A Contribution to the Knowledge of the Plant Associations on the rocks of the Miljacka Gorge

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This paper presents new knowledge on the phytocoenological composition of the rocks in the Miljacka gorge. The gorge has been explored over many years of field trips. Part of the research conducted on the north side of the gorge is set out in the paper and three new phytocoenological associations have been analysed. In addition to the phytocoenological composition of the associations, other parameters are given which provide significant detail of the relations in the gorge and represent the basis for further research. The paper also presents specific data on the distribution of certain rare and endemic species in the area studied. This creates the possibility for the specific protection of these species, since it is a protected area. A list of species of the area studiedas given in the list of plant species for the "Red Book forBosnia and Herzegovina" is provided at the end of this paper.

Key words: phytocoenosis, protected area, gorge, Miljacka

INTRODUCTION:

TOPOGRAPHIC POSITION OF THE AREA STUDIED

The area studied is located east of Sarajevo, extending from the Bentbaša area to the bridge known as Kozija ćuprija. The first association is located in the area of Bentbaša, on the rocks of the precipitous slope below the Bijela tabija. The other two are below Borije and Hrastova Glavica, and in the area near the Kozija ćuprija bridge.

The area lies between the 18th and 19thlongitudes east (18° 27´30´´-18° 28´20´´) and between the 43rd and 44thlatitudes north (43° 51´ 10´´-43° 51´ 40´´). It is important to point out that the location of the associations studied lies within the boundaries of the "Bentbaša" protected area (Map 1).

CLIMATE CHARACTERISTICS OF THE AREA STUDIED

CLIMATE OF THE AREA STUDIED

According to Đug et al., the climate of the area studied belongs to the climatic type designated as Cfb, a moderately warm and wet climate with warm summers and with no dry season. According to Drešković (2003: 147, 148), the average temperature of the hottest month ranges from 15 °C to 22 °C, at least four months have an average monthly temperature ≥ 10 °C, the average temperature of the coldest month is always > -3.0 °C, and the annual temperature amplitude ranges from 12 °C do 22 °C. Annual precipitation rangesfrom 700 to 1200 mm of rainfall, evenly distributed throughout the year.

In addition, the effects of the real Supra-Mediterranean and distant steppe areas are felt in this area (Redžić, 1997: 35). The most significant meteorological data are set out in tables 12, 13 and 14.

WIND AS AN ECOLOGICAL FACTOR

Wind is one of the most important factors for the formation of vegetation, and usually has a direct impact on the appearance as well as the structure and certain patterns of vegetation dynamics (Redžić, 1991: 12). According to Horvat (1948: 148), wind has a very significant physiological effect,causinga reduction in temperature and increased plant evaporation.Čirić (1984: 182) states that the effect of wind can cause permanent displacement of soil material, which constantly disturbs the normal development of the land, maintaining it permanently in the primary development stages. Wind has a significant impact in the area studied, both by carrying away and by depositing soil particles, as well as on seed distribution– anemochory. Anemochory is one of the most important ways in which plants living in such ecosystems are able to spread, the other being mirmecochory. According to research by various authors, these two methods of plant displacement relate principally to the terrestrial layer of the community (Horvat, 1949: 305). The winds in the Miljacka gorgeblow ENE and WSW; during the day, and for most of the year, the prevailing direction in the Miljacka gorge is ENE (Drešković, 2003).

FROST AS AN ECOLOGICAL FACTOR

Frost as an ecological factor is very important for vegetation development. It is formed by evaporation of the wet soil layers (Horvat 1949: 133). According to Milosavljević (1970), the area studiedfalls within a wider areaaveraging 21-30 days with frost during the vegetation period (March-October), and with a maximum of 3-4 days with frost during the peak growth period (May). The same author (Milosavljević, 1940: 4) states thatthere is a high risk of frost in narrow and winding valleys. There is no doubt, therefore, that the plants in the Miljacka gorge suffer severe adverse effects of frost during part of the year.

GEOLOGICAL COMPOSITION OF THE AREA STUDIED

According to Čičić (1984), this area belongs to the Mesozoic period, specifically the lower Triassic. As regards tectonics, the same author (Čičić, 1984) states that the Miljacka gorge belongs to the transit zone and is very close to the border with the internal zone. In chemical composition, these rocks are of dolomitised limestone. Some rocks have undergone a process of mineralization and the production of calcite minerals. There are various relief forms on many of the rocks in the area studied. The most famous of these is the Triassic limestone spireknown as Babin zub, which is over 30 metres high (Lepirica, 2013: 84).

PEDOLOGICAL COMPOSITION OF THE AREA STUDIED

Lithosol is predominant on the whole area studied, with calcomelanosol occurring only to a minor extent. Calcomelanosol is most common on terraces or shelvesproviding an opportunity for the accumulation and development of this type of soil. According to Škorić et al. (1973), lithosol is regarded as an undeveloped soil of (A)-C profile. According to Škorić (1977: 24), a lithosol is a very shallow soil that is very close to the geological base. For this reason, the possibility of plants taking root in this usually very xerothermic substrate depends on the character of the rock. Such soils are very poor in nutrients, and biological activity is also very poor. This results in sparse plant populations. Ćirić (1984: 181) also states that lithosols are ecologically extremely dry habitats exposed to considerable warming and poor in accessible nutrients. The same author (Ćirić, 1984: 181) states that lithosol is an automorphic soilwatered only by atmospheric precipitation, where the absorbed water percolates freely, so that stagnant water is absent and the soil is deficient in humidification (wetting). It should also be noted that the lithosol on the rocks of the area studied is of different colours,for a variety of reasons. The most common is the

reddishcolour resulting from theiron-rich present on many rocks in the area studied.

GENERAL DATA ON FLORA AND PHYTOCOENOLOGY OF ROCKS

Gorges provide shelter for many plant species that have survived unfavourable glaciation periods. This makesgorges very interesting for botanical and phytocoenological research. Plants that inhabit rock crevices are called chasmophytes, a word deriving from the Greek *khazma* (chasm or fissure) and *phyton* (plant) (Lakušić, 1990: 180). Such plants are commonly known asrock plants (Horvat, 1949: 198). They usually inhabit exposed places subject to extreme environmental factors, such as intense solar radiation, wind and temperature, as well as very specific natural habitats with steep slopes and sparse, undeveloped soil (Janković, 1963: 172),resulting in a series of characteristic morpho-anatomical adaptations, primarily of the leaves.

Chasmophytes are most commonlycalciphile, basiphile, heliophile, and eurythermal species, and many are ombrophile species, i.e. species that are not exposed to direct rainfall and that live in sheltered places, overhangs and the like. It should also be emphasised that types of sciophyte and semi-sciophyte character are frequent. They mostly grow on limestone, but also on dolomite and dolomitised limestone. In the Alps, they also inhabit crevicesin silicate rocks (Horvat, 1949: 178).

Chasmophytes are well adapted to unfavourable external conditions and especially to physiological and physical drought. The most important morpho-anatomic adaptationsare hairiness, small growth, leaves covered with pubescent hairs, andindumentumcomposed of long glandular hairs (Šilić, 1990: 30).

An interesting phenomenon among certain species is that high altitude populations are heliophytes, while those at lower altitudes are sciophytes or semi-sciophytes. An example of this is*Edraianthus sutjeskae*(Lakušić, 1990: 125).

As for soil, chasmophytes most often inhabit primary undeveloped soils, mostly lithosol and rarely calcomelanosol. As these are soils that are directly generated by rock weathering, they are very poor in nutrients.

Plants that grow in rock crevices constitute a distinct class, *Asplenietea rupestris* (H. Meier) Br.-Bl. This consists of three orders in Bosnia and Herzegovina:

1. *Potentilletalia caulescentis* Br.-Bl. with relations: *Micromerion croaticae* H-at, restricted to the Dinarides, and the related*Moehringion muscosae* H-at et H-ić,restricted to the serpentine vegetation of central and eastern Bosnia and to crevicesin shady rocks in the forested area of the Dinarides.
2. *Amphoricarpetalia* Lkšić, with the related*Amphoricarpion autariati* Lkšić, restricted to warm gorges in BH, and penetrating in part into the continental region of Bosnia. Another relation is *Amphoricarpion neumayeri* Lkšić, which iswidespread in the subalpine belt of the Southeastern Dinarides. The third relation of this order is *Edraianthionjugoslavici* Lkšič, which is widespread in river gorges of the continental Dinarides. The area studied, the Miljacka gorge, belongs to this last.
3. *Molkeetalia petraeae* Lkšić with two relations: *Centaureo-Campanulion* H-ić, restricted mostly to the Adriatic area, but extending along the Neretva River as far as Mostar and beyond, and the related*Edraianthion* Lkšić, restricted to Orjen and southeast Herzegovina.

HISTORY OF EXPLORATION OF THE MILJACKA GORGE

Many botanists have studied the Miljacka gorge, drawn by its attraction, beauty and refugial character.

The first researcher to visit and pass through this area was the French geologist Ami Boué. Boué (1840) travelled from Pljevlje, via Čajniče and Goražde, and walking through the Miljacka gorge he came to Sarajevo.

