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SARA's tale of Herzegovinian Centre of Endemism

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Abstract: According to the Herbarium of the National Museum of Bosnia and Herzegovina (SARA), the Herzegovinian Centre of Endemism represents significant biodiversity of higher plants: 98 families, 460 genera, 1104 species, and 224 subspecies. Within this number, there are 156 endangered, as well as 96 endemic and 13 stenoendemic taxa. Forty-seven (47) registered nomenclatural types are a particular feature of the researched area. The Herbarium of the National Museum of Bosnia and Herzegovina contributes a large amount of valuable and unique specimen data for future investigations. To access them quickly and make them available for scientific investigations, we must prioritize SARA's digitization and data sharing.

Keywords: Herbarium, specimen, nomenclatural type, endangerment, biodiversity, digitization

INTRODUCTION

By the 17th century, herbarium collections were critical components of biological research infrastructure (Marsico et al., 2020). In the beginning, they were the precious basis of information for the extensive assortment of classical taxonomic and floristic studies (Metsger and Byers, 1999; Lister et al., 2010). The last century opened the door to progressively diverse and innovative uses of herbaria and assigned possible forthcoming applications (Heberling et al., 2019). Diversification of herbaria research and increased citation of its authors of specimen were clarified by the impending development of interdisciplinary and integrative studies. Nowadays, herbarium specimens provide a valuable source for different research areas: from global changes, conservation biology, and bioprospecting to fundamental taxonomic, ecological, molecular, phylogeographic, and evolutionary investigations.

Regional, national, and small herbaria collections represent a crucial source of information with the aim to overpass critical geographic gaps in preserving and expanding our knowledge of taxonomy, phytogeography, and global biodiversity. Therefore, digitization and data sharing are crucial for balancing research access to all herbaria (Williams & Crouch, 2017; Marsico et al., 2020).

NATIONAL MUSEUM OF BOSNIA AND HERZEGOVINA

The founding of the National Museum of Bosnia and Herzegovina in Sarajevo in 1888 represents an important event in the cultural history of this country. From its establishment until today, the National Museum has left deep traces in the development of science and culture, enabling crucial changes that led to the birth and development of many scientific disciplines and fields of culture (Dautbegović, 1988).

Since the founding of the Museum, the Department of Natural Sciences has been functioning throughout three divisions: Geological, Botanical, and Zoological. The Botanical division encloses the Library, the Botanical Garden, and Herbarium collection. Herbarium of the National Museum, with the museum code-name SARA, includes five units: the Bosnian-Herzegovinian collection with about 55,000 specimens, the general part with about 60,000, the collection of Otto Blau 2,503, the collection of Erich Brandis 13,013 and the collection of Nomenclatural types with 392 specimens. The collection of Erich Brandis is the oldest large-scale botanical collection in the territory of Bosnia and Herzegovina.

RESEARCH AREA

The Bosnian-Herzegovinian collection, among others, holds specimens from the area designated as the Herzegovinian Centre of Endemism (HENC). This centre represents glacial, rare, and endemic flora concentrated on high mountains: Prenj, Čvrsnica, Čabulja, and Velež, which lie on both sides

of the middle course of the river Neretva, to the north and northwest of the city of Mostar (Bjelčić & Šilić, 1971). The Herzegovinian centre of endemism roughly covers the area from the accumulation of Lake Jablanica in the north to the Bijelo Polje valley in the south, and from the settlement of Boračko Lake in the east to the furthestmost northwest slopes of Mt. Čabulja in the west (Fig. 1).



Figure 1. Herzegovinian Centre of Endemism (HENC)

The elevation of mountains Prenj, Čvrsnica, and Čabulja massifs to today's heights, the formation of the Neretva canyon and well-cut valleys of its tributaries, are the result of vertical uplift movements in the late Neogene and the Quaternary (Lepirica, 2007). The glaciations that followed in this area found an already formed mountain relief, and the extent of glacial phenomena depended on the relief, deep Neretva canyons, and geographical position (Bjelčić & Šilić, 1971). The most dominant modern geological process present in the study area is karst erosion. It created the bays and plateaus of Prenj, Čvrsnica, Plasa, and Čabulja mountains. In addition, the diversity of landscapes of the Herzegovinian Centre of Endemism supplements the appearance of exokarst forms (Lepirica, 2007).

The geographical position of the researched area resulted in the intersection of various, rare and significant species for science. Mesozoic carbonate rocks (limestone and dolomites) have a dominant role in their structure (Lepirica, 2005). The mountains Prenj, Čvrsnica, and Čabulja, were influenced by continental climate from the north and the Mediterranean from the south while the highest peaks (Velika Čvrsnica, 2228 m above sea level and Zelena glava, 2155 m above sea level) have alpine climatic conditions. Precisely, such climate transitions and diversity have contributed to biodiversity of the Herzegovinian Centre of Endemism (Bjelčić & Šilić, 1971).

The objectives of this paper were: to explore the diversity of flora of the Herzegovinian Centre of Endemism, according to the data from the Herbarium of the National Museum; to review the nomenclature of the specimens; to detect the presence of endangered and endemic taxa, and to identify nomenclatural types from the study area.

MATERIAL AND METHODS

The SARA Catalogue of vascular plants from the Herzegovinian Centre of Endemism (HENC) was prepared as an electronic supplementary material temporary available at the editorial office while the official database is under construction (Supplement 1). It included all available specimen label records: taxonomic identification, collector(s) name, date of collection, and collection site with not so often given details (e.g., geopolitical location, GPS coordinates, or habitat information). Supplement 1 provides an overview of all the above-mentioned data, classified into eight columns: family name, species name and infraspecies taxa, revised taxon name (Euro+Med, 2021; WFO, 2021), site name, phytocenological affiliation, geological background and altitude, name of legator and determinant, and date of collection. The list of families, as well as genera, is given in alphabetical order.

Conservation status was specified according to the IUCN Red List (IUCN 2021) and the Red List of Vascular Flora for the Federation of BiH (Đug et al., 2013). The endemic status of plant species is indicated, with an asterisk next to the species name, according to Đug et al. (2013), Lubarda et al. (2014), and nomenclatural types according to Šilić et al. (1984).

RESULTS AND DISCUSSION

The oldest specimen in the herbarium of the National Museum, from the Herzegovinian Centre of Endemism, is *Satureja subspicata* Bartl. ex Vis. subsp. *subspicata* from Mt. Prenj (Supplement 1), collected by Moellendorff in 1871. Out of 55 participated legators from this region, Karl Malý made the largest contribution with 2001 collected specimens, which makes up 43.6%. Additional legators were Čedomil Šilić with 564 collected exicates (12.3%), Franz Fiala with 374 (8.15%), V. Loschnigg with 344 (7.50%), etc.

SARA'S COLLECTION OF THE VASCULAR PLANTS FROM THE HERZEGOVINIAN CENTRE OF ENDEMISM

The SARA Catalogue of vascular plants (Supplement 1) from the Herzegovinian Centre of Endemism provides an updated reference list of 4585 registered exicates of vascular plants, namely 1104 accepted species and 224 subspecies from 98 families (Tab. 1). Several exicates (110) were excluded from further analyses, more specifically: 82 were determined up to

the genus level, 24 still do not have a resolved taxonomic status, and 4 have uncertain hybrid origin.

It is important to underline, concerning some problematic taxonomic cases, that the consulted databases (Euro+Med, 2021 WFO, 2021) were not always congruent with other respectful references. For illustration, such a case was with *Crataegus oxyacantha* L. recognized as a synonym of the *C. rhipidophylla* Gand. (Supplement 1, Euro+Med, 2006; WFO, 2021), that is in contradiction with miscellaneous typifications of this taxon according to other opinions (Christensen, 1992).

Herzegovinian Centre of Endemism (HENC) collection comprised of 56% of the total number of vascular plants families (175), 38% of species (3359), and 20% of subspecies (1091) recognized in Bosnia and Herzegovina by Redžić et al. (2008). According to SARA's collection, this region highly contributes to the vascular plant diversity of Bosnia and Herzegovina.

The family Compositae is the most numerous, with 71 genera, 183 accepted species and 74 subspecies. It is followed by families Apiaceae with 35 genera (54 species and 11 subspecies) and Poaceae with 34 genera (61 species and 11 subspecies). A large number of families represented by only one genus (48.9% of the total number, Tab. 1) notably contributes to the diversity of the researched area (Tab. 1).

SARA'S COLLECTION OF THE ENDANGERED AND ENDEMIC PLANTS FROM THE HERZEGOVINIAN CENTRE OF ENDEMISM

The collection of the Herzegovinian Centre of Endemism contains specimens for 156 threatened taxa (Supplement 1). Out of 156 threatened taxa, 28.20% (44) are Endangered (EN), 3.84% (6) are Critically Endangered (CR), and 30.2% (48) are Vulnerable (VU, Đug et al., 2013, Tab. 2). The species with Endangered and Critically Endangered conservation status were collected from 253 sites.

Due to the period when threatened species were collected, their existence remains questionable. Thankfully, the current presence was confirmed for some of the species. For example, author Šilić confirmed the presence of the Critically Endangered species *Doronicum grandiflorum* Lam. on Mt. Čvrsnica in 2002. (Supplement 1), firstly registered by Vandas in 1889. According to SARA's collection, 3.42% have a certain kind of conservation status (Tab. 2). Often the local conservation status did not correspond to the IUCN Red List (IUCN 2021). For instance, according to the Red List of Vascular Flora for the Federation of BiH (Đug et al., 2013), nine taxa have the status of Vulnerable species, while according to the IUCN Red List (IUCN, 2021), these taxa are the Least Concern (Tab. 2).

Table 1. Different taxonomic ranks of the vascular flora deposited in the SARA from HENC

Number of genera per family	Families (number of: exicates/species/subspecies)
1	Acanthaceae (3/2/0), Amaranthaceae (2/1/0), Amaryllidaceae (4/2/2), Anacardiaceae (1/1/0), Aquifoliaceae (2/1/0), Araceae (1/1/0), Aspleniaceae (18/6/0), Athyriaceae (2/1/0), Berberidaceae (1/1/0), Betulaceae (1/1/0), Cannabaceae (1/1/0), Caprifoliaceae (4/4/0), Clusiaceae (9/3/1), Colchicaceae (8/1/0), Cornaceae (4/2/0), Cucurbitaceae (1/1/0), Cupressaceae (20/3/1), Dennstaedtiaceae (1/1/0), Grossulariaceae (3/2/0), Haloragaceae (1/1/0), Lentibulariaceae (3/2/0), Liliaceae (1/1/0), Linaceae (14/7/1), Loranthaceae (1/0/1), Lycopodiaceae (1/1/0), Moraceae (2/1/0), Nymphaeaceae (1/1/0), Oleaceae (4/2/0), Ophioglossaceae (1/1/0), Oxalidaceae (1/1/0), Parnassiaceae (1/1/0), Paulowniaceae (1/1/0), Pinaceae (13/3/0), Plumbaginaceae (11/1/1), Potamogetonaceae (9/4/0), Resedaceae (3/1/0), Salicaceae (26/9/0), Santalaceae (5/3/0), Sapindaceae (20/4/1), Saxifragaceae (56/13/0), Selaginellaceae (2/1/0), Tamaricaceae (1/1/0), Taxaceae (4/1/0), Tiliaceae (3/2/0), Ulmaceae (1/1/0), Urticaceae (1/1/0), Violaceae (40/9/3), Vitaceae (2/1/0)
2	Apocynaceae (12/3/1), Aristolochiaceae (2/2/0), Asparagaceae (4/2/0), Celstraceae (2/2/0), Cistaceae (22/5/2), Cystopteridaceae (9/2/1), Dryopteridaceae (24/5/0), Euphorbiaceae (47/20/0), Geraniaceae (22/11/0), Iridaceae (6/2/1), Juncaceae (7/5/0), Lythraceae (3/3/0), Malvaceae (9/4/0), Onagraceae (14/6/0), Polygalaceae (34/4/2), Scrophulariaceae (45/12/3), Thymelaeaceae (9/5/0), Typhaceae (3/3/0), Viburnaceae (15/3/0)
3	Convolvulaceae (7/5/0), Corylaceae (8/3/0), Crassulaceae (28/9/0), Fagaceae (16/4/0), Polygonaceae (17/7/1), Rhamnaceae (52/5/1), Rutaceae (14/3/0), Solanaceae (12/4/0), Valerianaceae (29/9/1)
4	Chenopodiaceae (6/3/0), Dipsacaceae (47/12/3), Gentianaceae (82/9/4), Papaveraceae (7/4/1), Rubiaceae (85/25/3)
7	Campanulaceae (86/23/0), Ericaceae (32/9/0), Primulaceae (66/13/1)
8	Cyperaceae (34/19/0), Orobanchaceae (93/25/1), Plantaginaceae (125/36/3)
10	Ranunculaceae (96/24/3)
11	Orchidaceae (32/16/1)
13	Caryophyllaceae (260/53/16)
14	Boraginaceae (110/27/3)
20	Fabaceae (249/66/30)
22	Rosaceae (309/79/10)
24	Lamiaceae (661/60/25)
28	Brassicaceae (171/45/7)
34	Poaceae (155/61/4)
35	Apiaceae (202/54/11)
71	Compositae (890/183/74)

Table 2. The threatened taxa of the vascular flora deposited in the SARA from HENC (¹Dug et al., 2013; ²IUCN Red List)

