissias					1.1							+.1				I
Pyrus pyraster							1.1					+.1				I
Campanula persicifolia								+					1.2			I
Chaerophyllum aureum					+.1		+.1									I
Lilium martagon				+		+										I

The following species were recorded in only one phytocenological relevé: *Carex hirta* 4.4 (6); *Rosa arvensis* 3.3 (2); *Chaerophyllum temulum* 3.1 (41); *Doronicum columnae* 2.3 (91); *Pteridium aquilinum* 2.3 (11); *Festuca heterophylla* 2.2 (2); *Symphitum tuberosum* 2.2k (5); *Poa pratensis* 2.2. (16); *Galium sylvaticum* 2.2. (44); *Lathyrus venetus* 2.1 (20); *Prunus spinosa* 2.1 (24); *Hieracium sabaudum* 2.1 (24); *Dactylis glomerata* 2.1 (40); *Carex divulsa* 1.2 (5); *Asperula odorata* 1.3 (6); *Euonymus verrucosus* 1.3 (16); *Lamium galeobdolon* 1.3 (44); *Dryopteris filix-mas* 1.2 (51); *Festuca rubra* 1.2 (2); *Danaa cornubiensis* 1.2 (5); *Asarum europaeum* 1.2 (6); *Vicia pisiformis* 1.2 (16); *Stellaria media* 1.2 (41); *Sanguisorba minor* 1.1 (2); *Hieracium murorum* 1.1 (2); *Galium schultesii* 1.1 (5); *Acer pseudoplatanus* 1.1 (6); *Viola sylvestris* 1.1 (6); *Populus tremula* 1.1 (6); *Anthriscus sylvestris* 1.1 (11); *Heracleum sphondylium* 1.1 (11); *Quercus farnetto* 1.1 (12); *Melitis melissophyllum* 1.1 (16); *Asparagus tenuifolius* 1.1 (16); *Robinia pseudoacacia* 1.1 (41); *Euphorbia platyphyllos* +.2 (51); *Polygonatum odoratum* +.1 (2); *Juglans regia* +.1 (40); *Athyrium filix femina* +.1 (40); *Chamaecytisus supinus* + (16); *Stachys germanica* + (12); *Fagus sylvatica* + (18); *Inula conyza* + (24); *Scilla bifolia* + (90); *Cephalanthera longifolia* + (44).

3.3. Spectrum of floral elements

Spectrum of range types of the association of sessile oak and Turkey oak (*Quercetum petraeae-cerridis* B. Jovanović 1979. s.l.) is presented in Table 2. Plant species of Central European range type are predominant in this association, and they are represented by 35%. Plant species of Eurasian range type have a somewhat smaller representation (22%), while they are followed by plants of Pontic range type (11%), Sub-Mediterranean (10%), Sub-Atlantic (7%), Circumpolar (7%), Balkan (2%), Cosmopolitan type (3%), and the least floristic element of desert regions (1%). There is 2% of adventive plants in this association.

Table 2. *Spectrum of floral elements in the association Quercetum petraeae-cerridis*

Individual range types	Number	Aggregate range types	Number	Share (%)	
Sub-Pontic	2	Pontic	13	11%	23%
Sub Pontic- Sub-Pannonian	1				
Pontic-Pannonian	1				
Pontic- Central Asian	2				
Pontic-Sub-Mediterranean	5				
Pontic-Eastern sub-Mediterranean	2				
Sub-Mediterranean	7	Sub-Mediterranean	11	10%	
Eastern sub-Mediterranean	4				
Sub Balkan-Apennine	1	Balkan	3	2%	
Mesian	1				
Central Balkan	1				
Central European	12	Central European	40	35%	42%
Sub-Central European	28				
Sub-Atlantic-Sub-Mediterranean	8	Sub-Atlantic	8	7%	
Sub-Iranian-Eastern sub-Mediterranean	1	Floral elements of desert landscapes	1	1%	1%
Eurasian	12	Eurasian	26	22%	25%
Sub-Eurasian	9				
Sub-South Siberian	5				
Cosmopolitan	4	Cosmopolitan	4	3%	
Circumpolar	3	Circumpolar	8	7%	7%
Sub-Circumpolar	5				
Adventive	2	Adventive	2	2%	2%
Total:	116	Total:	116	100%	100%

3.4. Life-form spectrum

Life-form spectrum in the association od sessile oak and Turkey oak (*Quercetum petraeae-cerridis* B. Jovanović 1979. s.l.) is presented in Table 3.

Hemicryptophytes (41%) are predominant in this association, followed by phanerophytes with 30% (phanerophytes 16%, nanophanerophytes 13% and phanerophytic lianas 1%). Geophytes are represented with 17%, which indicates favourable edaphic conditions (moisture, structure and soil depth). Annual species therophytes are represented with only 3%, while the transitional group of plants between therophytes and chamaephytes is represented by 6%. Out of the group of chamaephytes in this association there is 2% of plants (herbaceous chamaephytes 1% and woody chamaephytes 1%). Plants with this life form in syngenetic and

synecological sense belong to different plant associations which inhabit habitats with warm and dry Mediterranean climate, as well as landscapes in conditions of continental climate of the Pannonian Plain.