Silence on the subject then descended until the occupation of Bosnia and Herzegovina by the Austro-Hungarian Monarchy. Hofmann (1882) provides data on the presence of some plants in the Miljacka gorge, among them*Corydalis ochroleuca*, *Genista triangularis*, and *Lonicera alpigena*.One of the greatest botanists of his time, Svante Murbeck, also visited and explored the Miljacka gorge. Murbeck (1891) mentions a number of plants found in this gorge, including*Scirpus setaceus*, *Cyperus fuscus*, *Alnus incana*, and *Euphorbia stricta* f. *latifolia*.

The curator of the National Museum of Bosnia and Herzegovina, Franjo Fiala, often spent time in thegorge during the course of his research (1889, 1891, and 1896). He also collected and herbalised a large number of plants from thegorge, depositingthem in the Herbarium of the National Museum of BH.Another great botanist, G. Beck, provided a mass of data in his *Flora Bosne i Hercegovine i Novopazarskog Sandžaka* (Beck, 1901, 1903 a & b, 1906 a, b & c, 1907, 1909, 1914, 1916 a & b, 1918, 1920, 1921, and 1923).

Another curator of the National Museum of BH who explored the Miljacka gorge, Đorđe Protić, gave details of some of the species found in the Miljacka gorge in his *Prilog k poznavanju flore Bosne i Hercegovine* (1908). The same author (Protić, 1897 and 1899) provided data on the diatoms of the Miljacka and (Protić, 1933) examined the biological self-cleaning of the Miljacka River.

One of the greatest Bosnian-Herzegovinian botanists, curator and founder of the Botanical Garden of the National Museum of BH, Karlo Malý,carried out much of his research in this gorge and the tributaries of the Miljacka: the

Lapišnica and Mošćanica. Malý provided a wealth of data on the vegetation of the gorge in his *Prilozi za floru Bosne and Herzegovine* (Malý,1899, 1904, 1910, 1912, 1917, 1919, 1920, 1923, 1928, 1940, and 1948) and in other works (Malý, 1931, 1932, 1933 a & b, 1935, Malý & Zahn, 1925, 1926, and 1929).

Botanical investigations in the gorge continued after World War II. Thus, Ritter-Studnička (1958) provided information on the discovery of certain adventive species in this gorge. Stefanović (1955: 51) reported that *Ailanthus glandulosa* Desf. occurs as a weed in the Bentbaša-Kozija ćuprija region.

Abadžić (1974) explored the ecology and variability of the population of the species *Scabiosa leucophylla* Borb. in the part of a gorgeknown as Orlovo krilo. Investigating the ecological and morphological differentiation among the populations of the species *Edraianthusjugoslavicus*, the same author (1984) conducted part of her research on this species in the Miljacka gorge. Abadžić (1987: 72) also noted the presence of *Echinocystis lobata* (Michx) Torrey et Gray in the valley of the Miljacka River, in several places.

Strgar (1974 and 1981) described a new species of *Sesleria ujchelyii*in the Miljacka gorge, specifically on the Dariva rocks.Professor Redžićinvestigated the gorge on several occasions. He covered the gorge in his doctoral dissertation (Redžić, 1991), and published two articles in the popular science magazine *Fondeko svijet* in which he gave a concise description of the flora and other characteristics of thegorge (Redžić, 1997 a and b).

Tanović (1995) conducted part of his research in the Miljacka gorge as part of his thesis. Others who have explored the gorge include Jukić (2001), Merdan (2004), Ravlić (2004), Šoljan et al. (2007), and Hasanbegović (2018).

MATERIAL AND METHODS OF RESEARCH

THE MATERIAL AND METHODS OF RESEARCHFALL INTO TWO PHASES: FIELD WORK AND LABORATORY WORK.

Field work:

The field work includes long-term field trips in every annual vegetation season. Each population was studied and monitored through several successive annual weather aspects, in order to identify ecological and especially phenological data.

During the vegetation season, phytocoenological populations were made according to the Braun-Blanket method (Braun-Blanket, 1932) in the area studied. Data on flora and phytocoenological composition were collected from these areas during the entire vegetation season, to be analysed in the next phase of work. The flowering of individual typical species was also observed throughout the season.

Laboratory work:

The collected data was statistically analysed, yielding data on the total number of species. The following parameters were also analysed: life form, phytocoenological affiliation, indicator value and floral element. Graphical representations for all the above parameters were produced. Finally, comparative relations of all parameters among the associations studied were given.

NOMENCLATURE

Many works and keys, both general and specialised for certain genera, were consulted in the determination of the plants.

General worksconsulted:

Aichele & Schwegler (1988), Beck (1916, 1920, 1922, 1927), Beck et al. (1950, 1967, 1974 and 1983), Čanak et al. (1978), Domac (1984), Horvatić (1954), Josifović et al. (1970-1977), Kojić (1981), Kvakan (1952), Šarić (1991), Šilić (1990, 2002, 2005) and Šoštarić-Pisačić & Kovačević (1968).

Specialised keys consulted for certain genera:

For genus *Edraianthus*-Lakušić (1973), for genera *Acinos* and *Micromeria*-Šilić (1979) and for genus *Allium*-Radić (1989).

Floral elements and life forms were taken from Lakušić & Redžić (1989 & 1991), Oberdorfer (1979), and Redžić (1988).

Phytocoenological affiliation was taken from Horvat et al. (1974), Lakušić (1989), Lakušić & Redžić (1989 & 1991), Oberdorfer (1979), and Redžić (1988).

Indicator values were taken from Lakušić & Redžić (1989 & 1991), Pavlović-Muratspahić (1995), and Redžić (1988).

Life forms were given according to Raunkiaer (1937).

The following works were consulted for the history of the research: Fiala (1892), Fukarek (1954), and Redžić (1997 b).

The following references were used for phytoceonology: Braun Blanket (1932), Horvat (1949), Mc Cune & Grace (2002), Kent & Coker (1992), and Stefanović (1986).

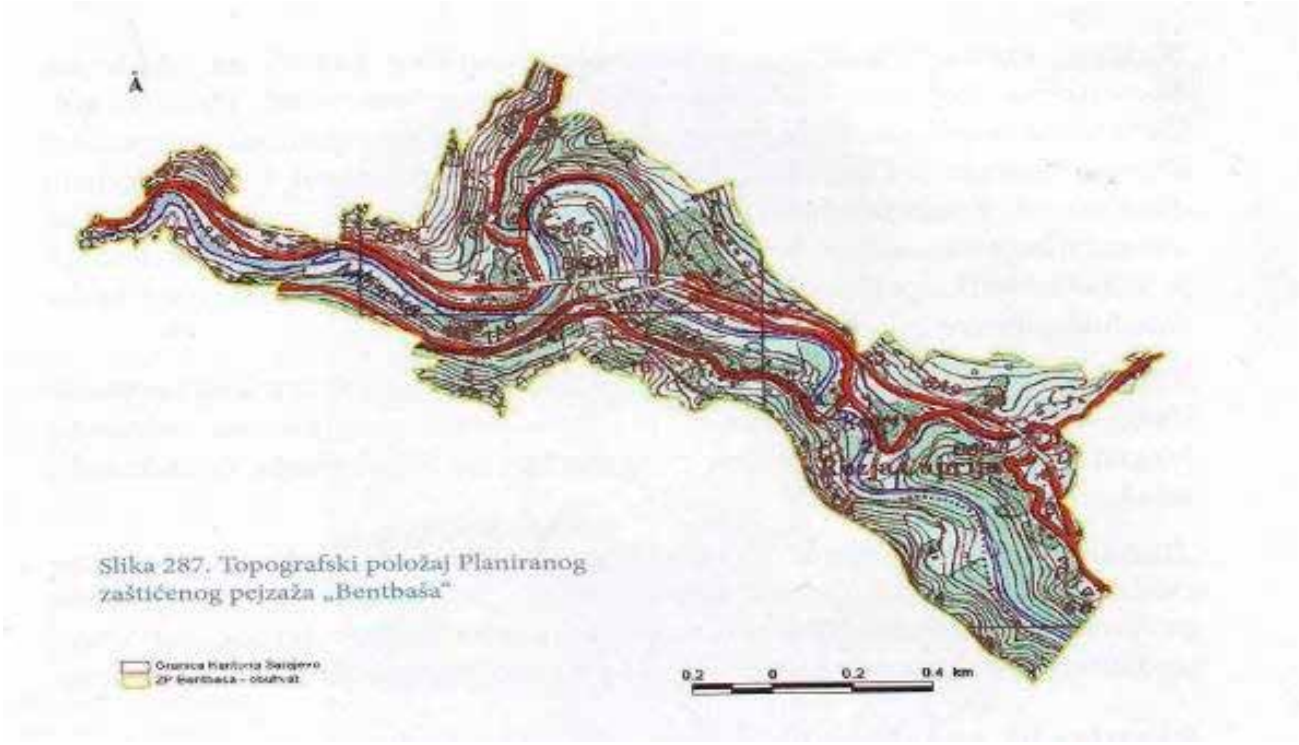
The phytocoenological division is given according to: Blečić & Lakušić (1976), Horvat (1937: 137), Lakušić 1968 and 1975 and Lakušić et al. 1969 and 1978, Zupančić et al. (1986).

Meteorological data, consisting ofmeasurements taken at two different hydrometeorological stations, were obtained with the assistance of the staff of the Federal Hydro-Meteorological Institute from Sarajevo.

Taxa in this paper are partly aligned with the *Flora Europaea* (Tutin et al., 1964-80).