Taxon	Status
<i>Cardamine graeca</i> L., <i>Doronicum grandiflorum</i> Lam., <i>Minuartia handelii</i> Mattf., <i>Primula acaulis</i> (L.) L., <i>Primula minima</i> L.	CR ¹
<i>Alyssum moellendorffianum</i> Asch. ex Beck, <i>Amphoricarpos neumayeri</i> Vis. (= <i>Amphoricarpos neumayerianus</i> (Vis.) Greuter), <i>Aquilegia dinarica</i> Beck, <i>Asperula hercegovina</i> Degen, <i>Asperula scutellaris</i> Vis., <i>Asyneuma canescens</i> (Waldst. & Kit.) Griseb. & Schenk, <i>Bartsia alpina</i> L., <i>Bellidiastrum michelii</i> Cass., <i>Centaurea glaberrima</i> Tausch, <i>Cephalaria flava</i> (Sibth. & Sm.) Szabó, <i>Chaerophyllum coloratum</i> L., <i>Euphrasia illyrica</i> Wettst., <i>Euphrasia liburnica</i> Wettst., <i>Festuca bosniaca</i> Kumm. & Sendtn., <i>Festuca halleri</i> All., <i>Galium boreale</i> L., <i>Gentiana lutea</i> subsp. <i>symphyandra</i> (Murb.) Hayek, <i>Hieracium humile</i> Jacq., <i>Kerneria saxatilis</i> (L.) Sweet, <i>Lathyrus alpestris</i> (Waldst. & Kit.) Čelak., <i>Linaria alpina</i> (L.) Mill., <i>Moehringia ciliata</i> (Scop.) Dalla Torre, <i>Opopanax chironium</i> (L.) W. D. J. Koch, <i>Oxytropis prenja</i> (Beck) Beck, <i>Petasites kablikianus</i> Bercht., <i>Peucedanum longifolium</i> Waldst. & Kit., <i>Peucedanum neumayeri</i> (Vis.) Reichb. fil. (= <i>Peucedanum arenarium</i> subsp. <i>neumayeri</i> (Vis.) Stoj. & Stef.), <i>Plantago gentianoides</i> Sibth. & Sm., <i>Polygala croatica</i> Chodat (= <i>Polygala alpestris</i> subsp. <i>croatica</i> (Chodat.) Hayek), <i>Rhamnus illyrica</i> Griesb. ap. Pant. (= <i>Rhamnus orbiculata</i> Bornm.), <i>Rhamnus pumila</i> Turra, <i>Saxifraga oppositifolia</i> L., <i>Scorzonera austriaca</i> Willd., <i>Scrophularia bosniaca</i> Beck, <i>Taraxacum alpinum</i> Hegetschw., <i>Thesium parnassi</i> A. DC., <i>Veronica saturejoides</i> Vis.	EN ¹
<i>Corylus colurna</i> L., <i>Daphne laureola</i> L., <i>Goodyera repens</i> (L.) R. Br., <i>Gymnadenia odoratissima</i> (L.) Rich., <i>Salix glabra</i> Scop., <i>Selaginella helvetica</i> (L.) Spring, <i>Vicia ochroleuca</i> Ten. (= <i>Vicia pisiformis</i> L.)	EN ¹ , LC ²
<i>Campanula hercegovina</i> Degen & Fiala, <i>Ajuga pyramidalis</i> L., <i>Anthyllis vulneraria</i> subsp. <i>alpestris</i> (Schult.) Asch. & Graebn., <i>Arenaria gracilis</i> Waldst. & Kit., <i>Cerastium decalvans</i> Schloss. & Vuk., <i>Cerastium grandiflorum</i> Waldst. & Kit., <i>Coronilla vaginalis</i> Lam., <i>Dianthus petraeus</i> Waldst. & Kit., <i>Edraianthus hercegovinicus</i> Malý, <i>Edraianthus serpyllifolius</i> (Vis.) A. DC., <i>Edraianthus tenuifolius</i> (Waldst. & Kit.) A. DC., <i>Euphorbia capitulata</i> Rchb., <i>Genista sylvestris</i> subsp. <i>dalmatica</i> (Bartl.) H. Lindb., <i>Knautia dinarica</i> (Murb.) Borbás, <i>Knautia sarajevensis</i> (Beck) Szabó, <i>Onosma stellulata</i> Waldst. & Kit., <i>Phyteuma orbiculare</i> L., <i>Primula kitaibeliana</i> Schott., <i>Satureja subspicata</i> Bartl. ex Vis. subsp. <i>subspicata</i> , <i>Scabiosa silenifolia</i> Waldst. & Kit., <i>Sedum atratum</i> L., <i>Soldanella alpina</i> L., <i>Stachys anisochila</i> Vis. & Pančić, <i>Teucrium arduinii</i> L., <i>Viola biflora</i> L.	LC ¹
<i>Cyclamen purpurascens</i> Mill., <i>Geum bulgaricum</i> Pančić, <i>Juniperus sabina</i> L., <i>Pinus heldreichii</i> H. Christ	LC ^{1,2}
<i>Gentiana dinarica</i> Beck, <i>Achillea abrotanoides</i> (Vis.) Vis., <i>Achillea clavennae</i> L., <i>Anemone baldensis</i> L., <i>Aster alpinus</i> L., <i>Astrantia carniolica</i> Jacq., <i>Bupleurum karglii</i> Vis., <i>Centaurea kotschyana</i> Heuff., <i>Centaurea murbeckii</i> Hayek, <i>Daphne blagayana</i> Freyer, <i>Delphinium fissum</i> Waldst. & Kit., <i>Dianthus freynii</i> Vandas, <i>Dryas octopetala</i> L., <i>Euphorbia fragifera</i> Jan., <i>Festuca dalmatica</i> (Hack.) K. Richt., <i>Gentianella crispata</i> (Vis.) Holub, <i>Grafia golaka</i> (Hacq.) Rchb., <i>Helleborus multifidus</i> Vis., <i>Knautia travnicensis</i> (Beck) Szabó, <i>Lathyrus binatus</i> Pančić, <i>Melampyrum trichocalycinum</i> Vandas, <i>Minuartia graminifolia</i> subsp. <i>clandestina</i> (Port.) Mattf., <i>Orobanche flava</i> F. W. Schultz, <i>Orobanche panicii</i> Beck, <i>Pedicularis leucodon</i> Griseb., <i>Poa minor</i> Gaudin, <i>Poa pumila</i> Host, <i>Potentilla apennina</i> Ten., <i>Potentilla speciosa</i> Willd., <i>Reichardia macrophylla</i> (Vis. & Pančić) Pančić, <i>Saxifraga aizoides</i> L., <i>Saxifraga caesia</i> L., <i>Saxifraga glabella</i> Bertol., <i>Saxifraga prenja</i> Beck, <i>Silene acaulis</i> (L.) Jacq., <i>Silene marginata</i> (Kit.) Kit., <i>Silene retzdorffiana</i> (K. Malý) H. Neumayer, <i>Veronica aphylla</i> L., <i>Vicia montenegrina</i> Rohlena.	VU ¹
<i>Adenophora liliifolia</i> (L.) A. DC., <i>Cephalanthera rubra</i> (L.) Rich., <i>Ilex aquifolium</i> L., <i>Nuphar lutea</i> (L.) Sm., <i>Pinguicula leptoceras</i> Rchb., <i>Rhodiola rosea</i> L., <i>Sorbus chamaemespilus</i> (L.) Crantz, <i>Tanacetum cinerariifolium</i> (Trevir.) Sch. Bip., <i>Taxus baccata</i> L.	VU ¹ , LC ²
<i>Asplenium lepidum</i> C. Presl	VU ¹ NT ²
<i>Androsace lactea</i> L., <i>Arenaria biflora</i> L., <i>Campanula cochleariifolia</i> Lam., <i>Festuca panciciana</i> (Hack.) K. Richt., <i>Genista sericea</i> Wulfen, <i>Legousia hybrida</i> (L.) Delarbre, <i>Moltkia petraea</i> (Tratt.) Griseb., <i>Oxytropis campestris</i> (L.) DC., <i>Saxifraga marginata</i> Sternb., <i>Scutellaria alpina</i> L., <i>Sedum magellense</i> Ten., <i>Silene reichenbachii</i> Vis., <i>Thymus alpestris</i> (Čelak.) Tausch ex A. Kern., <i>Thymus bracteosus</i> Vis. ex Benth., <i>Trifolium noricum</i> Wulfen	NT ¹
<i>Anacamptis pyramidalis</i> (L.) Rich., <i>Petteria ramentacea</i> (Sieber) C. Presl., <i>Platanthera chlorantha</i> (Custer) Rchb.	NT ¹ , LC ²
<i>Carduus ramosissimus</i> Pančić, <i>Centaurea rupestris</i> L., <i>Erigeron atticus</i> Vill., <i>Geum molle</i> Vis. et Pančić, <i>Linaria pelisseriana</i> (L.) Mill., <i>Melampyrum hoermannianum</i> K. Malý, <i>Oxytropis jacquinii</i> Bunge	DD ¹
<i>Arabis scopoliana</i> Boiss., <i>Veronica scardica</i> Griseb.	DD ^{1,2}
<i>Carex nigra</i> (L.) Reichard, <i>Prunus cocomilia</i> Ten.	DD ¹ , LC ²

The complex of Čvrsnica, Čabulja, Prenj, and Velež mountains is named the Herzegovinian Centre of Endemism due to its exceptional wealth of endemic taxa (Bjelčić & Šilić, 1971; Šilić et al., 1984; Bjelčić, 1987). According to the SARA's collection and Euro+Med PlantBase, including WFO (2021), 96 taxa from HENC were endemic (Supplement 1). Regrettably, there is a great variety of unrecognized endemic taxa, from the Balkan region, especially the Dinaric Alps. Such is the case with the endemic taxon *Rhamnus pumila* Turra subsp. *illyrica* Šilić (Šilić, 2005) whose subspecies status has not been accepted so far (Euro+Med PlantBase; WFO, 2021). Namely, 13 stenoendemic taxa (of 23 in total for Bosnia and Herzegovina) from the centre of endemism were deposited in SARA's herbarium: *Clinopodium alpinum* subsp. *orontium* (K. Malý) Govaerts, *Alyssum moellendorffianum* Asch. ex Beck, *Asperula hercegovina* Degen, *Campanula hercegovina* Degen & Fiala, *Centaurea murbeckii* Hayek, *Dianthus freynii* Vandas, *Edraianthus hercegovinicus* K. Malý, *Euphorbia barrelieri* subsp. *hercegovina* (Beck) Kuzmanov, *Melampyrum trichocalycinum* Vandas, *Minuartia handelii* Mattf., *Oxytropis prenja* (Beck) Beck, *Thymus richardii* Pers. subsp. *richardii*, including *Potentilla heptaphylla* subsp. *veležensis* currently registered as *P. heptaphylla*.

SARA'S COLLECTION OF THE NOMENCLATURAL TYPE SPECIMENS FROM THE HERZEGOVINIAN CENTRE OF ENDEMISM

Nomenclatural types determine the relevance of names of taxonomic groups. According to Shenzhen Code (Turland et al., 2018), a type (*typus*) in biological nomenclature is a constituent to which the name of a taxon is eternally linked. Consequently, nomenclatural types have great significance for Herbarium collections, and they are subjects of particular preservation. A catalogue of vascular plants types from the SARA's herbarium includes 392 type specimens (Šilić et al., 1984). The nomenclatural types from the Herzegovinian Centre of Endemism make 12% (47 specimens) of the total number of species (Tab. 3). The oldest holotype (Fig. 2) is *Alyssum cinereum* O. Blau (= *Alyssum moellendorffianum* Asch. ex G. Beck) collected by Otto Blau in 1869 (Tab. 3).

Table 3. The nomenclatural types, including *Jocuss classicus*, deposited in the SARA from HENC

No	Taxon	Locus classicus	Nomenclatural types
1	<i>Seseli hercegovinum</i> K. Malý	<i>In saxosis montis Glogovo prope Jablanica</i>	HOLOTYPUS
2	<i>Peucedanum illyricum</i> K. Malý	<i>In declivibus petrosis et dumetosis faucis Gudura Neretve prope Karaula; cca 140 m s. m.</i>	SYNTYPUS
3	<i>Anthriscus fumaroides</i> (W.K.) Spreng. f. <i>calvescens</i> K. Malý	Čabulja pl.; 1240 m	TYPUS
4	<i>Hyacinthus dalmaticus</i> Backer var. <i>veležensis</i> Beck	na Velikoj Veleži kod Mostara	SYNTYPUS
5	<i>Myosotis ronnigeri</i> K. Malý	<i>In pratis saxosis apricis vallis Lapov dol in montibus Preslica planina; solo calcareo; cca 1300 m s. m.</i>	HOLOTYPUS
6	<i>Campanula hercegovina</i> Degen & Fiala	<i>In rupium calcar. fissuris montis Glogovo planina prope Jablanica</i>	ISOTYPUS
7	<i>Campanula hercegovina</i> Degen & Fiala var. <i>squarosa</i> Degen & Fiala	Čvrsnica pl. (Waldregion)	HOLOTYPUS
8	<i>Campanula patula</i> L. var. <i>micrantha</i> K. Malý	<i>In fauce Naronitana prope stationem ferrem Prenj; 170 m s. m.</i>	HOLOTYPUS
9	<i>Hedraeanthus hercegovinus</i> K. Malý	Veliki Jelenak, do vrha - 2170 m	HOLOTYPUS
10	<i>Phyteuma sieberi</i> Spreng. var. <i>brandisianum</i> K. Malý	Mala i Velika Čvrsnica	HOLOTYPUS
11	<i>Dianthus freynii</i> Vandas	Plasa pl.	TOPOTYPUS
12	<i>Heliosperma retzdorffianum</i> K. Malý (<i>Silene quadridentata</i> /Murr./ Pers. subsp. <i>retzdorffiana</i> /Malý/ Neumayer; <i>Silene retzdorffiana</i> /K. Malý/ Walters)	Jablanica (Narenta): An Felsen umweit der Doljanka	HOLOTYPUS
13	<i>Moenchia mantica</i> (L.) Bartl. var. <i>hercegovinica</i> K. Malý	bei Soviči - Ljubuški	SYNTYPUS
14	<i>Alyssum cinereum</i> O. Blau (<i>Alyssum moellendorffianum</i> Ascherson)	In kalkigem Berglezum in Treschanitz - Tal	HOLOTYPUS