Table 3. *Life-form spectrum of plants in the association Quercetum petraeae-cerridis*

Life forms								
P	Np	Pl	Zc	Dc	H	G	T	Th
16%	13%	1%	2%	1%	41%	17%	3%	6%
30%			3%					

Legend: P- phanerophytes; Np-nanophanerophytes; Pl-phanerophytic lianas; Zc-herbaceous chamaephytes; Dc-woody chamaephytes; H-hemicryptophytes; G-geophytes

4. DISCUSSION

The phytogeographical position of Kosmaj in the region where two floristic subregions in Serbia meet – the Central European-Balkan-Illyrian and Pannonian-Wallachian (Stevanović, 1995), the specific geological composition of the terrain, the altitude up to 630 m, as well as the historical development of the flora and vegetation of the entire Balkans have influenced significantly the floristic and vegetational diversity of this area.

Forests of sessile oak and Turkey oak (*Quercetum petraeae-cerridis* B. Jovanović 1979. s.l.) are widely spread on Kosmaj, where in alternation with the forests of Hungarian oak and Turkey oak (rarely the forests of Turkey oak), they precede mixed beech and sessile oak forests or pure beech forests. The ground flora layer in the researched association is very rich (114 species were registered in total) and some species of beech forests are included in its composition, besides the species from oak forests. Most of the phytocoenological relevés contain over 30 species in the ground flora layer, which is significantly more than in some other researched associations in this area (Stajić *et al.*, 2021). The floristic abundance is a consequence of the characteristics of the association and characteristics of stands in which the research was carried out.

Based on the floristic composition and habitat conditions the association was divided in two sub-associations. Sub-association *typicum* is floristically rich, with stable, typical assemblage Altitudes range from 356 to 573 m, aspects are mostly warmer, slope from 8 to 28°.

Sub-association *caricetosum silvaticae* is more mesophilous variant of sessile oak and Turkey oak forest, which here occurs on colder aspects (North, Northeast, Northwest), on somewhat deeper variants of eutric brown soils and slope from 14° to 27°. In the tree and shrub layers, besides the species that occur in typical variant, some mesophilous species like *Fraxinus excelsior* L., *Populus tremula* L, *Crataegus oxyacantha* L. are also registered. This sub-association is characterized by the presence of the species *Carex sylvatica* Huds. in the ground flora layer. Out of other species that are not present in typical variant of sessile oak and Turkey oak forest the following are registered: *Carex hirta* L., *Asperula odorata* L., *Lamium galeobdolon* (L.) Crantz., *Dryopteris filix-mas* (L.) Schott., *Asarum europaeum* L., *Acer pseudoplatanus* L., *Viola sylvestris* Lam., *Euphorbia platyphyllos* L., *Cephalanthera longifolia* (L.) Fritsch. As can be seen, this sub-association, as a more

mesophilous one, stands out by the presence of the larger number of species characteristical for beech forests. In this sub-association also are present the facies rubosum.

The analysis of the spectrum of floral elements shows that in association of sessile oak and Turkey oak (*Quercetum petraeae-cerridis* B. Jovanović 1979. s.l.) the most represented are mesophilous plants with 42% (of Central European and Sub-Atlantic range types). It is known that these forests are somewhat more mesophilous than monodominant forests of Turkey oak, so besides the xerophilous species of the order *Quercetalia pubescentis* some more mesophilous elements of sessile oak forests and even beech forests occur (Tomić, 2004). Considering such floristic composition of this association, such share of mesophilous plants is expected. In order of representation in this association, plants of wide ecological amplitude follow with 25% (of Eurasian and Cosmopolitan range types), and then also xerothermophilous plants with 23% (of Pontic, sub-Mediterranean and Balkan range types).

Based on the life -form spectrum of plants, the association of sessile oak and Turkey oak is hemicryptophytic-phanerophytic. Similar biological spectrum of the association of sessile oak and Turkey oak was registered also on Vršačke mountains (Pekanović, 1981). The forest of sessile oak and Turkey oak on the territory of Đerdap, which is situated on the transitional habitat between climatogenic forest of Hungarian oak and Turkey oak and sessile oak forest in its composition has 48% of hemicryptophytes (Krstić, 2000).

5. CONCLUSION

Association of sessile oak and Turkey oak (*Quercetum petraeae-cerridis* B. Jovanović 1979. s.l.) on Kosmaj has a large ecological amplitude, i.e. it is spread in the wide range of altitudes (phytocoenological relevés are from altitudes ranging from 348 to 573 m), on various aspects (it appears more often on warmer aspects) and slopes from 8° to 28°. These forests are the most widespread on the slopes of Veliki Kosmaj, where they alternate with the forests of Hungarian oak and Turkey oak (rarely Turkey oak) and precede mixed beech and sessile oak forests or pure beech forests.