Abbreviations:

Abbreviations for phytocoenologic units: *T.-S. u.- Thymo-Seslerietum ujchelyii*, *T.-E. l.- Thymo-Erysimetum linearifoliae*, *D.-G. j.- Diantho-Genistetum januensis*



Map 1. Position and boundaries of the "Bentbaša" protected area (Taken from Đug et al., 2008).

Abbreviations for indicator values: P-primary, PS-primary secondary, S-secondary, SP-secondary primary, T-tertiary.

Abbreviations for phytocoenologic orders (in alphabetical order): Amp.-*Amphoricarpetalia*, A. f.-*Arabidetalia flavescentis*, Arr.-*Arrhenatheretalia*, Art.-*Artemisietalia*, B. e.-*Brometalia erectii*, Che.-*Chenopodietalia*, E.-P.-*Erico-Pinetalia*, F.-*Fagetalia*, O.-*Onopordetalia*, P. m.-*Plantaginetalia* majoris, P. s.-*Prunetalia spinosae*, Q. p.-*Quercetalia pubescentis* and S.-C.-*Scorzonero-Chrysopogonetalia.*

Abbreviations for life forms: H-*hemicriptophyta*, Ch-*chamaephyta*, P-*phanerophyta*, G-*geophyta* and T-*therophyta.*

Abbreviation for IUCN status: R-rare species.

RESULTS AND DISCUSSION

THYMO-SESLERIETUM UJCHELYII COMB. NOVA ASSOCIATION

In the area studied, this association occupies the rocks located in the tunnel area of Bentbaša and Babin zub. Table 15 shows that the most important species are *Sesleria ujchelyii* and *Thymus jankae*. Here, *Sesleria ujchelyii* is the most common in the entire area studied, but it should be noted that this *Sesleria* does not appear at all on the opposite, south-eastern side of the gorge, where it is replaced by*Sesleria angustifolia*. It is not very common on the rest of the north side, apart from the Dariva rocks.On the other hand, *Thymus jankae* is one of the most important plants of this gorge. It appears on both sides of the gorge and participates in the formation of many associations In. addition to these species, high values have been identified for the following species:*Galium purpureum*, *Silene vulgaris*, *Erysimumlinearifolium*, *Sedum album*, *Leontodon crispus*, *Sanguisorba muricata*, *Stipa calamagrostis,* and *Tunica saxifraga*. It is interesting to note that this is the only site and association in the entire area studied where *Onosma stellulatum* was detected, in only one population. Similarly, *Sempervivumtectorum* was detected in this area only,in two separate populations with a small number of specimens.Other rare species include*Rhamnus rupestris, Minuartia bosniaca,* and *Genista januensis*. As regards ecological conditions, the association develops on limestone rocks. Most of the soil appears to be lithosol,while calcomelanosol occurs to a much smaller extent. The association is strongly influenced by

direct solar radiation. The largest number of species found in this association belong to the order of *Amphoricarpetalia*, with a somewhat smaller number of *Brometali erecti*. The following ordershave also high values: *Scorzonero-Chrysopogonetalia, Arrhenatheretalia,* and *Chenopodietalia* (Chart 1).

The highest indicator values are those of secondary and primary species (Chart 2).

The most common life form consists ofhemicryptophytes,with a much smaller number of chamaephytes, phanerophytes and other forms (Table 1). The largest number of species belong to sub-Mediterranean floral elements, with slightly lower values recorded in the Balkan and EurasSuboceanicfloral elements. The Euroasian and Nordic Euroasian floral elements also have high values (Table 2).

THYMO-ERYSIMETUM LINEARIFOLIAE **COMB. NOVA ASSOCIATION**

This association develops under the significant influence of the surrounding forest vegetation of the order *Quercetalia pubescentis*. It develops on dolomitised limestone rocks on which the soil is a lithosol and in places where a thin layer of calcomelanosol can be found.

In addition to the edificator types, the following species also have high values in this association: *Galium corrudaefolium*, *Sedum album,* and *S. ochroleucum*, *Stipa calamagrostis*, *Hypericum perforatum*, *Silene vulgaris*, *Chondrilla juncea*, *Tunica saxifrage,* and *Clematis vitalba* (table 16). The following species were identified from the *Quercetalia pubescentis* order: *Fraxinus ornus*, *Inula conyza*, *Arabis turitta*, *Hedera helix*, *Dactylis aschersoniana,* and *Ostrya carpinifolia*.

It is interesting to note that some species which makea significant contribution to the formation of many associations in the area studied occur in very small numbers in this association. Such is the case with *Micromeriathymifolia*, an important member of many associations on both sides of the Miljacka gorge, great burnet and canary clover, which can be found innumerous associations on both sides, *Sesleriaujchelyii*, an important member of some associations on the north side of the area studied, and Kitaibel's Pink, which is almostubiquitous on the eastern side

Table 1. Life forms of the association *Thymo-Seslerietum ujchelyii* comb. nova.

Life form	Total number	Total	%	Σ %
H	34		53.96	
H(Ch)	2		3.17	
H(T)	2		3.17	
H(G)	2		3.17	
		40		63.49
Ch	7		11.11	
Ch(H)	2		3.17	
		9		14.28
P	7		11.11	
P(Ch)	1		1.58	
		8		12.69
T	4		6.34	
T(Ch)	1		1.58	
		5		7.93
G	1		1.58	
		1		1.58
Total:	63	63	100 %	100 %

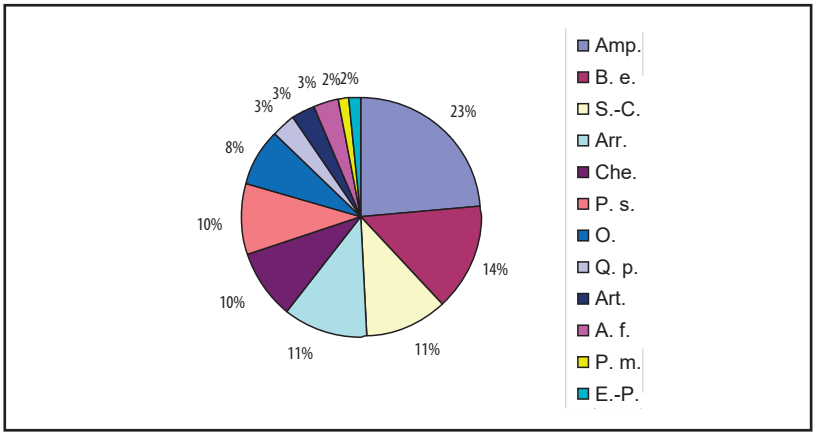


Chart 1. Phytocoenological affiliation to particular orders of the association *Thymo-Seslerietum ujchelyii comb.* nova (expressed in %).

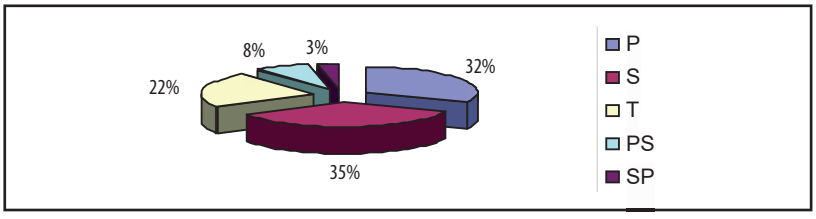


Chart 2. Percentage ratio of indicator values in the association *Thymo-Seslerietum ujchelyii* comb. nova.

Table 2. Spectrum of floral elements of the T*hymo-Seslerietum ujchelyii comb.* nova association.

Floral element	Number of species	Total	Participation (%)
din din-so-alp	3 1	4	6.77
balc s. o. balc balc-apen	5 1 2	8	13.55
pralp pralp-smed	1 1	2	1.69
smed (pralp)smed-subatl osmed osmed-gemässkont smed-subatl(circ) smed-euras smed(-euras) (o)smed submed(-subatl)	6 1 1 1 1 1 1 1 1	14	22.22
omed med(-kont) med med-smed-kont	2 1 1 1	5	7.93
subatl(-smed) subatl-smed (no-)subatl(smed)	1 1 1	3	5.08
euras(kont) euras(kont)smed euras(kont)-smed euras(kont)(-smed) euras-smed euras-smed,circ	1 1 1 1 1 1	6	10.16
no-euras-med no-euras-smed no-euras no-euras(subozean)	1 1 2 1	5	8.47
eurassubozean eurassubozean-smed eurassubozean(-smed) (no-)eurassubozean(smed)	5 4 1 1	11	12.25
euraskont(-smed)	1	1	1.69
(euras)kont-smed s. o. kont	1 1	2	3.38
gemässkont-osmed	1	1	1.69
n-persia	1	1	1.69
Total number of group floral elements: 13			
Total number of individual floral elements: 40			
Total:	63	63	100

Figure 1. *Sesleria ujchelyii*, an important member of the *Thymo-Seslerietum ujchelyii* comb. nova association.

of the gorge, and appears in this part at the very end of the gorge, but in this association it is very poorly represented.

Most species of this association belong to the *Amphoricarpetalia* order,while a significantly smaller number of species are listed in the following orders: *Quercetalia pubescentis, Chenopodietalia, Scorzonero-Chrysopogonetalia, Brometalia erecti* and *Prunetalia spinosae* (Chart 3). Primary indicator values are prevalent, with secondary values also present (Chart 4). The prevalent life forms arehemicryptophytes. chamaephytes and phanerophytes (Table 3). The largest number of species of this association belong to the sub-Mediterranean floral element. A significantly smaller number belong to the EurasSuboceanic, Mediterranean and Nordic Eurasian (Table 5).