15	<i>Hieracium cottetii</i> Godet subsp. <i>glogošnicae</i> Loschnigg & Zahn	Prenj planina - Glogošnica (Obodić)	HOLOTYPUS
16	<i>Hieracium praecurrens</i> Vukot. subsp. <i>megaladenophyes</i> K. Malý & Zahn	<i>In saxosis vallis</i> Doljanka <i>prope</i> Jablanica; cca 300 m s. m.	HOLOTYPUS
17	<i>Hieracium guentheri</i> - <i>beckii</i> Zahn subsp. <i>ortisanum</i> Fiedler & Zahn	Prenj planina - <i>in rupibus calcareis montis</i> Ortiš; 1950 m	TOPOTYPUS
18	<i>Hieracium tauschii</i> Zahn subsp. <i>bokševicanum</i> K. Malý & Zahn	<i>In monte</i> Bokševica <i>prope</i> Ostrožac; 1000 m s. m.	HOLOTYPUS
19	<i>Hieracium tauschii</i> Zahn subsp. <i>viridantiforme</i> K. Malý & Zahn	<i>In monte</i> Bokševica <i>prope</i> Ostrožac; 1000 m s. m.	HOLOTYPUS
20	<i>Tragopogon tommasinii</i> Schultz - Bip. var. <i>glaber</i> K. Malý	Velež kod Mostara; cca 1200 m s. m.	HOLOTYPUS
21	<i>Leontodon illyricus</i> K. Malý	Auf einer humosen Stelle der Čvrtnica pl.; cca 2000 m s. m.	HOLOTYPUS
22	<i>Centaurea variegata</i> Lam. var. <i>pseudomontana</i> K. Malý	Hänfig in den mit Weiskiefern bepflanzten Bergabhängen <i>bei</i> Konjic; cca 300 m s. m.	HOLOTYPUS
23	<i>Anthyllis jancheniana</i> K. Malý	Mala Čvrtnica	HOLOTYPUS
24	<i>Oxytropis prenja</i> G. Beck	<i>In saxosis calc. montis</i> Prenj pl.: Ortiš; cca 2000 m	TOPOTYPUS
25	<i>Lathyrus alpestris</i> Rchb. var. <i>regis</i> - <i>alexandri</i> G. Širjaev	Čvrtnica planina: Veliko Šljeme; cca 1700 m s. m.	TYPUS
26	<i>Calamimorpha</i> × <i>narentana</i> (K. Malý) Šilić	<i>In declivibus lapidosus secus flumen Narenta et in faucibus finitimis singulariter, solo calcareo</i> , 130-150 m s. m.	HOLOTYPUS
27	<i>Clinopodium vulgare</i> L. f. <i>minus</i> Šilić	iznad sela Kostajnica kod Ostrošca, cca 370 m s. m.; na kiselom zemljištu	HOLOTYPUS
28	<i>Micromeria thymifolia</i> (Scop.) Fritsch f. <i>condensata</i> Č. Šilić f. nov.	Prenj: Kantar	HOLOTYPUS
29	<i>Micromeria thymifolia</i> (Scop.) Fritsch f. <i>macrodonata</i> Č. Šilić f. nov.	Diva Grabovica <i>prope</i> Jablanica	HOLOTYPUS
30	<i>Satureja</i> (<i>Calamintha</i>) <i>orontia</i> K. Malý (Syn. <i>Acinos orontia</i> /K. Malý/ Šilić)	<i>In apricis declivibus et in pinetis (Pinetum nigrae) agri Konjicensis</i> ; cca 280 m s. m.	HOLOTYPUS
31	<i>Satureja subspicata</i> Bartl. ex Vis. subsp. <i>subspicata</i> f. <i>obovata</i> Č. Šilić	Prenj pl.: Kantar	HOLOTYPUS
32	<i>Stachys anisochila</i> Vis. & Pančić var. <i>diversicalyx</i> K. Malý f. <i>micrantha</i> K. Malý <i>in sched.</i>	<i>In saxosis vallis</i> Trešnica <i>ad viam inter</i> Podorašac <i>et</i> Konjic; cca 280-360 m s. m.	SYNTYPUS
33	<i>Stachys sendtneri</i> G. Beck	Dugo polje, <i>inter montis</i> Čvrtnica <i>et montis</i> Vran; cca 1200 m s. m.	TYPUS
34	<i>Stachys labiosus</i> Bertol. var. <i>sendtneri</i> G. Beck f. <i>diversicalyx</i> K. Malý (Syn. <i>S. anisochila</i> Vis. & Pančić var. <i>diversicalyx</i> K. Malý)	<i>In vallis</i> Trešnica <i>inter</i> Podorašac - Konjic; cca 350-370 m s. m.	SYNTYPUS
35	<i>Stachys subcrenata</i> Vis. var. <i>petragena</i> (Malý) Hayek f. <i>illyrica</i> K. Malý	<i>In declivibus orientalis. m.</i> Veliki Jelenak; cca 1700 m s. m.	TYPUS
36	<i>Stachys subcrenatus</i> Vis. var. <i>illyricus</i> K. Malý	Am Jelenak <i>in der</i> Čvrtnica pl.; cca 1800 m s. m.	SYNTYPUS
37	<i>Stachys subcrenatus</i> Vis. var. <i>angustifolia</i> Vis. f. <i>hercegovina</i> K. Malý	<i>In subalpinis mte</i> Velež; <i>solo calcareo</i> ; cca 1400 m s. m.	HOLOTYPUS
38	<i>Stachys anisochila</i> Vis. & Pančić f. <i>elliptica</i> K. Malý	<i>In saxosis dolomitica vallis</i> Trešnica <i>inter</i> Podorašac <i>et</i> Konjic	TYPUS
39	<i>Acinos orontius</i> (K. Malý) Šilić f. <i>albiflora</i> Č. Šilić	Vrtaljica: <i>in saxosis dolomit.</i> ; cca 280 m s. m.	HOLOTYPUS
40	<i>Koeleria splendens</i> Presl. var. <i>ciliata</i> K. Malý	So besonders typisch auf Dolomit bei Podorašac, Konjic, in Ljutatale bei Konjic	HOLOTYPUS
41	<i>Rhamnus pumila</i> Turra subsp. <i>illyrica</i> Šilić (Syn. <i>Oreohertzogia pumila</i> /Turra/ Vent subsp. <i>illyrica</i> Šilić)	kanjon Rakitnice (<i>sub montem</i> Jasenov vrh) <i>in rupium fissuris</i> ; <i>solo calcareo</i> ; cca 600 m s. m.	HOLOTYPUS
42	<i>Potentilla heptaphylla</i> L. subsp. <i>veležensis</i> Beck	<i>Ad pedem montis</i> Velež <i>prope</i> Mostar, 1400 m s. m. (loc. class.!)	TOPOTYPUS
43	<i>Rubus hercegovinicus</i> Malý et Hruby (<i>R. sanctus</i> > <i>procerus</i>)	<i>Secus rivulum</i> Neretvica <i>prope</i> Ostrožac	HOLOTYPUS
44	<i>Rubus ulmifolius</i> Schott. var. <i>zahnii</i> Hruby	Bijelo polje <i>prope</i> Mostar	HOLOTYPUS
45	<i>Asperula aristata</i> L. fil. var. <i>gracilis</i> K. Malý	<i>In fauce</i> Rakitnica <i>ad oppidum</i> Konjic; <i>solo calcareo</i> ; cca 400 m s.m.	HOLOTYPUS
46	<i>Saxifraga prenja</i> Beck	<i>Ad nives montis</i> Plasa; <i>solo calcareo</i> ; ca 1800 m s. m.	TOPOTYPUS
47	<i>Viburnum lantana</i> L. var. <i>naronitanum</i> K. Malý	Čvrtnica: Muharnica; <i>habitat in fagetis loci</i> "Bilike" dom; cca 1130 m s. m.	HOLOTYPUS



Figure 2. The oldest Holotype: *Alyssum cinereum* O. Blau (= *Alyssum moellendorffianum* Asch. ex Beck)

CONCLUSION

Herzegovinian Centre of Endemism (HENC) represented by the mountain complex: Prenj, Čvrtnica, Čabulja, and Velež, which includes canyons of the Neretva River and its tributaries. It corresponds to the landscapes of Refugio-relict ecosystems and signifies one of the most relevant European biodiversity hotspots. SARA's collection also testifies to the importance of this unique centre of natural heritage. Regrettably, anthropo-

genic pressures are progressively reshaping its habitats, reducing, and disintegrating boundaries of this still unprotected area. According to Heberling et al. (2019), the role of museum research has transferred from documenting the diversity of life to documenting biodiversity change and predicting the future. Therefore, the digitization of this SARA's collection provides a good starting point to assist with conservation assessments for the Herzegovinian Centre of Endemism (Fig. 2).

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SAŽETAK

U periodu od 1871. do 2017. godine veliki broj botaničara je terenski istraživao floru Hercegovačkog endemnog centra čiji su podaci evidentirani u priručnoj kartoteci Herbarijuma Zemaljskog muzeja Bosne i Hercegovine. Cilj ovog rada bio je proučiti diverzitet flore Hercegovačkog endemnog centra kroz analizu podataka priručne kartoteke Herbarijuma. Utvrđena je brojnost zastupljenih taksona počevši od nivoa porodice, primijenjena nomenklatura u priručnoj kartoteci je usklađena sa važećom koja prati svjetske baze podataka, utvrđeni su ostali dostupni podaci koji su se nalazili uz eksikate (lokaliteti, legatori, datum sakupljanja itd.), te je dat poseban osvrt na ugrožene i endemične taksone, kao i na tipske primjerke sa istraživanog područja. Od ukupno 175 biljnih porodica koje se nalaze na području Bosne i Hercegovine, čak 98 njih (56%) nalazi se rasprostranjeno na području Hercegovačkog endemnog centra što govori o bogatom genofondu istraživanog područja. Uzevši u obzir činjenicu da se na prostoru Hercegovačkog endemnog centra nalazi 156 ugroženih, 96 endemičnih i 13 stenoendemičnih taksona, očuvanje istraživanog područja je neminovno. Jedan dio endemičnih taksona je vezan isključivo za istraživano područje što ukazuje na opravdanost korištenog naziva "Hercegovački endemni centar" koji se susreće u botaničkoj literaturi. Rezultati ovog rada daju značajan doprinos ukazivanju potrebe zaštite biodiverziteta istraživanog područja, kao i pokušaj da se ukaže na izuzetno bogatstvo i važnost Herbarijuma Zemaljskog muzeja Bosne i Hercegovine te na nužnost njegovog očuvanja i digitalizacije podataka.

Ključne riječi: herbarium, primjerak, nomenklaturni tip, ugroženost, biodiverzitet, digitalizacija

Index florae Bosnae et Hercegovinae (Part 5)

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Review article

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INTRODUCTION

Part 5 of the Index presents particulars of the families Violaceae and Liliaceae. The significant contribution to investigations of these families in Bosnia and Herzegovina was given by Lijerka Kutleša, M.Sc. (1929-2019), through her own works and the works she co-authored with Bosnian and Herzegovinian botanists. For three decades, she taught Botany as an assistant professor at the University of Sarajevo, Faculty of Science, Department of Biology. Professor Kutleša was also a passionate researcher who devoted much of her work life to the study of the flora of Bosnia and Herzegovina, above all the families of Violaceae and

Liliaceae (Lakušić & Kutleša, 1971, Lakušić et al., 1977; Kutleša, 1982; Kutleša, 1988-1992; Kutleša, 2006-2007; Kutleša, 2008).

Findings of Kutleša (Kutleša, 1988-1992, 2006-2007, 2008) about the diversity of the family Violaceae in the flora of Bosnia and Herzegovina have remained mostly unchanged. Changes in this paper are related to the updates to the nomenclature and the current taxonomic status of detected taxa (Euro+Med, 2019), including the conservation status (IUCN, 2019). Moreover, the first record of the alien species *Viola sororia* in Bosnia and Herzegovina by

Maslo et al. (2018) was included. The family Violaceae in Bosnia and Herzegovina comprises of 28 species and 10 subspecies belonging to the genus *Viola*.

Special attention was paid to the family Liliaceae in terms of chorology, ecology, genetics, and systematics for the last two decades (Muratović et al., 2003, 2005a, 2005b, 2006, 2007, 2008, 2010a, 2010b, 2010c, 2011; Siljak-Yakovlev et al., 2003a, 2003b; Zoldoš et al., 2018; Koljanin et al., 2021). Due to the different classification scheme based on the phylogeny of monocots (APG II, 2003; APG III, 2009; APG IV, 2016), the current treatment of the family includes a significantly lower number of genera compared to the traditional classification (Heywood & Chater, 1980).

Consequently, the family Liliaceae in Bosnia and Herzegovina includes 6 genera, 20 species and 3 subspecies. The List is additionally modified with two species from the genus *Gagea* (*G. sphatacea* and *G. villosa*), recently observed in Bosnia and Herzegovina (Milanović et al., 2013; Maslo, 2014).

Part 5 of the Index, like the previous ones, provides the following details for each taxon:

- Botanical name of the genus, authority, and common name(s) in the English language,
- Botanical name of the species, authority, and first publication,
- Synonyms, where applicable,
- The nomenclature following Euro+Med PlantBase (Euro+Med, 2019), or the World Checklist of Selected Plant Families (WCSP, 2019) wherever possible,
- Conservation status following the IUCN Red List criteria (IUCN, 2019) and the Red List of Vascular Flora for the Federation of BiH (Đug et al., 2013) and the Republic of Srpska (Crvena lista zaštićenih vrsta flore i faune Republike Srpske-Lista vaskularne flore, 2012).
- Within a family, the genera and the species within each genus are listed alphabetically.

INDEX PART 5:

VIOLACEAE BATSCH, TAB. AFFIN. REGNI VEG.: 57. 1802

VIOLA L., SP. PL.: 933. 1753. (=MNEMON SPACH)– LJUBICA, LJUBIČICA (VIOLET)

(EN2) **aetolica Boiss. & Heldr.**, Boissier, Diagn. Pl. Orient., ser. 2, 6: 24. 1859.

alba Besser, Prim. Fl. Galiciae Austriac. 1: 171. 1809. (=V. *besseri* Rupr., nom. illeg., V. *martii* subsp. *alba* [Besser] Döll)

subsp. **alba** (V. *armena* Boiss. & A. Huet, V. *scotophylla* Jord., V. *thessala* Boiss. & Heldr., V. *virescens* Boreau, V. *alba* subsp. *scotophylla* [Jord.] Nyman, V. *alba* subsp. *thessala* [Boiss. & Heldr.] Hayek)

subsp. **dehnhardtii (Ten.) W. Becker**, Ber. Bayer. Bot. Ges. 8: 257. 1902. (= V. *dehnhardtii* Ten., V. *cadevallii* Pau, V. *pentelica* Vierh. [provisional])

ambigua Waldst. & Kit., Descr. Icon. Pl. Hung. 2: 208. 1804. (=V. *campestris* M. Bieb., V. *ambigua* subsp. *campestris* [M. Bieb.] Gams)

(LC1) **arvensis Murray**, Prodr. Stirp. Gott.: 73. 1770. (=V. *tricolor* subsp. *arvensis* [Murray] Gaudin, V. *agrestis* Jord, V. *banatica* Roem. & Schult., V. *segetalis* Jord.)

beckiana Beck, Wiener Ill. Gart.-Zeitung 21: 197. 1895.
(NT2,o) subsp. **beckiana**

(LC2) **biflora L.**, Sp. Pl.: 936. 1753. (=Chrysion *biflorum* [L.] Spach)

calcarata L., Sp. Pl.: 935. 1753.
(VU2,o) subsp. **zoysii (Wulfen) Murb.**, Lunds Univ. Årsskr. 27: 165. 1891. (=V. *zoysii* Wulfen)

(LC1) **canina L.**, Sp. Pl.: 935. 1753. (=V. *apetala* F. W. Schmidt, V. *flavicornis* Sm., V. *canina* subsp. *silvensis* [Font Quer] O. Bolòs & Vigo, V. *montana* subsp. *silvensis* Font Quer)
subsp. **canina**
subsp. **ruppii (All.) Schübl. & G. Martens**, Fl. Württemberg: 159. 1834. (=V. *ruppii* All., V. *montana* L., nom. rej., V. *nemoralis* Kütz., V. *canina* subsp. *montana* [L.] Hartm.)

chelmea Boiss. & Heldr., Boissier, Diagn. Pl. Orient., ser. 2, 1: 54. 1854.