Based on floristic composition and habitat conditions the association was divided on two sub-associations. Sub-association *typicum* is floristically rich, with stable, typical assemblage. Sub-association *caricetosum silvaticae* is more mesophilous variant of sessile oak and Turkey oak forest, which occurs here on colder aspects (North, Northeast, Northwest), on somewhat deeper variants of eutric soils and slope ranging from 14° to 27°, and differential species *Carex sylvatica* Huds is present in it.

According to the spectrum of range types the researched association has a Central European character, while according to the life-form spectrum it is of hemicryptophytic-phanerophytic character, with an increased share of geophytes.

Acknowledgement: *This study was funded by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, Contract No. 451-03-66/2024-03/ 200027.*

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PYTOCOENOLOGICAL ANALYSIS OF SESSILE OAK AND TURKEY OAK FORESTS (*QUERCETUM PETRAEAE-CERRIDIS* B. JOVANOVIĆ 1979. S.L.) IN THE TERRITORY OF KOSMAJ

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Summary

The results of phytocoenological research of sessile oak and Turkey oak forest (*Quercetum petraeae-cerridis* B. Jovanović 1979. s.l.) which is carried out in the protected area Kosmaj are presented in this paper. On the researched territory the forest of sessile oak and Turkey oak has a large ecological amplitude, it is spread in the wide range of altitudes (phytocoenological relevés are from altitudes ranging from 348 to 573 m), on all aspects (more often it occurs on warmer aspects) and slopes from 8° to 28°. These forests are the most widespread on the slopes of Veliki Kosmaj, where they alternate with the Hungarian oak and Turkey oak forests (rarely Turkey oak forests), and precede mixed forests of beech and sessile oak or pure beech forests. The association of sessile oak and Turkey oak on Kosmaj occurs on flysch, and the soils found in this association are eutric cambisol and dystric cambisol.

Ground flora layer is very rich (114 species were registered in total) and its composition includes, in addition to species from oak forests, some species of beech forests. The largest number of phytocoenological relevés contains over 30 species in the ground flora layer, which is significantly more than in some other researched associations in this area. Floristic abundance is a consequence of the characteristics of the association and characteristics of stands in which the research was carried out. The degree of coverage by ground flora ranges from 0.3 to 1.0. Based on the floristic composition and habitat conditions the association was divided into two sub-associations: *typicum* and *caricetosum silvaticae*.

By analysis of the spectrum of range types it was determined that the researched association of sessile oak and hornbeam has a Central European character, while according to the life-form spectrum it is of hemicryptophytic-phanerophytic character, with increased share of geophytes.

FITOCENOLOŠKA ANALIZA ŠUMA KITNJAKA I CERA (*QUERCETUM PETRAEAE-CERRIDIS* B. JOVANOVIĆ 1979. S.L.) NA PODRUČJU KOSMAJA

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Rezime

U radu su prikazani rezultati fitocenoloških istraživanja šume kitnjaka i cera (*Quercetum petraeae-cerridis* B. Jovanović 1979. s.l.) koja su sprovedena u zaštićenom području Kosmaj. Na istraživanom području šuma kitnjaka i cera ima veliku ekološku amplitudu, rasprostranjena je u širokom dijapazonu nadmorskih visina (fitocenološki snimci

su sa nadmorskih visina 348-573 m), na svim eskpozicijama (češće se pojavljuje na toplijim) i nagibima od 8°-28°. Ove šume najviše su rasprostranjene na padinama Velikog Kosmaja, gde alterniraju sa šumama sladuna i cera (ređe šumama cera), gde prethode mešovitim bukovo-kitnjakovim ili čistim bukovim šumama. Zajednica kitnjaka i cera na Kosmaju se javlja na flišu, a od zemljišta u ovoj zajednici su konstatovani eutrični kambisol i distrični kambisol.

Sprat prizemne flore je vrlo bogat (registrovano ukupno 114 vrsta) i u njegov sastav, pored vrsta iz hrastovih šuma, ulaze i neke vrste bukovih šuma. Najveći broj fitocenoloških snimaka sadrži preko 30 vrsta u spratu prizemne flore, što je znatno više nego u nekim drugim istraživanim zajednicama na ovom području. Florističko bogatstvo je posledica osobina same zajednice i karakteristika sastojina u kojima su vršena istraživanja. Pokrovnost prizemnom florom kreće se od 0.3 do 1.0. Na osnovu florističkog sastava i stanišnih uslova izvršena je podela zajednice na 2 subasocijacije: *typicum* i *caricetosum silvaticae*.

Analizom spektra areal tipova utvrđeno je da istraživana zajednica kitnjaka i graba ima srednjeevropski karakter, dok je prema spektru životnih oblika hemikriptofito-fanerofitskog karaktera, sa povećanim učešćem geofita.