DIANTHO-GENISTETUM JANUENSIS COMB. NOVA ASSOCIATION

This association has developed at the end of the area studied from the north side and near the Kozija ćuprija bridge. Kitaibel's Pink is one of the most important plants in the area studied. It is common on the southeastern side and is a member of numerous associations. On the northern side, it appears only at the end of the area studied, where it forms this association together with *Genistajanuensis*, which also more frequently appears only in this area. The association develops under the influence of the surrounding forest ecosystem and is therefore partly in shade, with reduced insolation.

These specific conditions have led to the creation of this association. Among important species of this association are*Thymus jankae*, *Galium corrudaefolium*, *Stipa calamagrostis* and *Melica ciliata* (Table 17). *Silene vulgaris*, *Sanguisorba muricata*, *Tunica saxifraga*, *Galium purpureum* and

Micromeria thymifolia also have high values. Members of the forest eco-system include-*Fraxinus ornus*, *Potentilla micrantha*, *Crataegus monogyna*, *Campanula trachelium*, *Clematis vitalba* and *Ligustrum vulgare*. As with the previous association (*Thymo-Erysimetum linearifoliae*), in this association too some of the very widespread species from the *Amphoricarpetalia* order of this side of gorge are missing or detected in a small number of populations or with a small number of specimens. These are*Asplenium trichomanes*, *Allium carinatum*, *Sesleria ujchelyii*, *Chondrilla juncea* and *Erysimum linearifolium*. Representatives of other orders which are quite common in the area studied which have very low values are *Coronilla emerus* ssp. *emeroides*, *Scabiosa leucophylla* and*Dorycnium herbaceum*, as well as *Inula conyza* and *Syringa vulgaris.*

Table 3. Life forms of the *Thymo-Erysimetum linearifoliae comb.* nova association.

Life form	Total number	Total	%	Σ %
H	19		42.22	
H(Ch)	1		2.22	
H(T)	1		2.22	
H(G)	1		2.22	
		22		48.88
Ch	8		17.77	
Ch(P)	1		2.22	
		9		20
P	8		17.77	
		8		17.77
T	2		4.44	
T(Ch)	2		4.44	
		4		8.88
G	1		2.22	
G(H)	1		2.22	
		2		4.44
Total:	45	45	100 %	100 %

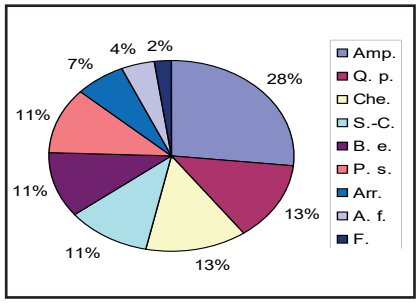


Chart 3. Phytocoenological affiliation to the individual orders of the *Thymo-Erysimetumlinearifoliae comb.* nova association (expressed in %).

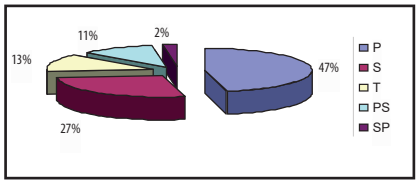


Chart 4. Percentage share of individual indicator values in the *Thymo-Erysimetum linearifoliae comb.* nova association.

Table 4. Floral elements of the *Thymo-Erysimetum linearifoliae comb.* nova association.

Floral element	Number of species	Total	Participation (%)
din	2	2	4.44
balc s. o. balc	2 1	3	6.66
pralp-smed	1	1	2.22
smed (pralp)smed-subatl osmed smed(-subatl) smed-subatl(circ) smed-gemässkont smed(-euras) smed-euras (o)smed submed(-subatl)	6 1 2 1 1 1 1 1 1 1	16	35.55
omed-smed med(-cont) med med-smed-cont	1 1 2 1	5	11.11
subatl-smed	2	2	4.44
euras(cont)(-smed) euras-smed euras-smed,circ	1 1 1	3	6.66
no-euras(-med) no-euras-smed no-euras(subocean)	1 2 1	4	8.88
eurassubocean eurassubocean-smed	1 4	5	11.11
s. o. cont europcont	1 1	2	4.44
gemässkont	1	1	2.22
china	1	1	2.22
Total number of group floral elements: 12			
Total number of individual floral elements: 31			
Total:	45	45	100 %

The highest number of the plants identified belong to the orders of *Amphoricarpetalia*,*Quercetaliapubescentis* and *Brometaliaerecti*. Orders *Prunetalia spinosae* and *Scorzonero-Chrysopogonetalia* also have high values (Chart 5). The highest indicator values are those of primary vegetation, with a rather smaller number for secondary vegetation (Chart 6). Hemicryptophytes predominate in life forms,with phanerophytes and chamaephytes in significantly smaller numbers(Table 5). The most common floral element is sub-Mediterranean, while representatives of EurasSuboceanic, Euro-Asian, and Balkan elements are represented in small numbers (Table 6).

COMPARATIVE TABLES ON THE RELATIONSHIP BETWEEN PHYTOCOENOLOGICAL ASSOCIATIONS, INDICATOR VALUES, LIFE FORMS, AND FLORAL ELEMENTS OF THE ASSOCIATIONS STUDIED

Table 7 shows that representatives of the order *Amphoricarpetalia*occur in the highest percentage in all associations. There is also a high percentage of representatives of the orders *Brometalia erectii* and *Scorzonero-Chrysopogonetalia*, representatives of meadow ecosystems, and of the orders *Quercetalia pubescentis* and *Prunetalia spinosae*, representatives of forest ecosystems. The main reason for such a high percentage of representatives

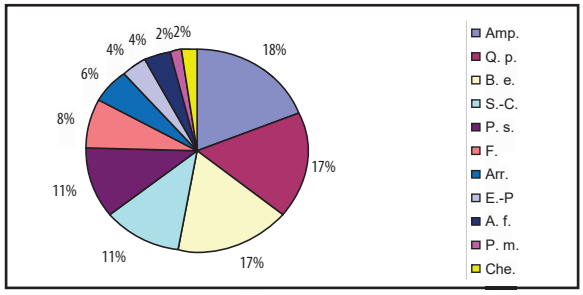


Chart 5. Phytocoenological affiliation to certain orders of the *Diantho-Genistetumjanuensis comb.* nova association (expressed in %).

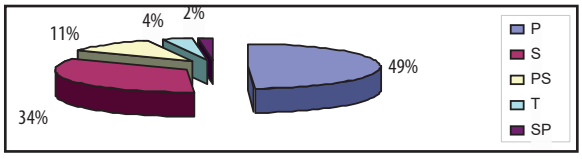


Chart 6. Percentage share of individual indicator values in the *Diantho-Genistetum januensis comb.* nova association (expressed in%)

Table 6. Life forms of the *Diantho-Genistetum januensis* comb. nova association.

Life form	Total number	Total	%	Σ %
H	27		50.94	
H(G)	2		3.77	
H(T)	2		3.77	
H(Ch)	1		1.88	
		32		60.37
P	11		20.75	
P(Ch)	1		1.88	
		12		22.64
Ch	7		13.20	
		7		13.20
G	1		1.88	
		1		1.88
T(Ch)	1		1.88	
		1		1.88
Total:	53	53	100 %	100 %

Table 7. Floral elements of the Diantho-Genistetum januensis comb. nova association.

Floral element	Number of species	Total	Participation (%)
din	2	3	5.66
din-so-alp	1		
balc	4	5	9.43
s. o. balc	1		
s. o. eur	1	1	1.88
pralp-smed	1	1	1.88
smed	5	18	33.96
(pralp)smed-subatl	1		
osmed	3		
smed(-subatl)	1		
smed-subatl(circ)	1		
smed(-gemässkont)	1		
smed-med	1		
smed(-euras)	2		
o(smed)	1		
(o)smed	1		
submed(-subatl)	1		
omed-smed	1	4	7.54
med(-cont)	1		
med	2		
subatl-smed	1	1	1.88
euras(cont)	1	6	11.32
euras(cont)-smed	1		
euras(kont)(-smed)	1		
euras(-smed)	1		
euras-smed	1		
euras-smed,circ	1		
no-euras-smed	1	4	7.54
no-euras	1		
no-euras(subocean)	1		
no-eurassubocean	1		
eurassubocean	5	6	11.32
eurassubocean-smed	1		
(gemäss)cont-smed	1	3	5.66
s. o. cont	1		
europcont	1		
gemässcont-osmed	1	1	1.88
Total number of group floral elements: 12			
Total number of individual floral elements: 37			
Total:	53	53	100

of these orders is in the proximity of these ecosystems with the associations studied. The table shows that the location of the association of *Thymo-Seslerietum ujchelyii* is under the influence of meadow ecosystems,while on the other hand, the associations of *Thymo-Erysimetum linearifoliae* and *Diantho-Genistetum januensis*are also subject to the strong influence of forest ecosystems because both associations are beneath the forest ecosystem.

Table 8 shows that the representatives of primary vegetation are dominant in two associations, whilerepresentatives of secondary vegetation in one. The main cause is the proximity of the secondary ecosystem and the association study. Tertiary vegetation representatives, which mostly inhabit terraces, also have high values. Secondary vegetation

Table 7. Relation of affiliation to certain phytocoenological orders in the phytocenoses studied (expressed in percentages).