(CR2,o) subsp. **vratnikensis Gáyer & Degen**, Magyar Bot. Lapok 13: 309. 1914. (V. *dinarica* Trinajstić, nom. illeg., V. *vilaensis* Hayek, V. *dinarica* subsp. *vilaensis* [Hayek] Trinajstić, nom. illeg.)

collina Besser, Enum. Pl.: 10. 1822. (=V. *odorata* subsp. *collina* [Besser] Čelak., V. *porphyrea* Garcke)

dacica Borbás, Magyar Növényt. Lapok 13: 79. 1890. (=V. *polydonta* W. Becker, V. *prolixa* [Adamović] W. Becker)

elatio Fr., Novit. Fl. Suec. Alt.: 277. 1828. (=V. *stipularis* Fr. [non Sw.], nom. illeg.)

(LC2,o) **elegantula Schott**, Oesterr. Bot. Wochenbl. 7: 167. 1857. (= *V. latisejala* Wettst.)

(DD2) **grisebachiana Vis.**, Mem. Reale Ist. Veneto Sci. 10: 436. 1861. (= *V. korabensis* Trinajstić)

hirta L., Sp. Pl.: 934. 1753. (= *V. calcarea* [Bab.] Greg., *V. hirta* subsp. *brevifimbriata* W. Becker, *V. hirta* subsp. *longifimbriata* W. Becker, *V. hirta* var. *calcarea* Bab.)

kitaibeliana Schult, Roemer & Schultes, Syst. Veg. 5: 383. 1819. (= *V. arvensis* subsp. *kitaibeliana* [Schult.] W. Becker, *V. parviflora* Roem. & Schult., des. inval., *V. tricolor* subsp. *minima* Gaudin)

mirabilis L., Sp. Pl. 936. 1753. (= *V. brachysejala* Maxim.)

(LC1) **odorata L.**, Sp. Pl.: 934. 1753. (= *V. maderensis* Lowe, *V. stolonifera* J. J. Rodr., *V. wiedemannii* Boiss., *V. odorata* var. *maderensis* [Lowe] Lowe)

(LC1) **palustris L.**, Sp. Pl.: 934. 1753.

pinnata L., Sp. Pl.: 934. 1753.

pyrenaica DC., Lamarck & Candolle, Fl. Franç., ed. 3, 4: 803. 1805. (= [CR2] *V. prenja* Beck, *V. sciaphila* W. D. J. Koch)

reichenbachiana Jordon ex Borean, Fl. Centre Fr. Ed. 3, 2: 78. 1857. (= *V. sylvestris* Lam., *V. sylvatica* Fries ex Hartm.)

riviniana Rchb., Iconogr. Bot. Pl. Crit. 1: 81. 1823. (= *V. canina* subsp. *riviniana* [Rchb.] Schübler & G. Martens, *V. sylvestris* subsp. *riviniana* [Rchb.] Tourlet, *V. caniniformis* K. Richt., *V. insularis* Gren. & Godr., *V. riviniana* subsp. *minor* [Greg.] Valentine, *V. riviniana* subsp. *neglecta* W. Becker)

rupestris F. W. Schmidt, Neuere Abh. Königl. Böhm. Ges. Wiss. 1: 60. 1791. (*V. arenaria* DC., *V. glaberrima* [Murb.] Sergent, [LC*] *V. rupestris* subsp. *arenaria* [DC.] Tzvelev, *V. rupestris* subsp. *glaberrima*, *V. rupestris* subsp. *relicta* Jalas, *V. rupestris* var. *glaberrima* Murb.)

sororia Willd., Hort. Berol. [Willdenow] 1(6): t. 72 (1806). (= *V. alachuana* Murrill, *V. allardii* Greene, *V. chalcosperma* Brainerd), Maslo et al. 2018.

(EN2) **stagnina Schult.**, Oestr. Fl., ed. 2, 1: 426. 1814. (*V. persicifolia* Schreb., nom. rej.)

suavis M. Bieb., Fl. Taur.-Caucas. 3: 164. 1819. (= *V. austriaca* A. Kern. & Jos. Kern., *V. beraudii* Boreau, *V. catalonica* W. Becker, *V. cyanea* Čelak., *V. pontica* W. Becker, *V. segobricensis* Pau, *V. sepincola* Jord., *V. sepincola* subsp. *austriaca* [A. Kern. & Jos. Kern.] W. Becker, *V. sepincola* subsp. *cyanea* [Čelak.] W. Becker, *V. sepincola* subsp. *wolfiana* [W. Becker] W. Becker, *V. suavis* subsp. *catalonica* [W. Becker] O. Bolòs & Vigo, *V. suavis* subsp. *cyanea* [Čelak.] Dostál, *V. suavis* subsp. *sepincola* [Jord.] Becker)

(o) subsp. **adriatica (Freyn) Haesler**, Mitt. Bot. Staatssamml. München 12: 111. 1975. (= *V. adriatica* Freyn)

(LC1) **tricolor L.**, Sp. Pl.: 935. 1753. (= *V. kupfferi* Klokov, *V. luteola* Jord., *V. nemausensis* Jord., *V. tricolor* subsp. *faeroeensis* W. Becker) subsp. **alpestris (Ging.) Ces.**, Cattaneo, Not. Nat. Civ. Lombardia 1: 288. 1844. (= *V. tricolor* var. *alpestris* Ging., *V. alpestris*

[Ging.] Jord., *V. saxatilis* F. W. Schmidt, *V. vespertina* Klokov, *V. tricolor* subsp. *saxatilis* [F. W. Schmidt] Arcang., *V. tricolor* subsp. *subalpina* Gaudin, nom. illeg.)

(VU2) subsp. **macedonica** (Boiss. & Heldr.) A. F. W. Schmidt, Feddes Rept. 74:30. 1967. (= *V. macedonica* Boiss. & Heldr., *V. saxatilis* subsp. *macedonica* [Boiss. & Heldr.] Hayek)

LILIACEAE

ERYTHRONIUM L., SP. PL.: 305. 1753. (= *DENS-CANIS* TOURN. EX RUPP., DES. INVAL., *MITHRIDATIUM* ADANS.) – **P A S J I Z U B (TROUT LILY)**

(LC2) **dens-canis L.**, Sp. Pl. 305. 1753. (= *E. bifidum* Sweet, *E. bulbosum* St.-Lag., *E. caninum* Dulac, *E. latifolium* Schur, *E. longifolium* Mill., *E. maculatum* DC., *E. maculosum* Lam., *E. obtusiflorum* Opiz, *E. ovatifolium* Poir., *E. vernale* Salisb., *E. dens-canis* subsp. *albi-florum* Kricsf., *E. dens-canis* var. *niveum* Baumg., *E. dens-canis* var. *purpureum* Baumg., *E. dens-canis* var. *roseum* Baumg., *E. dens-canis* var. *tetragonum* Schur)

FRITILLARIA TOURN. EX L., SP. PL.: 303. 1753. (= *AMBLIRION* RAF., *BAIMO* RAF., *CORONA* FISCH. EX GRAHAM, *EUCRINUM* [NUTT.] LINDL., *IMPERIALIS* ADANS., *KOROLKOWIA* REGEL, *LILIORHIZA* KELLOGG, *LYPERIA* SALISB., *MELORIMA* RAF., *MONOCODON* SALISB., *OCHROCODON* RYDB., *PETILIMUM* LUDW., *RHINOPE TALUM* FISCH. EX D. DON, *SARANA* FISCH. EX BAKER, *THERESIA* K. KOCH, *TOZZETTIA* PARL.) – **K O C K A V I C A (FRITILLARY)**

(CR2) **meleagris L.**, Sp. Pl. 304. 1753. (= *Lilium meleagris* [L.] E. H. L. Krause)

subsp. **meleagris** (*F. contorta* Baker, *F. graminifolia* Stokes, *F. lutea* Rchb., nom. illeg., *F. major* Baker, *F. montana* Sanguin., nom. illeg., *F. pallida* Salisb., *F. praecox* K. Koch, *F. tessellata* Salisb., *F. meleagris* var. *contorta* [Baker] W. Mill.)

(LC1) **messanensis Raf.**, J. Bot. (Desvaux) 4: 272. 1814.

(VU2,o) subsp. **gracilis (Ebel) Rix**, Bot. J. Linn. Soc. 76: 356. 1978. (= *Lilium gracile* Ebel., *L. chalcedonicum* subsp. *gracile* [Ebel] K. Richt., *F. gracilis* [Ebel] Asch. & Graebn., *F. montana* var. *gracilis* [Ebel] Griseb., *F. lusitanica* subsp. *neglecta* [Parl.] K. Richt., *F. lusitanica* var. *neglecta* [Parl.] Baker, *F. messanensis* var. *neglecta* [Parl.]

(o) subsp. **neglecta (Parl.) Nyman**, Consp. Fl. Eur.: 721. 1882.

(DD1,VU2) **montana Hoppe ex W. D. J. Koch**, Flora 15: 476. 1832 (= *F. caussolensis* Goaty & Pons ex Ardoino, *F. degeniana* J. Wagner, *F. gawleri* Jaub. & Spach, *F. intermedia* N. Terracc., *F. orsiniana* Parl., *F. pollinensis* N. Terracc., *F. tenella* subsp. *orsiniana* [Parl.] Nyman, *F. pyrenaica* var. *multiflora* Ker Gawl., *F. tenella* var. *caussolensis* Goaty & Pons ex Nyman, nom. nud., *F. tenella* var. *intermedia* [N. Terracc.] Fiori, *F. tenella* var. *micrantha* Beck ex Fiori & Paol., *F. tenella* var. *orsiniana* [Parl.] Fiori, *F. tenella* var. *pollinensis* [N. Terracc.] Fiori)

GAGEA SALISB., ANN. BOT. (KÖNIG & SIMS) 2: 555. 1806. (BOISSIERA HAENS. EX WILLK., *BULBILLARIA* ZUCC., *HEMIERIUM* RAF., *HORNUNGIA* BERNH., *ORNITHOXANTHUM* LINK, *PLECOSTIGMA* TURCZ., *REGGERIA* RAF., *SOLENIARIUM* DULAC, *SZECHENYIA* KANITZ, *UPOXIS* ADANS.) – **B A L O Č E** (YELLOW STAR OF BETHLEHEM)

(LC1) **lutea (L.) Ker Gawl.**, Bot. Mag. 30: t. 1200. 1809. (= *Ornithogalum luteum* L., *Ornithoxanthum luteum* (L.) Link, *Solenarium luteum* (L.) Dulac, *Stellaster luteus* (L.) Kuntze, *G. fascicularis* Salisb., nom. superfl., *G. burnatii* A. Terracc., *G. coreana* Nakai, nom. illeg., *G. elegans* Wall. ex G. Don, *G. escarelii* Arènes & Bouchard, *G. glauca* Blocki, nom. illeg., *G. indica* Pascher, *Gagea lowariensis* Pascher, *Gagea moorcroftiana* Wall., des. inval., *G. reverchonii* Degen, *G. sylvatica* [Pers.] Loudon, *G. szepusiana* Ullep. *G. transsilvanica* Schur, *Ornithogalum majus* Gilib., des. inval. *O. persoonii* Hoppe, *Ornithoxanthum sylvaticum* (Pers.) Link, *G. pusilla* subsp. *burnatii* [A. Terracc.] A. Terracc., *G. pusilla* subsp. *reverchonii* [Degen] A. Terracc.)

minima (L.) Ker Gawl., Quart. J. Roy. Inst. 1: 180. 1816. (= *G. stellaris* Salisb., nom. superfl., *Ornithogalum minimum* L., *Ornithoxanthum minimum* [L.] Link, *Stellaris minima* [L.] Moench, *Stellaster minimus* [L.] Kuntze, *G. arvensis* Dumort., nom. superfl., *G. baumgarteniana* Schur, *G. callosa* [Kit.] Schult. & Schult. f., *G. sternbergii* [Hoppe] Sweet, *Ornithogalum acutipetalum* Herb. ex Schult. & Schult. f., *O. arvense* Pers., nom. superfl., *O. callosum* Kit., *O. gracile* K. G. Hagen, *O. minutum* Pall., *O. pannonicum* Chaix ex Vill., *O. proliferum* Pall., *O. sternbergii* Hoppe, *Ornithoxanthum arvense* Link, *O. gracile* [K. G. Hagen] Link, *O. sternbergii* [Hoppe] Link, *Stellaster arvensis* Kuntze, *G. callosa* var. *alpina* A. Terracc.)