F. p.→ Association	Amp.	B. e.	S.-C.	Arr.	Che.	P. s.	O.	Q. p.	Art.	A. f.	P.m.	E.-P.	F.
T.-S. u.	23	14	11	11	10	10	8	3	3	3	2	2	-
T.-E. l.	28	11	11	7	13	11	-	13	-	4	-	-	2
D.-G. j.	18	17	11	6	2	11	-	17	-	4	2	4	8

Table 8. Indicator value ratio in the associations studied (expressed in percentages).

Indicator value Association	P	S	T	PS	SP
Thymo-Seslerietum ujchelyii	32	35	22	8	3
Thymo-Erysimetum linearifoliae	47	27	13	11	2
Diantho-Genistetum januensis	22	13	4	11	2

Table 9. Life form relationships in the associations studied (expressed in percentage).

Life form Association	H, H(Ch), H(T), H(G)	Ch, Ch (H)	P, P(Ch)	T, T(Ch)	G
Thymo-Seslerietum ujchelyii	63.49	14,28	12.69	7.93	1.58
Thymo-Erysimetum linearifoliae	48.88	20	17.77	8.88	4.44
Diantho-Genistetum januensis	60.37	22.64	13.20	1.88	1.88

Table 10. Ratio of floral elements in the associations studied (expressed in percentages).

Association Floral element	Thymo-Sesleritum ujchelyii	Thymo-Erysimetum linearifoliae	Diantho-Genistetum januensis
din.	6.77	4.44	5.66
balk	13.55	6.66	9.43
s. o. eur	-	-	1.88
pralp	1.69	2.22	1.88
smed	22.22	35.55	33.96
med	7.93	11.11	7.54
subatl-smed	5.08	4.44	1.88
euras	10.16	6.66	11.32
no-euras	8.47	8.88	7.54
eurasiansubocean	12.25	11.11	11.32
euraskont	1.69	-	-
kont	3.38	4.44	5.66
gemasskont	1.69	2.22	1.88
n. pers.	1.69	-	-
china	-	2.22	-

representatives mainly display low values, which are mainly related to the aforementioned associations that are in direct contact with the forest ecosystem.

Table 9 shows that members of the hemicryptophyte life form are the most widespread in the associations studied. Evidently, the hemicryptophyte life form developed as a means of survival by plants in harsh living conditions. Other forms appear in a much smaller percentage. Geophytes occur in the smallest percentage, because they need deeper soil for their development and survival, which is rare on the rocks.

Table 10 shows that the largest number of species belong to the sub-Mediterranean floral element. This is not surprising, sincethe penetration of the supra-Mediterranean climate (Redžić, 1997b: 35), to which members of this floral element correspond, can be felt in this gorge. The values of the Eurasian suboceanic, Balkan, Eurasian and Mediterranean floral elements are significant.

PHENOLOGICAL CALENDAR OF FLOWERING OF INDIVIDUAL PLANTS ON THE ROCKS OF THE MILJACKA GORGE

The first plants to come into bloom in the area studied are *Sesleria ujchelyii* and *Erysimum linearifolium*, usually in the middle of April although some plants, depending on their position on the rocks, bloom in late March or early April. The following plants also bloom during the month of April: *Arabis hirsuta*, *A. glabra*, *A. turrita*, and *Coronilla emerus* ssp. *emeroides*. After them, in late April, *Thymus jankae* blooms profusely during May. *Onosmastelullatum* also begins to bloom in early May. In mid May, *Galium corrudaefolium*, *Minuartia bosniaca,* and *Helianthemum nummularium* begin to bloom.During the month of June, *Micromeria thymifolia* and *Leontodon crispus* flourish, while the last species to come into flower in the gorge is *Allium sphaerocephallum*, which begins to bloom in late August and most frequently during September and October.

A LIST OF PLANT SPECIES OF THE AREA STUDIED FOUND FOR THE "RED BOOK OF BOSNIA AND HERZEGOVINA" (ŠILIĆ 1996) WITH IUCN STATUS:

1. *Minuartia bosniaca* (G. Beck) K. Malý-(R),
2. *Onosma stellulata* W. et K.-(R),
3. *Micromeria thymifolia* (Scop.) Fritsch-(R),
4. *Scabiosa leucophylla* Borb.-(R).

CONCLUSIONS:

1. Three new phytocoenoses for the Miljacke Gorge have been described.
2. The most significant species are *Thymus jankae*, *Erysimum linearifolium*, *Minuartia bosniaca*, *Dianthus kitaibelii*, *Micromeria thymifolia*, *Sesleria ujchelyii*, *Galium corrudaefolium*, *Stipa calamagrostis*, and *Melica ciliata*.
3. The following species are also frequent: *Silene vulgaris, Sanguisorba muricata, Tunica saxifraga, Fraxinus ornus, Potentilla micrantha,* and *Clematis vitalba*.
4. The rarest species of the phytocoenoses studied are*Onosma stellulata, Sempervivum tectorum,* and *Rhamnus rupestris.*
5. There are also four species found on the "Red List of Bosnia and Herzegovina" of rare species (R) status.
6. Thelargest number of species in the associations studied belong to the phytocoenological order *Amphoricarpetalia*.
7. Primary species are dominant in the associations studied.
8. Hemicryptophytes represent the most numerous group of life forms in the associations studied.
9. Geophytes occur in the smallest percentage of life forms, revealing that the rocks constitute an extremely disadvantageous ecosystem for the development of this form.
10. The most significant floral element is sub-Mediterranean.
11. Representatives of the Eurasian Suboceanic, Balkan, Eurasian and Mediterranean floral elements have also significant values.

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SAŽETAK

Ovaj rad predstavlja nova saznanja o fitocenološkom sastavu stijena kanjona Miljacke. Kanjon je istraživan kroz višegodišnje terenske izlaske. U radu je prikazan dio istraživanja sa sjeverne strane kanjona i obrađene su tri nove fitocenološke zajednice. Također, osim fitocenološkog sastava zajednica date su i ostali parametri koji značajno govore o odnosima u kanjonu te predstavljaju bazu za dalja istraživanja. Isto tako rad donosi i konkretne podatke o rasprostranjenosti pojedinih rijetkih i endemičnih vrsta na istraživanom području što stvara mogućnosti konkretne zaštite tih vrsta pošto je riječ o zaštićenom području.

Ključne riječi: fitocenoza, zaštićeno područje, kanjon, Miljacka.

Figure 2. View of the habitat of *Thymo-Erysimetum linearifoliae* comb. nova association.

Figure 3. The habitat of *Sesleria ujchelyii* and *Thymus jankae* on the rocks on the northern side in the area studied.

Figure 4. Janke's thyme (*Thymus jankae*) is one of the most prominent plants in the area studied.

APPENDIX 1

Figure 5. *Erysimum linearifolium* is one of the most widespread plants in the area studied.

Figure 6. The Bosnian sandwort (*Minuartia bosniaca*) and in the background Janke's thyme (*Thymus jankae*) are among the most significant plants in the area studied.

Figure 7. *Onosma stellulatum* is one of the rarest plants in the area studied.

APPENDIX 2

Table 11. Meteorological data for the Sarajevo area, Sarajevo-Bjelave meteorological station, period 2007-2016.

Parameter	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Medium	Max.	Min.	Sum
Medium temperatures (C°)	1.2	2.8	6.0	11.1	14.8	18.9	21.2	21.1	16.0	10.6	6.9	1.1	11.0			
Absolute maximum temperatures (C°)	18.2	21.4	24.7	29.4	33.2	35.6	38.0	38.8	38.0	28.4	23.7	17.8		38.8		
Absolute minimum temperatures (C°)	-16.5	-19.0	-10.9	-3.7	-0.3	5.7	7.8	6.9	1.8	-3.1	-8.4	-16.0			-19.6	
Average number of days with min. temp. <0°C	18.5	14.5	9.1	1.1	0.0	0.0	0.0	0.0	0.0	1.5	8.0	20.3				73
On average the first day with the appearance of frost (min. temp. <0 °C)													October 21			
On average the last day with the appearance of frost (min. temp. <0 °C)													April 1			
Average number of days with max. temp. <0 °C	6.2	3.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	6.5				17
Average number of days with max. temp. ≥ 25 °C	0.0	0. 0	0.0	2.4	9.3	17.0	24.2	25.8	11.8	2.3	0.0	0.0				93
Average number of days with max. temp. ≥ 30 °C	0.0	0.0	0.0	0.0	1.1	6.7	13.4	15.1	4.2	0.0	0.0	0.0				41
Average number of days with min. temp. ≥ 20 °C	0.0	0.0	0.0	0.0	0.0	0.5	0.3	0.7	0.1	0.0	0.0	0.0				2
Average precipitation sums (mm)	84	69	79	67	103	94	67	48	85	96	85	72				949
Maximum daily precipitation sums (mm)	45.0	65.7	29.4	32.6	73.7	58.7	45.0	29.0	56.7	60.4	51.2	36.7		73.3		
Average number of days with daily precipitation ≥ 0.1 mm	16.1	15.8	15.3	14.8	15.5	13.1	10.4	8.8	10.9	13.7	13.1	15.3				163
Average number of days with daily precipitation ≥ 1.0	10.4	10.5	10.8	9.9	11.5	9.8	7.5	5.8	8.1	9.5	9.0	9.3				112
Average number of days with daily precipitation ≥ 10 mm	2.4	1.9	2.9	2.2	3.8	3.0	2.5	1.8	2.9	3.7	2.7	2.5				32
Average number of days with daily precipitation ≥ 20 mm	0.8	0.2	0.8	0.1	1.2	1.1	1.0	0.4	1.3	1.2	1.0	0.9				10
Maximum height of the snow cover (cm)	31	107	42	9	9	0	0	0	0	23	40	37		107		
Average number of days with snow cover ≥ 10 cm	6.6	6.6	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	2.0	5.2				24
Average number of days with snow cover ≥ 30 cm	0.2	2.6	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.2				4
Average number of days with snow cover ≥ 50 cm	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1				2
Medium cloudiness (tenth)	7.0	7.1	6.1	6.1	6.1	5.4	4.3	3.6	5.3	5.9	6.0	7.5	5.9			
Medium relative humidity (%)	78	73	68	64	67	67	64	63	69	76	75	80	70			
Insolation (hours)	76.7	89.7	139.9	168.2	192.8	221.7	268.1	255.5	181.8	147.9	114.3	68.0				1924.5

Table 12. Meteorological data for the Sarajevo area, Faletići-Mošćanica vrelo meteorological station, period 1961-1990.

Parameter	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**Medium**	**Max.**	**Min.**	**Sum**
Average precipitation sums (mm)	82	76	78	80	95	101	88	81	78	85	104	95				1042
Maximum daily precipitation sums (mm)	103.6	53.9	49.2	81.0	59.6	50.8	47.8	45.5	90.1	54.0	62.1	60.2		103.6		
Average number of days with daily precipitation ≥ 0.1 mm	11.3	11.1	11.1	11.0	11.6	11.7	9.4	8.0	8.0	8.4	10.0	11.0				116.1
Average number of days with daily precipitation ≥ 1.0	10.0	9.8	10.2	10.5	11.0	11.2	8.8	7.9	7.6	8.1	10.0	11.0				116.1
Average number of days with daily precipitation ≥ 10 mm	2.5	2.5	2.2	2.6	3.2	3.6	3.4	3.0	2.8	2.9	3.8	3.2				35.7
Average number of days with daily precipitation ≥ 20 mm	0.9	0.7	0.7	07	1.2	1.1	1.2	0.9	1.0	1.1	1.4	1.0				12.0

Table 13. Data on the direction of wind movement (the wind rose) in the area of Sarajevo, Sarajevo-Bjelave Meteorological Station, period 2007-2016.
Data for tables 11 and 12 were prepared by Ms. Slavica Jovanović and for table 13 by Mr. Bakir Krajinović.

Parameter	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	WN	NNV	C
Frequences of directions (%)	2.1	0.8	0.8	2.2	7.0	26.5	6.1	4.6	3.0	2.7	2.5	5.9	9.7	11.3	6.7	6.2	1.8
Medium wind speed (m/s)	1.4	1.3	1.4	1.7	2.2	2.4	1.6	1.5	2.1	1.8	1.5	1.2	1.1	1.3	1.3	1.4	0.0

Table 14. Phytocoenological presentation of the *Thymo-Seslerietum ujchelyii* comb. nova association.

Phytocoenological position	Indicator value	Association	Thymo-Seslerietum ujchelyii comb. nova									
		Locality	The Miljacka canyon-Bentbaša									
		Altitude (m)	540	540	545	545	545	550	555			
		Exposition	E	N	E-NE	N-NE	E	E	E			
		Slope (°)	80-90	90	90	90-100	90	80-90	80-100			
		Geological base	Limestone (dolomitized limestone)									
		Type of soil	Lithosol and calcomelanosol									
		Image size (m^2)	Per 100 m^2									
		General cover (%)	35	30-40	30	20-30	30	25	20			
		Date	May 11, 2016.									
		Ordinal image number	1.	2.	3.	4.	5.	6.	7.	Frequency	Floral element	Life form
		Floristic composition										
Amp.	P	Thymus jankae Čelak.	1.2	1.2	1.2	+2	+2	+2	1.1	7/100 %	balk	Ch
Amp.	P	Sesleria ujchelyii Strgar	1.2	1.2	2.2	1.1	+2	+2	2.2	7/100%	din	H
S.-C.	S	Galium purpureum L.	1.2	2.2	1.1	1.1	-	1.1	+2	6/85 %	balk	H
B. e.	S	Silene vulgaris (Mch) Garcke	1.2	1.2	1.1	1.1	1.1	1.1	1.1	7/100 %	no-euras-smed	H(Ch)
B. e.	S	Sanguisorba muricata (Spach) Focke	1.2	+1	+2	+2	-	1.1	1.2	6/85 %	med(-cont)	H
Amp.	P	Leontodon crispus Vill.	1.2	1.1	+2	+1	-	-	-	4/55 %	balk	H
S.-C.	S	Tunica saxifraga (L.) Scop.	1.1	1.2	+2	1.1	2.2	1.1	-	6/85 %	(o)smed	H
Amp.	P	Erysimum linearifolium Tausch	1.1	+2	1.1	1.2	-	-	+2	5/70 %	s. o. balc	H
Che.	T	Veronica hederifolia L.	1.1	+2	+2	+2	-	-	-	4/55 %	eurassubocean-smed	T
S.-C.	S	Acinos arvensis (Lam.) Dandy	1.1	1.2	-	-	-	+2	-	3/40 %	smed-euras	T(Ch)
Arr.	S	Hypochoeris radicata L.	1.1	-	-	-	-	-	-	1/15 %	subatl(-smed)	H
Q. p.	P	Carex humilis Leyss.	1.1	-	-	-	-	-	-	1/15 %	(euras)cont-smed	H
S.-C.	S	Sedum album L.	+2	-	1.2	+2	1.1	1.1	1.2	6/85 %	(pralp)smed-subatl	Ch
S.-C.	S	Centaurea rhenana Borb.	+2	-	1.1	-	-	+1	+2	4/55 %	s. o. kont	H
Art.	T	Artemisia absinthium L.	+2	-	+2	-	-	-	+2	3/40 %	eurascont(-smed)	Ch(H)
P. s.	PS	Campanula trachelium L.	+2	-	-	-	-	-	-	1/15 %	eurassubocean-smed	H
O.	T	Tanacetum parthenifolium Willd.	+2	-	-	-	-	-	-	1/15 %	omed	H
Amp.	P	Stipa calamagrostis (L.) Wahlenb.	+1	1.2	+2	-	1.1	+2	-	5/70 %	pralp-smed	H
Arr.	S	Taraxacum officinale Web.	+1	-	+2	+1	-	-	-	3/40 %	no-euras(subocean)	H
Amp.	P	Asplenium trichomanes L.	+1	-	+2	-	-	-	-	2/30 %	eurassubocean	H
Amp.	P	Chondrilla juncea L.	+1	-	+2	-	-	-	-	2/30 %	med-smed-cont	H
O.	T	Carduus crispus L.	+1	-	+1	-	-	-	-	2/30 %	eurassubocean	H
B. e.	SP	Hypericum perforatum L.	+1	+1	-	-	-	-	-	2/30 %	eurassubocean-smed	H
Che.	T	Prunus domestica L.	+1	-	-	-	-	-	-	1/15 %	n-persia	P
P. s.	PS	Crataegus monogyna Jacq.	+1	-	-	-	-	-	-	1/15 %	submed(-subatl)	P
B. e.	S	Medicago lupulina L.	-	1.1	-	+2	+2	-	-	3/40 %	euras-smed	H(T)
Arr.	S	Poa pratensis L.	-	+2	+2	-	-	+2	-	3/40 %	euras(cont)(-smed)	H(G)