pratensis (Pers.) Dumort., Fl. Belg.: 140. 1827. (= *Ornithogalum pratense* Pers., *Ornithoxanthum pratense* [Pers.] Link, *Stellaster pratensis* [Pers.] Kuntze, *G. bracteolaris* Salisb., nom. superfl., *G. stenopetala* subsp. *pratensis* [Pers.] K. Richt., *G. composita* Opiz, *G. equitans* Wallr., *Gagea gussonei* [A. Terracc.] Stroh, *Gagea polymorpha* F. W. Schultz, nom. illeg., *G. schreberi* Rchb., *G. stenopetala* [Fr.] Rchb., *G. succedanea* Griseb. & Schenk, *Ornithogalum exscapum* Schultz, nom. illeg., *O. glaucum* Dethard. ex Schult. & Schult. f., *O. intermedium* Schultz ex Schult. & Schult. f., *O. nudiscapum* Schultz, *O. schreberi* Rchb., *O. simplex* Becker, *O. stenopetalum* Fr., *G. pratensis* subsp. *gussonei* A. Terracc., *G. pratensis* subsp. *stenopetala* [Fr.] O. Schwarz, *G. stenopetala* subsp. *schreberi* [Rchb.] K. Richt.)

pusilla (F. W. Schmidt) Sweet, Hort. Brit.: 418. 1826. (= *Ornithogalum pusillum* F.W. Schmidt, *Ornithoxanthum pusillum* [F. W. Schmidt] Link, *Stellaster pusillus* [F. W. Schmidt] Kuntze, *G. clusiana* Schult. & Schult. f., nom. illeg., *G. pineticola* Klokov, *G. praeciosa* Klokov, *G. reflexa* Czern. ex Rchb., *G. tunicata* [J. Presl & C. Presl] Kretzer, *Ornithogalum marginatum* Pall., *O. podolicum* Besser ex Schult. & Schult. f., *O. trigonophyllum* Schult. & Schult. f., *O. tunicatum* J. Presl & C. Presl, *O. uniflorum* Zauschn., nom. illeg., *G. pusilla* var. *reflexa* [Czern. ex Rchb.] Nyman, *G. pineticola* f. *praeciosa* [Klokov] Levichev)

(CR2) **spathacea (Hayne) Salisb.**, Ann. Bot. (König & Sims) 2: 556. 1806. (= *Ornithogalum spathaceum* Hayne, *O. belgicum* Lej., *O. heynii* Roth, *Stellasterspathaceus* [Hayne] Kuntze, *Gagea belgica* [Lej.] Dumort., *G. spathacea* var. *transcarpatica* Domin), Milanović et al 2013.

villosa (M. Bieb.) Sweet, Hort. Brit.: 418. 1826. (= *Ornithogalum villosum* M. Bieb., *Ornithoxanthum villosum* [M. Bieb.] Link), Maslo 2014.

LILIUM TOURN. EX L., SP. PL.: 302. 1753. (= *LIRIUM* SCOP., NOM. ILLEG., *MARTAGON* [RCHB.] OPIZ, NOM. ILLEG., *MARTAGON WOLF*) – **LJILJAN (LILY)**

(LC1, DD2,o) **albanicum Griseb.**, Spic. Fl. Rumel. 2: 385. 1846. (= *L. carniolicum* subsp. *albanicum* [Griseb.] Hayek, *L. chalcidonicum* subsp. *albanicum* [Griseb.] K. Richt., *L. chalcidonicum* var. *albanicum* [Griseb.] Asch. & Graebn., *L. pyrenaicum* var. *albanicum* [Griseb.] V. A. Matthews).

(LC2,o) **bosniacum (Beck) R. M. Fritsch**, Mitt. Naturwiss. Vereines Steiermark 45: 163. 1909. (= *L. carniolicum* var. *bosniacum* Beck, *L. carniolicum* subsp. *bosniacum* [Beck] Asch. & Graebn., *L. pyrenaicum* var. *bosniacum* [Beck] V. A. Matthews)

(DD2) **bulbiferum L.**, Sp. Pl. 302. 1753. (= *L. atosanguineum* H. Vilm., *L. aurantiacum* Weston, *L. biligulatum* Baker, *L. croceum* Chaix, *L. elatum* Salisb., *L. fulgens* Baxter, *L. haematocroum* Lem., *L. humile* Mill., *L. lateritium* Baker, *L. latifolium* Link, *L. luteum* Gaterau, *L. pictum* Baker, *L. pubescens* Bernh. ex Hornem., *L. sanguineum* Lindl., *L. scabrum* Moench, *L. sibiricum* Willd., *L. bulbiferum* subsp. *croceum* [Chaix] Nyman, *L. bulbiferum* var. *aurantiacum* Regel, *L. bulbiferum* var. *chaixii* [Elwes] Stoker, *L. bulbiferum* var. *croceum* [Chaix] Pers., *L. bulbiferum* var. *giganteum* N. Terracc., *L. croceum* var. *chaixii* Elwes)

(NT1, cult.) **candidum L.**, Sp. Pl.: 302. 1753. (= *L. album* Houtt., *L. peregrinum* Mill., *L. striatum* Baker, des. inval., *L. candidum* subsp. *peregrinum* [Mill.] Baker, *L. candidum* var. *aureomarginatum* Elwes, *L. candidum* var. *cernuum* Weston, *L. candidum* var. *monstruosum* H. Vilm., *L. candidum* var. *peregrinum* [Mill.] Pers., *L. candidum* var. *plenum* Weston, *L. candidum* var. *purpureostriatum* Souillet, *L. candidum* var. *purpureum* Weston, *L. candidum* var. *rubrolineatum* H. Vilm., *L. candidum* var. *salonikae* Stoker, *L. candidum* var. *striatum* Baker, *L. candidum* var. *variegatum* Loudon, *L. candidum* f. *peregrinum* [Mill.] Voss, *L. candidum* f. *striatum* [Baker] Voss)

(DD2) **carniolicum Bernh. ex W. D. J. Koch**, Syn. Fl. Germ. Helv.: 708. 1837. (= *L. pyrenaicum* subsp. *carniolicum* [Bernh. ex W. D. J. Koch] V. A. Matthews, *L. pomponium* var. *carniolicum* [Bernh. ex W. D. J. Koch] Fiori)

(VU2,o) **cattaniae (Vis.) Vis.**, Mem. Reale Ist. Veneto Sci. 16: 64. 1871. (= *L. martagon* L. var. *martagon*, *L. martagon* subsp. *cattaniae* [Vis.] Nyman, *L. martagon* L. var. *cattaniae* Vis., *L. catanii* Baker, *L. dalmaticum* Vis., des. inval.)

(LC1) **martagon L.**, Sp. Pl.: 303. 1753.

STREPTOPUS MICHX, FL. BOR.-AMER. 1: 200. 1803.
(*HEKORIMA* KUNTH, *KRUHSEA* REGEL, *TORTIPES* SMALL)
– **Č E P N J A K (CLASPLEAF TWISTEDSTALK)**

(EN2) **amplexifolius (L.) DC.**, Lamarck & de Candolle, Fl. Franç., ed. 3, 3: 174. 1805. (= *Convallaria amplexifolia* [L.] E. H. L. Krause, *C. dichotoma* Thibaud ex Pers., *Tortipes amplexifolius* [L.] Small, *Streptopus amplexifolius* var. *genuinus* Fassett, des. inval., *S. distortus* Michx., *S. fassettii* Á. Löve & D. Löve, *S. amplexifolius* subsp. *americanus* [Schult. & Schult. f.] Á. Löve & D. Löve, *S. amplexifolius* var. *americanus* Schult. & Schult. f., *S. amplexifolius* var. *chalcidatus* Fassett, *S. amplexifolius* var. *denticulatus* Fassett, *S. amplexifolius* var. *grandiflorus* Fassett, *S. amplexifolius* var. *oreopolis* Fassett, *S. amplexifolius* var. *papillatus* Ohwi, *S. amplexifolius* f. *indivisus* Lepage, *Uvularia amplexicaulis* Mill.)

TULIPA L., SP. PL.: 305. 1753. (= *EDUARDOREGELIA* POPOV, *LIRIACIS* RAF., *LIRIOPOGON* RAF., *ORITHYIA* D. DON, *PODONIX* RAF.) – **T U L I P A N (TULIP)**

(EN2) **grisebachiana Pant.**, Oesterr. Bot. Z. 23: 265. 1873. (= *T. sylvestris* L. subsp. *sylvestris*, *T. sylvestris* subsp. *grisebachiana* (Pant.) Hayek, *T. australis* subsp. *grisebachiana* /Pant./ Hayek)

(EN2) **sylvestris L.**, Sp. Pl. 305. 1753. (= *Lirio pogon sylvestre* [L.] Raf.)

ABBREVIATIONS AND SYMBOLS

(cult.) - cultivated

(o) - endemic

(CR) - critically endangered

(EN) - endangered

(VU) - vulnerable

(NT) - near threatened

(LC) - least concern

(DD) - data deficient

- Conservation status at the EU biogeographical level (IUCN 2019)
- Conservation status at Bosnia and Herzegovina according to Red List of Vascular Flora for the Federation of BiH (Đug et al. 2013) and the Republic of Srpska (2012).

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Contribution to Rock Flora of the “Bentbaša” Protected Area (Canton Sarajevo, Bosnia and Herzegovina)

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Scientific paper

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Abstract: Between 2013 and 2018, floristic research of rock ecosystems was carried out in the protected area of Bentbaša, i.e., in the canyon of the Miljacka River. A total of 225 species with two subspecies and one form were identified. The largest number of species was found in the *Asteraceae* family (30 species). Most species belong to the orders of *Brometalia erecti* and *Amphoricarpetalia*. As for indicator values, most species belong to the secondary and primary types of vegetation. Most of the species identified are conventionally hemicryptophytes, and the most important floral element is submediterranean. The most widespread species in the investigated area are: *Thymus praecox* subsp. *jankae* (Čelak.) Jalas, *Micromeria thymifolia* (Scop.) Fritsch, *Asplenium trichomanes* L., *Melica ciliata* L. and others, while the rarest plants are *Onosma stellulatum* W. K., *Malcolmia illyrica* (Halacsy) Hay., *Ajuga chamaepithys* L., *Frangula rupestris* L., etc. In the investigated area, 8 species from the “List of plant species (*Pteridophyta* and *Spermatophyta*) for the Red Book of Bosnia and Herzegovina” were recorded in the category of vulnerable species (V). Also, 9 species are on the “Red List of Flora Federation Bosnia and Herzegovina, and recorded in the following categories: DD-1, LC-2, NT-1, VU-2, EN-2 and CR-1 species. Eventually, there are also floristic data on individual sides with all the relevant parameters. From a scientific side, this paper gives a specific approach to research: comparative data in researching different sides of the canyon, the comprehensiveness of research: flora under influence different ecological factors and given new fitocenological provisional units; new association *Asplenio ruta-murariae-Saxifragetum aizoon* comb. nov. prov. and facies *Ceteratosum officinarum* comb. nov. prov.

Keywords: flora, rocks, canyon, Miljacka, “Bentbaša” protected area, hemicryptophytes

INTRODUCTION

GENERAL INFORMATION ABOUT ROCK FLORA

Today, the canyons are refugiums for many plant species that managed to survive unfavorable conditions during the period of glaciation. Because of that, the canyons are very rich in rare and endemic plant species, especially in rock flora. Unfortunately, in Bosnia and Herzegovina, besides the Una River canyon, which has been comprehensively studied (Lakušić et al., 1991; Lakušić & Redžić, 1991; Stefanović, 1991; Dizdarević, 1991; Pavlović, 1991; Đug & Redžić, 1991; Redžić, 1991a; Mišić, 1991; Vagner, 1991; Hafner, 1991; Šoljan, 1991), as well the canyon of the Drina River and some of its tributaries (Lakušić & Redžić, 1989), flora and vegetation in other canyons is mainly unexplored.

Plants that grow in rock fissures are called chasmophytes (gr. *khásma*-abyss, fissure and *phytón*-plant, Lakušić, 1990). Chasmophytes most often inhabit exposed places with the most pronounced influence of various ecological factors such as intense solar radiation, wind, temperature, as well as very specific natural habitats with large slopes and scarce and undeveloped soil (Janković, 1963). This results in a whole series of characteristic morphoanatomical adaptations, primarily leaves. Of these morpho-anatomical adaptations, the most important are: the presence of hairs, stunted growth, leaf cover with specific hairs, indumentum built from long glandular hair (Šilić, 1990), etc. Chasmophytes are well adapted to unfavorable external conditions, and in particular to physiological and physical drought. They mostly inhabit limestone, then dolomite and dolomitized limestone. In the Alps, they also inhabit fissures in silicate rocks (Horvat, 1949). Chasmophytes are very often heliophytes, but also sciophytes and semi-sciophytes. The occurrence among some species is interesting, where the populations living at high altitudes are heliophytes and the ones at lower altitudes are sciophytes or semi-sciophytes, e.g. *Edraianthus sutjeskae* Lkšić (Lakušić, 1990).

Vegetation in rock fissures forms a special order of *Asplenietea rupestris* (H. Meier) Br.-Bl. Plant communities in rock fissures represent permanent stages conditioned by the rock structure, meaning that these communities, as well vegetation, are of primary character. Jovanović & Jovanović-Dunjić (1986) point out that plants of shady forests and moist habitats are related communities, especially from the surrounding meadows and forests, can be found on rock terraces as well. Likewise, many weed species are able to colonize on terraces. It is important to mention that numerous chasmophytes are found not only in the Bosnian Herzegovinian but also in many European Red books of endangered plant species.

Finally, vegetation in rock fissures often shows significant differences, not only from one forest massif to another, but often rocks, as well, differ on the same mountain range (Horvat 1934) and they have a great variability of habitats, microcli-

mate, and pedological factors on them (Lakušić 1968). Such differences can also be observed in the investigated area.

DESCRIPTION OF THE INVESTIGATED AREA

The investigated area is located to the east of Sarajevo and extends from the area of Bentbaša to Kozija čuprija. On the northern side of the investigated area, there are no rock terraces, the plant life of the rocks is much poorer, as more favorable conditions are created in these areas. Firstly, it is the accumulation of larger quantities of calcomelanosol and a more favorable water regime. Because of that, plants from other phytocoenological orders often grow on specific microhabitats (terraces or hidden faults between the rocks) in which they find the minimum necessary conditions for their existence. They extend from the extreme slopes beneath Bijela tabija, Obhodža (including the rocks of Dariva), Borija, and Hrastova Glavica, to somewhat before Kozija čuprija bridge. In the southeast, the investigated area is located in Močila settlement area in Sarajevo and below Jarčedol and Popov gaj and it extends up to the borders of the Canton of Sarajevo, i.e., some what to the east of Kozija čuprija. In fact, this area represents the northeastern slopes of Trebević mountain. The investigated area is situated between 43° and 44° N longitude and between 18th and 19th E latitude (Fig. 1).