S.-C.	S	Sedum acre L.	-	+2	-	-	-	+2	+2	3/40 %	(no-)eurassuboce-an(-smed)	Ch
Amp.	P	Sempervivum tectorum L.	-	+2	-	-	-	-	-	1/15 %	pralp	Ch
Art.	T	Artemisia vulgaris L.	-	+1	-	+2	-	-	-	2/30 %	eurassubocean	Ch(H)
Amp.	P	Micromeria thymifolia (Scop.) Fritsch.	-	-	2.2	+2	-	+2	1.2	4/55 %	balk	Ch
Amp.	P	Galium corrudaefolium Tausch	-	-	1.1	-	+2	1.1	1.1	3/40 %	med	H
B. e.	S	Euphorbia cyparissias L.	-	-	+2	-	-	+1	-	2/30 %	smed(-euras)	H
Che.	T	Cirsium oleraceum (L.) Scop.	-	-	+2	-	-	-	-	1/15 %	euras(cont)	H
B. e.	S	Bromus erectus Huds.	-	-	+2	-	-	-	-	1/15 %	smed	H
Amp.	P	Minuartia bosniaca (G. Beck) K. Malý	-	-	+2	-	-	-	-	1/15 %	din	Ch
A. f.	P	Arabis hirsuta (L.) Scop.	-	-	+1	+1	-	+2	-	3/40 %	euras-smed,circ	H(T)
B. e.	S	Picris hieracioides L.	-	-	+1	-	-	-	-	1/15 %	euras(cont)-smed	H
B. e.	S	Sanguisorba minor Scop.	-	-	-	+2	-	-	-	1/15 %	smed	H
Amp.	P	Allium sphaerocephalum L.	-	-	-	+1	+1	+2	+2	4/55 %	balc	G
Arr.	S	Arrhenatherum elatius (L.) J. & K. Presl	-	-	-	+1	-	-	-	1/15 %	subatl-smed	H
O.	T	Anthemis tinctoria L.	-	-	-	+1	-	-	-	1/15 %	euras(cont)smed	H
Amp.	P	Melica ciliata L.	-	-	-	-	+2	-	-	1/15 %	smed	H
P. s.	PS	Rubus discolor Weihe & Nees	-	-	-	-	+2	-	-	1/15 %	(no-)subatl(-smed)	P
Che.	T	Stellaria media L.	-	-	-	-	+2	-	-	1/15 %	no-euras-med	T
Che.	T	Bromus sterilis L.	-	-	-	-	+2	-	-	1/15 %	smed	T
P. s.	PS	Clematis vitalba L.	-	-	-	-	+1	+2	+2	3/40 %	smed-subatl(circ)	P
Q. p.	P	Fraxinus ornus L.	-	-	-	-	+1	+2	-	2/30 %	osmed	P
Arr.	S	Vicia sepium L.	-	-	-	-	+1	+2	-	2/30 %	eurassubocean	H
Amp.	P	Rhamnus rupestris Scop.	-	-	-	-	+1	-	+2	2/30 %	balc-apen	P
Che.	T	Ballota nigra L.	-	-	-	-	+1	-	-	1/15 %	osmed-gemässkont	H(Ch)
O.	T	Bifora radians M. Bieb.	-	-	-	-	+1	-	-	1/15 %	omed	T
Arr.	S	Plantago lanceolata L.	-	-	-	-	+1	-	-	1/15 %	eurassubocean	H
P. s.	SP	Coronilla varia L.	-	-	-	-	-	+2	-	1/15 %	gemässkont-osmed	H
A. f.	P	Scrophularia canina L.	-	-	-	-	-	+2	-	1/15 %	smed	H
P. m.	T	Agropyron repens (L.) Beauv.	-	-	-	-	-	+2	-	1/15 %	no-euras	H(G)
P. s.	PS	Rosa canina L.	-	-	-	-	-	+2	+1	2/30 %	eurassubocean-smed	P
Arr.	S	Vicia cracca L.	-	-	-	-	-	+1	+1	2/30 %	no-euras	H
E.-P.	P	Genista januensis Viv.	-	-	-	-	-	-	1.1	1/15 %	din-so-alp	P(Ch)
Amp.	P	Onosma stellulatum W. K.	-	-	-	-	-	-	+2	1/15 %	din	H
B. e.	S	Helianthemum nummularium (L.) Run.	-	-	-	-	-	-	+2	1/15 %	smed	Ch
S.-C.	S	Eryngium amethystinum L.	-	-	-	-	-	-	+2	1/15 %	balc-apen	H
O.	T	Melilotus officinalis L.	-	-	-	-	-	-	+1	1/15 %	eurassubocean(-smed)	H

Table 15. Phytocoenological table on *Thymo-Erysimetum linearifoliae* comb. nova.

Phytocoenological position	Indicator value	Association	Thymo-Erysimetum linearifoliae comb. nova										
		Locality	The Miljacka canyon, rocks behind the Dariva										
		Altitude (m)	565	565	570	570	570	575	576	578			
		Exposition	E-SE	E-SE	SE	S-SE	S-SE	E-SE	E-SE	E-SE			
		Slope (°)	90	80-90	90	80-90	90-100	90	80	80-100			
		Geological base	Limestone (dolomitized limestone)										
		Type of soil	Lithosol and calcomelanosol										
		Image size (m²)	100	100	100	100	100	100	100	100			
		General cover (%)	20	20-30	30	20-25	30	20	5	5-10			
		Date	May 12, 2016.										
		Ordinal image number	1.	2.	3.	4.	5.	6.	7.	8.	Fre-quency	Floral element	Life form
		Floristic composition											
Amp.	P	Thymus jankae Čelak.	1.1	2.2	1.1	1.1	1.1	2.2	+2	2.2	8/100%	balk	Ch
Amp.	P	Galium corrudaefolium Tausch	1.1	-	+2	+2	1.1	1.1	+2	+2	7/87.5 %	med	H
Amp.	P	Stipa calamagrostis (L.) Wahlenb.	1.1	1.1	-	-	+1	+2	-	+2	5/62.5 %	pralp-smed	H
S.-C.	S	Sedum album L.	+2	1.1	+2	-	1.1	1.1	+2	2.2	7/87.5 %	(pralp)smed-subatl	Ch
Amp.	P	Erysimum linearifolium Tausch	+2	+1	+2	+1	+2	+2	+2	+2	8/100 %	s. o. balc	H
B. e.	SP	Hypericum perforatum L.	+2	+2	-	+1	+1	+1	-	+2	6/75 %	eurassubocean-smed	H
Amp.	P	Sedum ochroleucum Chaix	+2	1.1	-	-	-	+2	-	+2	4/50 %	med	Ch
Amp.	P	Melica ciliata L.	+2	-	-	1.1	-	-	-	-	2/25 %	smed	H
Amp.	P	Sesleria ujchelyii Strgar	+2	-	-	-	-	-	-	-	1/12.5 %	din	H
S.-C.	S	Acinos hungaricus Simonkai	+2	-	-	-	-	-	-	-	1/12.5 %	europcont	T(Ch)
P. s.	PS	Clematis vitalba L.	+1	-	+2	-	-	+2	+1	+2	5/62.5 %	smed-subatl(circ)	P
S.-C.	S	Centaurea rhenana Borb.	+1	-	-	-	-	+1	-	+2	3/37.5 %	s. o. cont	H
Q. p.	P	Inula conyza DC.	+1	-	-	-	-	-	+1	+2	3/37.5 %	smed(-euras)	H
Arr.	S	Taraxacum officinale Web.	+1	-	-	+1	-	-	-	-	2/25 %	no-euras(subocean)	H
P. s.	PS	Ligustrum vulgare L.	+1	-	-	-	-	-	-	-	1/12.5 %	smed	P
B. e.	S	Silene vulgaris (Mch) Garcke	-	1.1	+1	-	-	-	+1	+2	4/50 %	no-euras-smed	H(Ch)
S.-C.	S	Tunica saxifraga (L.) Scop.	-	1.1	-	-	+2	1.1	-	+2	4/50 %	(o)smed	Ch
Amp.	P	Micromeria thymifolia (Scop.) Fritsch	-	+2	-	+1	-	-	-	-	2/25 %	balk	Ch
B. e.	S	Helianthemum nummularium (L.) Run	-	+2	-	-	-	-	-	-	1/12.5 %	smed	Ch
Arr.	S	Poa pratensis L.	-	+1	+2	+2	-	-	-	-	3/37.5 %	euras(kont)(-smed)	H(G)
Che.	T	Ailanthus glandulosa Desf.	-	+1	-	-	-	-	-	-	1/12.5 %	china	P
Q. p.	P	Dactylis aschersoniana (Graebn.) Hay.	-	-	+2	-	+2	-	-	-	2/25 %	gemässkont	H
Amp.	P	Chondrilla juncea L.	-	-	-	+2	+1	+1	+1	+1	5/62.5 %	med-smed-cont	H

Q. p.	P	Fraxinus ornus L.	-	-	-	+2	-	-	-	-	1/12.5 %	osmed	P
Q. p.	P	Ostrya carpinifolia Scop.	-	-	-	+2	-	-	-	-	1/12.5 %	osmed	P
P. s.	PS	Rosa canina L.	-	-	-	+1	-	-	-	-	1/12.5 %	eurassubocean-smed	P
Che.	T	Rumex crispus L.	-	-	-	+1	-	-	-	-	1/12.5 %	eurassubocean-smed	H
Che.	T	Chenopodium album L.	-	-	-	+1	-	-	-	-	1/12.5 %	no-euras(-med)	T
Amp.	P	Dianthus kitaibeli Janka in Pančˇ.	-	-	-	+1	-	-	-	-	1/12.5 %	din	Ch
Che.	T	Tussilago farfara L.	-	-	-	+1	-	-	-	-	1/12.5 %	no-euras-smed	G(H)
S.-C.	S	Acinos arvensis (Lam.) Dandy	-	-	-	-	+2	-	-	-	1/12.5 %	smed-euras	T(Ch)
Q. p.	P	Arabis turitta L.	-	-	-	-	+2	-	-	-	1/12.5 %	smed	H
A. f.	P	A. hirsuta (L.) Scop.	-	-	-	-	+2	-	-	-	1/12.5 %	euras-smed.circ	H(T)
Che.	T	Euphorbia stricta L.	-	-	-	-	+2	-	-	-	1/12.5 %	smed-gemässkont	T
Amp.	P	Asplenium trichomanes L.	-	-	-	-	+1	-	-	-	1/12.5 %	eurassubocean	H
Q. p.	P	Hedera helix L.	-	-	-	-	+1	-	-	-	1/12.5 %	subatl-smed	Ch(P)
B. e.	S	Dorycnium herbaceum Vill.	-	-	-	-	+1	-	-	-	1/12.5 %	omed-smed	Ch
A. f.	P	Scrophularia canina L.	-	-	-	-	-	+2	-	+2	2/25 %	smed	H
Amp.	P	Allium carinatum L.	-	-	-	-	-	+2	-	-	1/12.5 %	smed(-subatl)	G
B. e.	S	Sanguisorba muricata (Spach.) Focke	-	-	-	-	-	+2	-	-	1/12.5 %	med(-cont)	H
Che.	T	Barbarea vulgaris R. Br.	-	-	-	-	-	+1	-	-	1/12.5 %	euras-smed	H
P. s.	PS	Prunus spinosa L.	-	-	-	-	-	+1	-	-	1/12.5 %	eurassubocean-smed	P
Arr.	S	Lolium perenne L.	-	-	-	-	-	-	+2	+2	2/25 %	subatl-smed	H
F.	P	Potentilla micrantha Ram.	-	-	-	-	-	-	+2	-	1/12.5 %	smed	H
P. s.	PS	Crataegus monogyna Jacq.	-	-	-	-	-	-	+1	-	1/12.5 %	submed(-subatl)	P

Table 16. Phytocoenological table of the *Diantho-Genistetum januensis* comb. nova association.