The Miljacka canyon belongs to the climate type marked as Cfb, which means moderately warm and rainy climate with warm summers and without a dry season (Đug et al., 2008). The average monthly temperature of the warmest month of the year ranges from 15°C to 22°C, at least four months have an average monthly temperature of $\geq 10^{\circ}\text{C}$, an average monthly temperature of the coldest month is always $> -3.0^{\circ}\text{C}$, the annual temperature amplitude ranges from 12°C to 22°C, annual precipitation ranges from 700 to 1200 mm of rain, evenly distributed throughout the year (Drešković, 2003). Likewise, the influence of the real Supra-Mediterranean and distant steppe regions is felt in this area (Redžić, 1997b).

The wind is one of the important factors for the formation of vegetation and most often it is in the immediate function of determining the appearance (physiognomy), as well as the structure and certain shapes of vegetation dynamics (Redžić, 1991). The direction of winds in the Miljacka canyon is ENE-WSW. During the day and most of the year, the prevailing direction in the Miljacka canyon is ENE (Drešković, 2003).

Frost is a very important ecological factor for vegetation development. It is formed by the evaporation of wet soil layers (Horvat, 1949). According to Milosavljević (1970), the investigated area belongs to the area with 21-30 average days of frost in the period of vegetation (March-October) and with a maximum of 3-4 days of frost in the period when vegetation has mostly lush character (May). The same author (Milosavljević, 1970) states that the degree of danger of frost is high in narrow and windy valleys. Consequently, plants in Miljac-

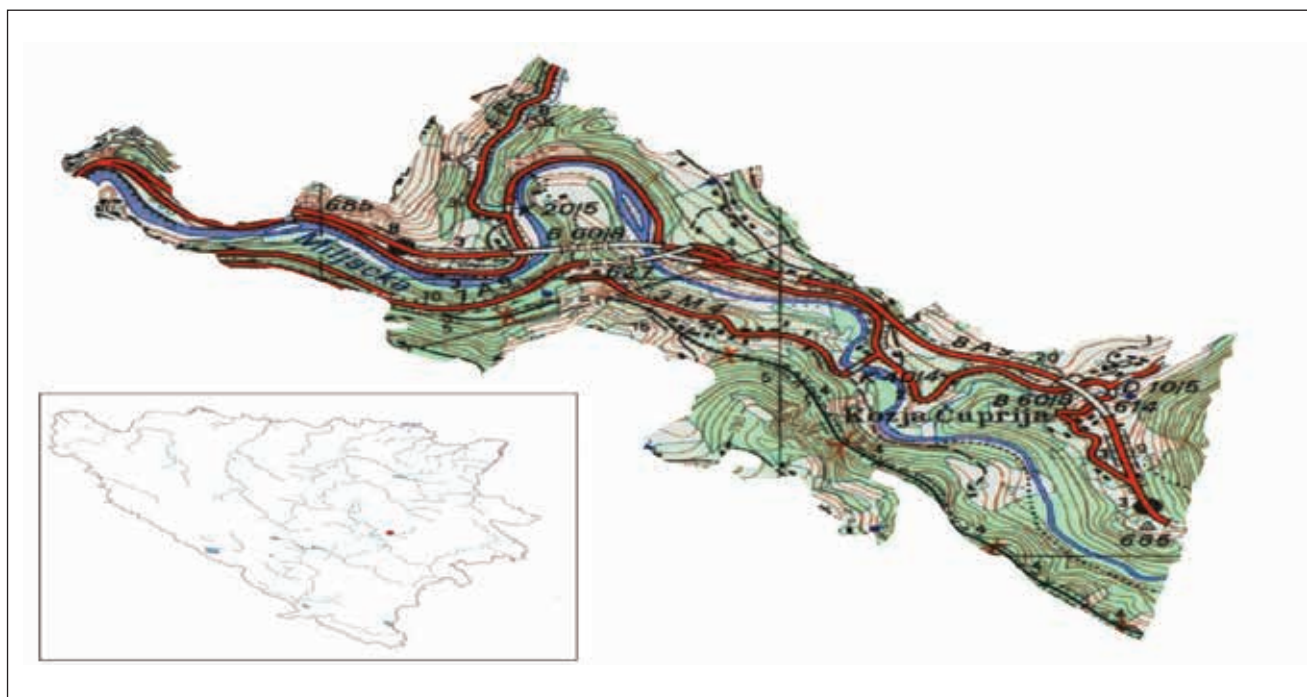


Figure 1. Position and boundaries of PA "Bentbaša" (Adopted from Đug et al., 2008) and position of the investigated area in Bosnia and Herzegovina.

ka canyon are certainly under severe adverse effects of frost during a certain part of the year.

By geological age, the investigated area belongs to the Mesozoic period – the Lower Triassic (Čičić, 1984). As far as tectonics is concerned, this area belongs to the transitional tectonic zone and is very close to the boundary with the inner tectonic zone (Čičić, 1984). By chemical composition, these rocks are labeled as dolomitized limestone (Redžić, 1991). The process of mineralization and the creation of calcite minerals occurs on some rocks. On many rocks of the investigated area, there is a noticeable presence of red color that comes from iron clay. This coloration of rocks was observed on both sides of the investigated area. Processes of metamorphosis can also be noticed. In the investigated area, there are also various relief forms, and the most famous one is the rocky needle of Babin zub, over 30 m high and shaped on Triassic limestone (Lepirica, 2013).

On all the investigated surfaces, lithosol prevails, however, on a smaller part there is calcomelanosol (humus), most often on "terraces" where the opportunity for development and accumulation of this type of soil has been created. According to Škorić et al. (1973), lithosol belongs to a group of undeveloped soils, (A)-C profile. Lithosol is a very shallow soil that is very close to the geological base (Škorić, 1977). For this reason, the character of the rocks and crushing of the detritus will determine the suitability and the possibility of rooting the plants in this, generally speaking, very xerothermic substrate. This soil is very poor in nutrients, the biological activity is weak, so the plant population is poor. Čirić (1984) states that lithosols are ecologically extremely dry habitats exposed to

strong warming and poor in available nutrients and that these automorphic soils, including lithosol, are typically moistened only by atmospheric precipitation, where the percolation of the absorbed water is free and there is no stagnation of water and deficient humidification (wetting).

HISTORY OF EXPLORATION OF THE MILJACKA CANYON AREA

Due to its attractiveness, beauty, and refugial character, a large number of botanists conducted research in the Miljacka canyon. Ami Boué, a French geologist, is the first researcher to visit and pass through this area. Boué (1840) started in Pljevlje, through Čajniče and Goražde, through the Miljacka canyon, to Sarajevo. After that, there was no data until the annexation of Bosnia and Herzegovina by the Austro-Hungarian Monarchy. Hofmann (1882) provides data on the presence of some plants in the Miljacka canyon such as: *Corydalis ochroleuca* Koch, *Genista janauensis* Viv., *Lonicera alpigena* L. and others. Svante Murbeck, also visited and explored the Miljacka canyon. Murbeck (1891) mentions a number of herbs found in the Miljacka canyon, such as *Scirpus setaceus* L., *Cyperus fuscus* L., *Alnus incana* (L.) Willd., *Euphorbia stricta* f. *latifolia* Murb., *Galeopsis bifida* Bolum., *Veronica anagalloides* Guss. and many others. This canyon was often visited by Franjo Fiala (1889, 1891, 1896), curator of the National Museum, during his research. Also, Fiala collected and herbarized a large number of plants from this canyon, and stored them in the Herbarium of the National Museum in Sarajevo (SARA). Beck-Mannagetta (1901, 1903-1921, 1923) in his "Flora Bosne i Herzegovine i

Novopazarskog Sandžaka" offers a large amount of data on the species found in the Miljacka canyon. Another curator of the National Museum who conducted his research in the Miljacka canyon, Protić (1908), gives information on some plants found in the Miljacka Canyon. The same author (Protić, 1897, 1899) provides data on the Diatoms in the Miljacka, and in the second paper, he performs tests on the biological self-cleaning of the Miljacka River (Protić, 1933). Malý (1899, 1904, 1910-1928, 1940, 1948), and in other works (Malý & Zahn 1925, 1926, 1929; Malý 1931, 1932, 1933a, b, 1935) surveyed the Miljacka canyon in detail and collected numerous data on its flora and vegetation.

Botanical exploration of this canyon continues after World War II. Thus, Ritter-Studnička (1958) provides data on the site of some adventive species in the Miljacka canyon. Stefanović (1955) reports that *Ailanthus altissima* (Mill.) Sw. appears in the Bentbaša-Kozija ćuprija region as a weed, while Abadžić (1974) explores the ecology and variability of populations of the species *Scabiosa leucophylla* Borb. on the part of the Miljacka canyon called Orlovo krilo. While investigating the ecological and morphological differentiation among the populations of the species *Edraianthus jugoslavicus* Lkšć, Abadžić (1984) also surveyed the Miljacka canyon. Similarly, Abadžić (1987) notes the presence of *Echinocystis lobata* (Michx.) Torr. & A. Gray in the valley of the Miljacka River, in several places. Strgar (1974, 1981), exploring Dariva rocks, describes a new species of moor grass – *Sesleria ujhelyii* Strgar or Ujhel's Moor Grass. Academician Sulejman Redžić surveyed this canyon on several occasions. Thus, in his doctoral dissertation (Redžić, 1991), he explored this canyon and in two papers in the scientifically popular magazine "FONDEKO svijet" offered a concise description of the flora and other characteristics of this canyon (Redžić, 1997a, b). Also, other researchers explored this canyon, such as Tanović (1995), Jukić (2001), Merdan (2004), Ravlić (2004), Šoljan et al., (2007).

MATERIAL AND METHODS

Materials and methods of work can be divided into two phases: field and laboratory.

Field-work

This work has been done through long-term field trips in all annual vegetation aspects, from 2013 to 2018. The investigated area was studied and monitored through several successive annual weather aspects to determine floral and phenological facts. Throughout the season, the bloom of individual, most characteristic species was observed.

Laboratory-work

Statistical data analysis included descriptive statistics methods in order to obtain data on the total number of taxa, the

number of taxa occurring only on the northern or just on the southeastern side, and the number of taxa appearing on both sides of the investigated area. The analysis provides data on life forms, phytocoenological affiliation, indicator values, and floral elements. Graphical depictions of all the above-mentioned items were given for the entire canyon as well as for individual sides, which also enabled a comparative analysis of the floristic composition of the north and southeast of the investigated area. The data on phytocoenological affiliation, indicator value, floral element, and life form was provided for all species.

The objectives of this paper are to:

1. Identify which plants appear on the rocks of the investigated area of the Miljacka canyon,
2. Determine which plants are recorded in the entire investigated area and which are only on the northern and which only on the southeastern side of the canyon,
3. Determine the boundaries of the average distribution of the most characteristic plants,
4. Determine the percentage ratios: life forms, phytocoenological affiliation, indicator values, and floral elements, both for the whole canyon and for individual sides,
5. Identify the most common plants of rock ecosystems,
6. identify the rarest plants of rock ecosystems,
7. Determine the phenology of the most important plants,
8. Note the presence of plants listed in the "List of Plant Species (*Pteridophyta* and *Spermatophyta*) for the Red Book of Protected Plant Species" and "Red list of Flora of Federation of Bosnia and Herzegovina".

DETERMINATION AND NOMENCLATURE

During the determination of plants, I used a large number of works and keys for determination, both general and specialized for certain genera.

Of the general ones, I used:

Aichele & Schwegler (1998), Beck-Mannagetta (1903-1923, 1927), Beck-Mannagetta et al. (1950, 1967, 1974), Čanak et al. (1978), Domac (1984), Josifović et al. (1970-77), Kojić (1981), Kvakan (1952), Šarić (1991), Šilić (1990, 2002, 2005) and Šoštarić-Pisačić & Kovačević (1968).

Of the specialized keys for certain genera, I used:

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

During the determination of plant material, the Herbarium Collection (SARA) of the National Museum of Bosnia and Herzegovina was also used.

Floral elements and life forms were given according to: Lakušić & Redžić (1989, 1991), Oberdorfer (1991), and Redžić (1988). Phytocoenological affiliation was given according to: Horvat et al. (1974), Lakušić (1989), Lakušić & Redžić (1989, 1991), Oberdorfer (1991), and Redžić (1988).

Indicator values were given according to: Lakušić & Redžić (1989, 1991), Pavlović-Muratpahić (1995), and Redžić (1988).

Life forms were given according to Raunkiaer (1937).

The research history was given by works: Fiala (1892), Fukarek (1954), and Redžić (1997 b).

The nomenclature follows that of *Flora Europaea* (Tutin et al., 1964-1980), *Flora Croatica Database* (<https://hirc.botanic.hr>) and www.theplantlist.org.

RESULTS AND DISCUSSION

In the entire research area, a total of 225 species with 2 sub-species and 1 form were identified from 49 families (Tab. 1 and 2). The most numerous families were: *Asteraceae* with 30, *Poaceae* with 25, and *Fabaceae* with 21 taxa. A slightly lower number of species was found from the following families: *Rosaceae* with 14 and *Lamiaceae* and *Apiaceae* with 13, *Scrophulariaceae* 11, and *Caryophyllaceae* with 9 taxa (Tab. 3). Other families were represented with a smaller number of taxa (Fig. 2).

In Figure 2, we can see that most species belong to the orders of *Brometalia erecti* and *Amphoricarpetalia*. A slightly smaller number of species belong to the following orders: *Chenopodietalia*, *Arrhenatheretalia*, *Quercetalia pubescentis*, *Fagetalia*, and *Scorzonero-Chrysopogonetalia*. It should also be noted that representatives from 18 phytocoenological orders were recorded in the entire investigated area (Tab. 1). Also, due to lack of space in the development of the chart, the chart contains data on phytocoenological orders with 1 representative and a percentage value of 0.5%, and these are the following orders: *Quercetalia robori-petraeae*, *Salicetalia purpureae*, *Festuco-Sedetalia*, *Secalinetalia* and *Plantagine-talia majoris*. As for the indicator value, the largest number belongs to secondary and primary vegetation (Fig. 3). Most species belong to the life form of hemicryptophytes, while others are less numerous (Fig. 4). The data in Table 2 show

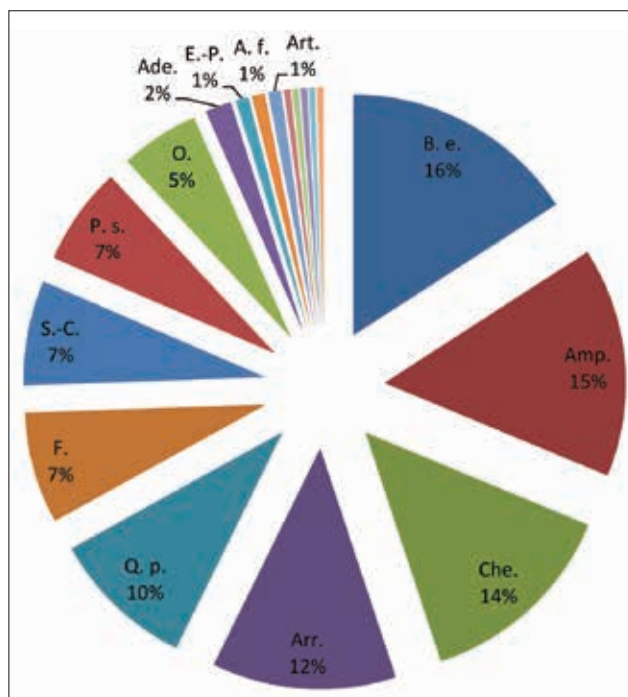


Figure 2. The percentage ratio of the vegetation orders in the entire research area

that the largest number of species in the entire research area belongs to the Submediterranean floral element. A slightly lower percentage belongs to the Eurasian, Eurassubozean, and Nordic Eurasian floral elements. And from this, it can be

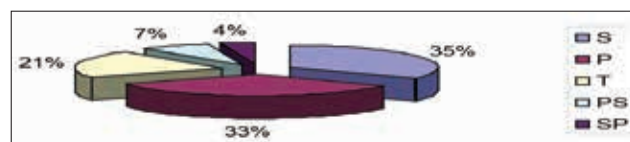


Figure 3. The percentage ratio of the indicator values for the entire investigated area

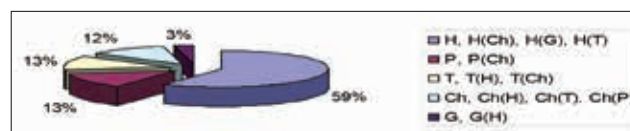


Figure 4. The percentage participation of life forms in the entire investigated area

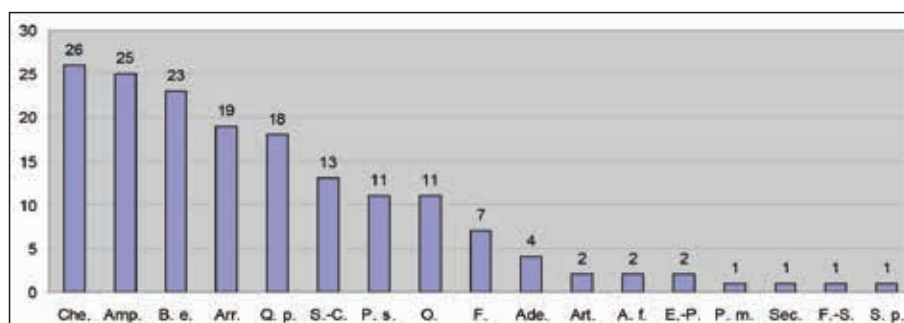


Figure 5. The number of representatives of particular orders on the northern side

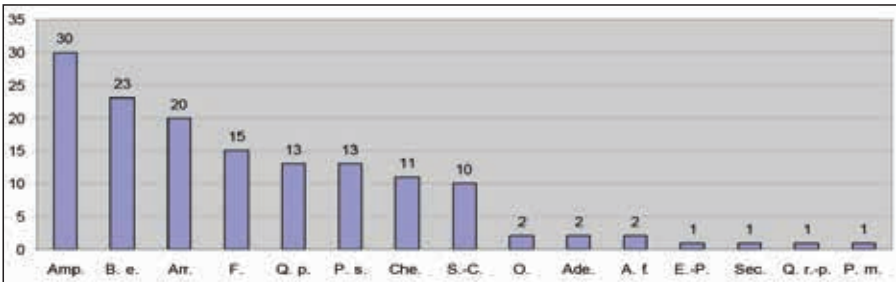


Figure 6. The number of representatives of particular orders on the southeastern side

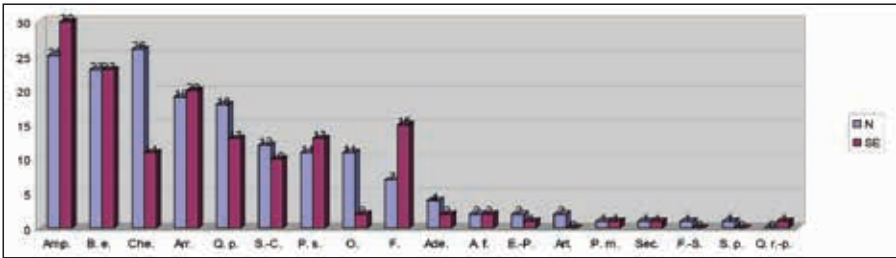


Figure 7. Comparative orders' relation between the investigated sides

concluded that this canyon is very warm and represents the penetration or influence of Supramediterranean, as previously mentioned in the climate section.

Figure 5 shows number of fitocenoligical orders for northern and Figure 6 for southern side. Figure 7 shows that, in the entire area, a large number of detected species belong to the orders of *Amphoricarpetalia* and *Brometelia erecti*. Interestingly, the number of *Chenopodietalia* order, present on the northern side of the canyon, due to a large number of terraces, there is a very large number of identified taxa, and on the opposite side, where the number of terraces is much smaller, the number of identified types of this order is significantly smaller. Of the other orders, with a slightly smaller number of taxa, we should mention: *Arrhenatheretalia*, *Quercetalia-pubescentis*, *Scorzonero-Chrysopogonetalia*, and *Prunetalia spinosae*. These ecosystems often border with rock ecosystem. Also, the ecosystem of beech forests borders on the south-eastern side with the ecosystem of rocks, and the number of species found on this side is far larger than in the north where this ecosystem is not identified. Table 1 shows that the species found on both sides come from 14 phytocoenological orders.

Figure 8 shows percentage ratio of indicators values in the northern and Figure 9 for the southeastern side. Figure 10 shows that representatives of the primary vegetation dominate throughout the entire research area, although the val-

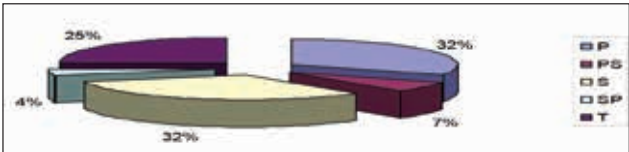


Figure 8. The percentage ratio of indicator values in the northern side of the investigated area

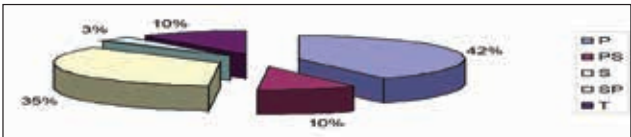


Figure 9. The percentage ratio of indicator values on the southeastern side of the investigated area

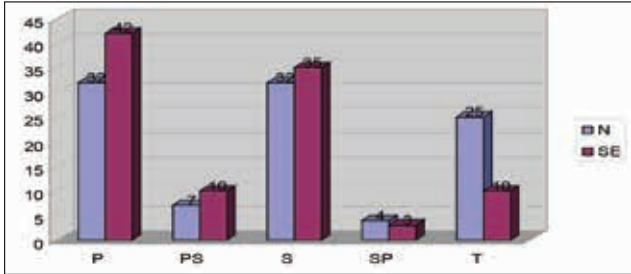


Figure 10. Comparative indicator values between the two sides

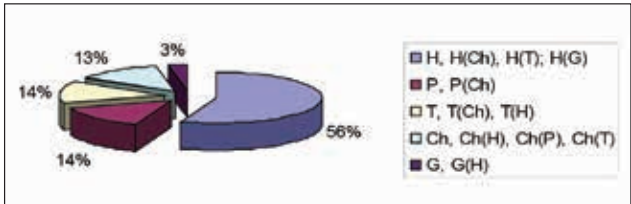


Figure 11. The percentage ratio of life forms in the northern side of the investigated area

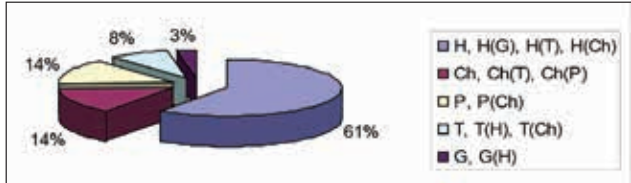


Figure 12. The percentage ratio of life forms on the southeastern side of the investigated area

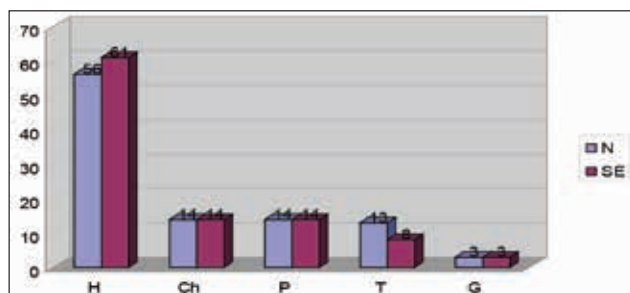


Figure 13. Comparative relationship of life forms between both sides

ue of the members of the secondary vegetation is also high. There is a difference in the number of tertiary species that are lower in the southeast, and the main reason is the small number of terraces suitable for the representatives of this group. On the other hand, there is a slightly higher number of primary-secondary species on the southeastern side. The main cause is the proximity of forest ecosystems, which in some places border with the ecosystem of rocks.

Figure 13 shows that most of the species are on both sides of the investigated area. They are hemicryptophytes. The ratio of chamaephytes and phanerophytes is equal, and a smaller number of therophytes on the southeastern side is the result of a smaller number of terraces. A very small presence of geophytes is also noticeable.

THE MOST WIDESPREAD ROCK PLANTS WITH DATA ON THE AREA OF DISTRIBUTION IN THE INVESTIGATED AREA

1. *Thymus praecox ssp. jankae* (Čelak.) Jalas, or Janka's thyme is one of the main edificators of the investigated area, spread both on the northern and southeastern sides, and in some places on the southeastern side of the canyon it is massively widespread.
2. *Melica ciliata* L. is one of the most widespread plants in the entire canyon, and we can say that it is evenly distributed on both sides.
3. *Micromeria thymifolia* (Scop.) Fritsch grows more on the northern than on the southeaster side. It is one of the species that begins to bloom in this area the last. Together with *Malcolmia illyrica* (Halacsy) Hay., it forms a community of *Malcolmio-Micromerietum thymifoliae* (Redžić, 1991), which is spread only on the rocks of Dariva.
4. *Asplenium ruta-muraria* L. is spread all over the canyon but it is mostly distributed on the carbonate embankments of the former narrow-gauge railway where, together with *Saxifraga aizoon* Jacq., it forms a community of *Asplenio ruta-murariae-Saxifragetum aizoon* comb. nov. prov.
5. *Asplenium trichomanes* L. is spread all over the canyon, but the most optimal living conditions are found on carbonate blocks below the forest vegetation of the order

Quercetalia pubescentis. This fern is best suited the places that are not too exposed to direct sunlight.

6. *Ceterach officinarum* DC. as opposed to *Asplenium trichomanes*, grows in dry places. It is spread all over the canyon. At the end of the investigated area from the south-eastern side, on the degraded site, it builds facies of the *Ceteratosum officinarum* comb. nova prov., which is within the association *Asplenio trichomani-Saxifragetum aizoon* comb. nova prov. It is also well represented in the association *Asplenio ruta-murariae-Saxifragetum aizoon* comb. nova prov., which occurs in the open limestone embankment.
7. *Dianthus kitaibelii* Janka in Panč. is spread on both sides of the canyon, massively widespread on the southeastern side while on the northern side it grows only at the end of the investigated area, i.e., behind Dariva's rocks to Kozija ćuprija. This indicates that some specific conditions appear to enable this plant to grow. It is an important member of many communities, especially on the southeastern side where it builds, together with the *Edraianthus jugoslavicus* Lkšić, the community *Edraiantho-Dianthetum kitaibelii* Lakušić that appears on the southeastern side of the rocks at the first houses of the lower part of Jarčedol. Kitaibel's pink is one of the most important edificators on the southeastern side of the Miljacka canyon.
8. *Erysimum linarifolium* Tausch is one of the species typical of this canyon. It is an important member of many communities. It is one of the species that is the first to begin to bloom in this area.
9. *Leontodon crispus* Vill. is spread across the entire investigated area individually or in small groups of 3-5 specimens. Regardless of not being massively spread nor high in number like some other species, this species is constant, and it can be said that it belongs to a group of indicator or edificator species of this canyon.
10. *Stipa calamagrostis* (L.) Wahlenb. is singled out individually or in smaller groups and certain associations it is a constant member. Spear Grass can also be considered an important member of many communities in this area.
11. *Sedum ochroleucum* Chaix is distributed mostly individually or in small groups. In some places, especially on the southeastern side, it also appears in a slightly larger number.
12. *Galium corrudaefolium* Tausch has been recorded on both sides and in a larger number of associations of the investigated area, and can also be considered as a significant indicator of this canyon. It is mostly related to open or slightly shady habitats. It is more numerous on the northern than on the southeastern side.

Of the species belonging to other orders, the following ones have a high prevalence in the investigated area: *Tunica*

saxifraga (L.) Scop. - in a series of communities on both sides, *Silene vulgaris* (Mch.) Garcke - same as the previous, but much more widespread than *Tunica saxifraga*, and it is an edicator of some communities, *Sedum album* L. - is also widespread on both sides, but much more common in the north, *S. acre* L. - also widespread on the northern side, but much less than the *Sedum album*, *Sanguisorba muricata* (Spach.) Focke - on both sides of the canyon and it is a significant member of many communities, *Galium purpureum* L. - more common in the north than in the southeast, *Bromus erectus* Huds. - in many communities on both sides of the investigated area, *Arabis hirsuta* (L.) Scop. - individually or in smaller groups on both sides but more in the southeast than in the north, *Acinos hungaricus* Simon. - mainly on the northern side and much less on the southeast, *A. arvensis* (Lam.) Dandy - as the previous species, *Helianthemum nummularium* (L.) Run. - common species in many associations with both sides of the canyon, *Coronilla emerus* ssp. *emeroides* (Boiss. et Spr.) Hay. - on both sides, in some places, like in the area near Dariva, more common than elsewhere, *Hieracium murorum* L. - mainly in the area of the southeastern canyon where it occurs in many associations and where it found favorable living conditions, as well as other species.