Phytocoenological position	Indicator value	Association	Diantho-Genistetum januensis comb. nova										
		Locality	The Miljacka canyon - in the vicinity of the Kozija ćuprija bridge										
		Altitude (m)	568	567	568	570	570	572	573	572			
		Exposition	E-SE	E-SE	E-SE	SE	E-SE	E-SE	E-SE	SE			
		Slope (°)	80	80-90	90	80-90	90	80-90	90	80-90			
		Geological base	Limestone (dolomitized limestone)										
		Type of soil	Lithosol and calcomelanosol										
		Image size (m²)	50	100	100	100	50	100	50	50			
		General cover (%)	30	30-35	25	30-40	30	30-40	30	30			
		Date	May 12, 2016.										
		Ordinal image number	1.	2.	3.	4.	5.	6.	7.	8.	Frequency	Floral element	Life form
		Floristic composition											
Amp.	P	Dianthus kitaibeli Janka in Panč.	2.2	1.1	2.2	1.1	1.1	1.1	1.1	1.1	8/100 %	din	Ch
Amp.	P	Thymus jankae Čelak.	1.1	1.1	1.1	1.1	1.1	-	1.1	1.1	7/87.5 %	balk	Ch
Amp.	P	Sedum ochroleucum Chaix.	1.1	1.1	+2	+2	+2	-	+2	1.1	7/87.5 %	med	Ch
S.-C.	S	S. album L.	1.1	-	-	-	-	+2	+2	1.1	4/50 %	(pralp)smed-subatl	Ch
E.-P.	P	Genista januensis Viv.	+2	+2	+2	+2	+2	+1	+2	+2	8/100 %	din-so-alp	P(Ch)
Amp.	P	Galium corrudaefolium Tausch	+2	1.1	+2	1.1	1.1	1.1	1.1	1.1	8/100 %	med	H
Amp.	P	Stipa calamagrostis (L.) Wahlenb.	+2	1.1	1.1	1.1	+2	1.1	1.1	1.1	8/100 %	pralp-smed	H
B. e.	S	Silene vulgaris (Mch) Garcke	+2	1.1	-	+2	1.1	-	+2	-	5/62.5 %	no-euras-smed	H(Ch)
B. e.	S	Sanguisorba muricata (Spach.) Focke	+2	+2	-	+2	+2	-	+2	+2	6/75 %	med(-cont)	H
Amp.	P	Melica ciliata L.	+2	1.1	-	-	1.1	+2	1.1	1.1	6/75 %	smed	H
S.-C.	S	Tunica saxifraga (L.) Scop.	+2	+2	-	+2	-	+2	-	+1	5/62.5 %	(o)smed	Ch
S.-C.	S	Galium purpureum L.	+2	-	+2	+2	-	-	+2	-	4/50 %	balc	H
B. e.	S	Teucrium chamaedrys L.	+2	+2	+2	-	-	-	-	-	3/37. 5 %	smed-med	Ch
A. f.	P	Arabis hirsuta (L.) Scop.	+2	-	-	+2	-	+1		-	3/37. 5 %	euras-smed, circ	H(T)
B. e.	S	Dorycnium herbaceum Vill.	+2	-	-	-	-	-	-	-	1/12.5 %	omed-smed	Ch
Q. p.	P	Fraxinux ornus L.	+1	+1	+1	+1	+1	-	+2	-	6/75 %	osmed	P
F.	P	Potentilla micrantha Ram.	+1	-	+1	+1	-	-	-	-	3/37.5 %	smed	H
P. s.	PS	Crataegus monogyna Jacq.	+1	+1	-	-	-	+1	-	-	3/37.5 %	submed(-subatl)	P
B. e.	S	Euphorbia cyparissias L.	+1	-	-	+1	-	-	-	+2	3/37.5 %	smed(-euras)	H
Arr.	S	Dactylis glomerata L.	+1	-	-	-	+1	-	-	-	2/25 %	euras(-smed)	H
P. s.	PS	Rosa canina L.	+1	-	-	-	+1	-	-	-	2/25 %	eurassubocean-smed	P
S.-C.	S	Centaurea rhenana Borb.	+1	-	-	-	-	-	1.1	-	2/25 %	s. o. cont	H
P. s.	PS	Campanula trachelium	-	+1	+1	+1	+2	-	+1	-	5/62.5 %	eurassubozean-smed	H
P. s.	PS	Clematis vitalba L.	-	+1	-	+1	-	+1	+2	+2	5/62.5 %	smed-subatl(circ)	P
F.	P	Geum urbanum L.	-	+1	-	-	-	-	-	-	1/12.5 %	eurassubozean-smed	H
P. m.	T	Agropyron repens (L.) Beauv.	-	+1	-	-	-	-	+2	-	2/25 %	no-euras	H(G)
Arr.	S	Poa pratensis L.	-	-	+2	+2	+2	-	-	-	3/37.5 %	euras(cont)(-smed)	H(G)
Amp.	P	Micromeria thymifolia (Scop.) Fritsch	-	-	+2	+2	-	-	1.1	1.1	4/50 %	balk	H
Q. p.	P	Coronilla emerus L. ssp. emeroides (Boiss. et Spr.) Hayek	-	-	+2	-	-	-	-	-	1/12.5 %	o(smed)	P
P. s.	PS	Ligustrum vulgare L.	-	-	+1	-	+1	+1	-	-	3/37.5 %	smed	P

Q. p.	P	Arabis turitta L.	-	-	-	+1	+2	-	-	-	2/25 %	smed	H
P. s.	PS	Cornus sanguinea L.	-	-	-	+1	-	-	-	-	1/12.5 %	osmed	P
S.-C.	S	Scabiosa leucophylla Borb.	-	-	-	+1	-	-	-	-	1/12.5 %	din	H
Arr.	S	Taraxacum officinale Web.	-	-	-	+1	-	-	-	-	1/12.5 %	no-euras(subocean)	H
Amp.	P	Asplenium trichomanes L.	-	-	-	+1	-	-	-	-	1/12.5 %	eurassubocean	H
B. e.	S	Plantago media L.	-	-	-	+1	-	-	-	-	1/12.5 %	euras(cont)-smed	H
B. e.	S	Stachys recta L.	-	-	-	-	+2	+2	-	+2	3/37.5 %	smed(-gemässkont)	H
Amp.	P	Erysimum linearifolium Tausch	-	-	-	-	+2	-	-	1.1	2/25 %	s. o. balk	H
Q. p.	P	Sesleria autumnalis (Scop.) F. W. Schul.	-	-	-	-	+2	-	-	-	1/12.5 %	balk	H
F.	P	Hieracium sylvaticum (L.) Grubf.	-	-	-	-	+1	+2	-	-	2/25 %	no-eurassubocean	H
B. e.	SP	Hypericum perforatum L.	-	-	-	-	+1	-	+2	+2	3/37.5 %	eurassubocean-smed	H
F.	P	Geranium robertianum L.	-	-	-	-	+1	-	-	-	1/12.5 %	eurassubocean-smed	H(T)
Amp.	P	Allium carinatum L.	-	-	-	-	-	+2	-	-	1/12.5%	smed(-subatl)	G
E.-P.	P	Cytisus nigricans L.	-	-	-	-	-	+1	-	-	1/12.5 %	gemässkont-osmed	P
Q. p.	P	Inula conyza DC.	-	-	-	-	-	+1	+1	-	2/25 %	smed(-euras)	H
S.-C.	S	Acinos hungaricus Simonkai	-	-	-	-	-	+1	-	-	1/12.5 %	europcont	T(Ch)
Q. p.	P	Silene otites (L.) Sm.	-	-	-	-	-	+1	-	-	1/12.5 %	(gemäss)kont(-smed)	H
B. e.	S	Galium verum L.	-	-	-	-	-	-	+2	+1	2/25 %	euras-smed	H
A. f.	S	Scrophularia canina L.	-	-	-	-	-	-	+2	-	1/12.5 %	smed	H
Q. p.	P	Syringa vulgaris L.	-	-	-	-	-	-	+2	-	1/12.5 %	s. o. eur	P
Q. p.	P	Ostrya carpinifolia Scop.	-	-	-	-	-	-	+1	-	1/12.5 %	osmed	P
Che.	T	Sonchus oleraceus (L). Scop.	-	-	-	-	-	-	+1	-	1/12.5 %	euras(cont)	H
Q. p.	P	Quercus petraea (Matt.) Lieb.	-	-	-	-	-	-	+1	-	1/12.5 %	subatl-smed	P