THE RAREST ROCK PLANTS IN THE INVESTIGATED AREA

The following species may be considered the rarest plants in the investigated area:

1. *Onosma stellulatum* W. & K.-one small population near Bentbaša tunnel.
2. *Sempervivum tectorum* L.-two populations with several individuals on the rocks of the tunnel at Bentbaša.
3. *Ajuga chamaeptytis* L.-it does not belong to rock plants, it was sampled because of its rarity, because the only one larger population on the rock near Dariva was found,
4. *Malcolmia illyrica* (Halacsy) Hay.-rare species of rock plants in this canyon and it occurs in separate groups of two to three individuals together. In the investigated area, this species can only be found on the rocks of Dariva and it is very scattered. In this area, it builds the community *Malcolmia-Micromerietum thymifoliae* Redžić. The nearest populations of this plant were only found on the rocks of Jekovac, the area not covered by this research. Interestingly, the habitat of these plants is rock crevice where they could not be scattered through the wind, or with difficulty, so it is most likely that the seeds of this species possess a "sweet supplement" or *caruncle* which are dispersed by ants. This is a prominent sciophyte (Šilić, 1990).
5. *Sedum maximum* (L.) Sut.-rare species in the investigated area. It was found on both sides of the canyon but only in small and limited areas and with a smaller number of

specimens. Thus, on the north side, it was found on a site near Dariva where it is a bit more widespread, and on the southeastern side, at the end of the investigation area, where it occurs with few specimens.

6. *Frangula rupestris* L.-rare, the most widespread on the rocks before the tunnel at Bentbaša. It is very rare in the other parts of the investigated area. On the southeastern side, it is recorded in two places as individual specimens.
7. *Sesleria ujchelyii* Strgar-Ujchel's Moor Grass is mainly associated with the northern side of the canyon. It is most numerous on the rocks around the Bentbaša tunnel, while further, i.e., in other parts of the canyon, it is quite rare.
8. *Minuartia bosniaca* (Beck) Malý-it is widespread throughout the canyon, in mainly smaller populations, except for one part of the northern side of the *Malcolmia-Micromerietum thymifoliae* Redžić association, whereas on the southeast, it is somewhat more significantly widespread.
9. *Athamanta haynaldii* Borb. et Uechrt.-found on the southeastern part of the canyon, most often in places that are not exposed to direct sunlight, but it can also be found in places with plenty of sun.
10. *Seseli rigidum* W. & K.-in similar habitats as the previous species but is more widespread. Tatić & Veljović (1982) provided interesting data that species *Stipa calamagrostis* and *Melica ciliata* are particularly important in the habitats in which this species occurs and develops specific communities, which is also the case with this investigated area.
11. *Campanula rotundifolia* f. *albiflora* (Don) House-is a white-floral form of the Harebell, that appears only on the rocks before the first houses on Jarčedol.
12. *Genista janauensis* Viv.-it does not belong to the order of the rock plant of *Amphoricarpetalia*, this broom is rare in the entire investigated area. It is mostly widespread at the end of the canyon on the north side near the Kozija ćuprija bridge. In the rest of the investigated area, it occurs in single or smaller groups, which is very rare.

Here we should add the information on discovering a very rare fern *Asplenium lepidum* C. Presl that was recorded on the rocks of Dariva and Bentbaša (Nizić, 2007).

RARE AND ENDANGERED PLANT SPECIES IN THE INVESTIGATED AREA

Plant species from the investigated area, that are found on the list of plant species for the "Red Book of Bosnia and Herzegovina" (according to Šilić, 1996), in the category of vulnerable species (V) are: *Minuartia bosniaca* (Beck) Malý, *Malcolmia illyrica* (Halacsy) Hay., *Athamanta haynaldi* Borb. et Uechrt and *Onosma stellulatum* W. K., *Micromeria thymifolia* (Scop.) Fritsch, *Scabiosa leucophylla* Borb., *Edraianthus jugoslavicus*

Lkšić, and *Hieracium waldsteinii* Tausch in "Red list Flora of Federation Bosnia and Herzegovina" (Đug et al., 2103), as well as 9 species from the following categories: DD-*Dactylis aschersoniana* (Graebn.) Hay., LC-*Onosma stellulatum* and *Scabiosa leucophylla*, NT-*Edraianthus jugoslavicus*, VU-*Minuartia bosniaca* and *Asplenium lepidum* C. Presl, EN-*Athamantha haynaldii* and *Hieracium waldsteinii*, CR-*Malcolmia illyrica*.

PHENOLOGY OF THE INVESTIGATED AREA

During the long-term field trips, it was noted that the first plants that begin to bloom mostly in late March or early April are: *Erysimum linarifolium* Tausch, *Sesleria ujhelii* Strgar, *S. angustifolia* (Hack. & Beck) Deyl, and *Arabis caucasica* Willd. In mid-April, these species already begin to bloom massively, and *Arabis glabra* (L.) Bernh., *A. hirsuta* (L.) Scop., and *A. turritta* L., *Coronilla emerus* ssp. *emeroides* (Boiss. et Spr.) Hay., *Cytisus hirsutus* L. as well start to bloom in the same period. During this period, in the area around Kozija ćuprija *Genista januensis* Viv. also begins to bloom, and on the rocks of Dariva, there is the blooming *Malcolmia illyrica* (Halacsy) Hay. It is also the time when one of the most widespread canyon plants, *Thymus praecox* ssp. *jankae* (Čelak.) Jalas, massively blooms at the beginning of May. This is the period when the following plants begin flowering: *Onosma stellulatum* W. & K. and *Dianthus kitaibelii* Janka in Panč., the latter one massively blooms in mid-May. Other plants are blooming in mid-May, such as *Minuartia bosniaca* (Beck) Maly, *Veronica jacquinii* Baumg., *Galium corrudaefolium* Tausch and *Helianthemum nummularium* (L.) Run. This is the time when *Edraianthus jugoslavicus* Lkšć begins to blossom at eastern exposures. At the beginning of June, the following plants begin to bloom, and massively in the middle of the same month: *Saxifraga aizoon* Jacq. and *Seseli rigidum* W. & K., while *Athamantha haynaldii* Borb. et Uechrt just begins to bloom. However, at the end of June, this species is in full bloom, together with *Campanula rotundifolia* L., *Micromeria thymifolia* (Scop.) Fritsch, and *Leontodon crispus* Vill. In September and October, *Allium sphaerocephalum* and *Euphrasia stricta* Host. is last species which blooming.

FLORISTIC CHARACTERISTICS OF THE NORTHERN SIDE OF THE INVESTIGATED AREA

In this investigated area, a total of 167 taxa was recorded. The most important taxa of this part of the investigated area are: *Micromeria thymifolia*, which is much more common in Bentbaša and Dariva than in the area around Kozija ćuprija, *Silene vulgaris* is well spread across the northern side of the canyon, *Tunica saxifraga*, which is also very widespread in this part of the investigated area as well as *Galium corrudaefolium*, *Sedum album*, *Melica ciliata*, *Erysimum linarifolium*, *Sanguisorba muricata*, *Thymus praecox* ssp. *jankae*, *Stipa calamagrostis*, and others. Figure 5 shows that the largest number of discovered

species belongs to the tertiary order of *Chenopodietalia*. The main reason for such a large number of species is a large number of terraces, especially on the rocks of Dariva and Bentbaša, which provide favorable conditions for the development of species not only of this order, but also of other orders. A large number of discovered species also belong to the *Amphoricarpetalia* order and a slightly lower number to the secondary order of thermophilic meadows *Brometalia erecti*. There are also numerous members of orders *Arrhenatheretalia* and *Quercetalia pubescentis* because these ecosystems in some places border the rock ecosystem. Slightly lower percentages but persistent constancy in the investigated area have representatives of the *Prunetalia spinosae* order that can be found in each association of the northern side of the investigated area. A larger part of the Miljacka canyon, especially along the road from Bentbaša to Kozija ćuprija, where constant anthropogenic impact is noticed, is occupied by associations as well as the species of this order. Moreover, representatives of other tertiary orders inhabit these habitats, especially from the order of *Onopordetalia*. The representatives of the *Fagetalia* order are also noted, but to a considerably smaller extent. It is also important to mention the order of *Arabidetalia flavescens*, the order of talus vegetation, which, especially on high mountains, often borders with orders of vegetation on rocks. On the north side of the investigated area, representatives of this order appear in many places, which points to their constancy. A total of 17 phytocoenologic orders were found. Figure 9 shows that the largest number of species found on the southeastern side belongs to primary vegetation. There is a smaller number of members of secondary vegetation and much lower values have members of primarily, secondary and tertiary vegetation. The smallest number of species was found in the order of secondary primary vegetation. In Figure 8, we can see that primary and secondary vegetation members are the most numerous on this side of the investigated area. As far as the tertiary vegetation representatives are concerned, a slightly smaller number was found, while representatives of primary and secondary primary vegetation are identified with the smallest number of species. In Figure 11, we can see that the largest number of species belongs to hemicryptophytes. Phanerophytes, therophytes, and chamaephytes are noted with fewer specimens, whereas the smallest number of species belong to the geophyte life form. The data presented in Table 4 indicate the most significant floral element on the northern side of the investigated area is Submediterranean. High values include the Eurasian suboceanic, Mediterranean, Eurasian, and Balkan flora elements. From this data, we can see the influence of supra-Mediterranean in Miljacka canyon.

FLORISTIC CHARACTERISTICS OF THE SOUTHEASTERN SIDE OF THE INVESTIGATED AREA

In this investigated area, 145 taxa were identified. The most numerous species of the southeastern part of the investigated area are: *Asplenium trichomanes*, *Thymus praecox* ssp. *jankaе*, *Arabis hirsuta*, *Dianthus kitaibeli*, *Fraxinus ornus*, *Sedum ochroleucum*, *Hieracium murorum*, *Sanguisorba muricata*, *Ceterach officinarum*, *Campanula rotundifolia*, *Edraianthus jugoslavicus* and *Saxifraga aizoon*, etc. The data presented in Figure 6 show that the number of species found in this area belongs to the order of rock vegetation *Amphoricarpetalia*, and slightly lower values have secondary orders of *Brometalia erecti* and *Arrhenatheretalia*. Lower values were found for members of orders of the forest ecosystems: *Fagetalia*, *Quercetalia pubescentis* and *Prunetalia spinosae*, which, in particular the *Fagetalia* order, often border in this area with rock ecosystems. There is also a small number of *Chenopodietalia* representatives due to a small number of terraces suitable for their life. Low values are noted for the order *Arabidetalia flavescentis*. A total of 15 phytocoenologic orders were found. Graph 8 shows that the largest number of species found on the southeastern side belongs to primary vegetation. A smaller number of members of secondary vegetation and lower values have representatives of primary, secondary and tertiary vegetation. The smallest number of species was found in the order of secondary and primary vegetation. Registered representatives of primary and secondary vegetation originate from the *Prunetalia spinosae* order which is again to the result of the presence of this ecosystem in the investigated area. The data presented in Figure 12 shows that hemicryptophytes area is the dominant life form in this investigated area. A much smaller number of chamaephytes and phanerophytes were recorded. It is noticeable, due to the smaller number of terraces, that there is a very small number of therophytes, and the smallest number of the observed species belongs to geophytes. Therophytes are mainly weed species and in this area, they most commonly inhabit terraces. On the other hand, geophytes are also found on the terraces, and since they mainly propagate by bulbs, this habitat, i.e., the rocks, is not suitable for their larger widespread. Finally, in Table 4 we can see that the largest number of species on the southeastern side of the investigated area belongs to the Submediterranean floral element. High values include also: Dinaric, Balkan, Mediterranean, Eurasian, and Eurasian-suboceanic floral elements. Lower values were found for species from: alpine, prealpine, and subatlantic floral elements which shows the unfavorable conditions for the distribution of these species in this part of the canyon, due to the influence of warm winds.

CONCLUSION

A total of 225 species with 2 subspecies and 1 form from 49 families were recorded in the entire investigated area.

The most numerous families are: *Asteraceae* with 30, *Poaceae* with 25, *Fabaceae* 21, *Rosaceae* 14, *Lamiaceae* and *Apiaceae* with 13 taxa.

In the total investigated area, species were recorded from 18 phytocoenological orders, 17 on the northern side, and 15 on the southeastern side.

The most widespread plants in the entire canyon are: *Thymus praecox* ssp. *jankaе* (Čelak.) Jalas, *Minuartia bosniaca* (Beck) Malý, *Melica ciliata* L., *Micromeria thymifolia* (Scop.) Fritsch, *Asplenium ruta-muraria* L., *Asplenium trichomanes* L., *Ceterach officinarum* DC., *Erysimum linarifolium* Tausch. *Leontodon crispus* Vill., *Stipa calamagrostis* (L.) Wahlenb., *Sedum ochroleucum* Chaix, *Dianthus kitaibeli* Janka in Panč. and *Galium corrudaefolium* Tausch,

The largest number of identified taxa of the entire investigated area belongs to *Amphoricarpetalia* order and a smaller number belongs to the following orders: *Brometalia erecti*, *Arrhenatheretalia*, *Chenopodietalia*, *Quercetalia pubescentis*, *Scorzonero-Chrysopogonetalia* and *Fagetalia* and they belong to secondary and primary vegetation.

Of life forms, the largest number of taxa belongs to hemicryptophytes where as fewer of them belong to other forms.

There were species from 17 floral groups with 103 different floral elements. The largest number of species belongs to the Sub-Mediterranean floral element.

Eight species were recorded in the investigated area with a list of plant species (*Pteridophyta* and *Spermatophyta*) for the Red Book of Bosnia and Herzegovina with the category of vulnerable species (V). More over, nine species from the "Red List of Flora of the Federation of Bosnia and Herzegovina were recorded in the following categories: DD-1, LC-2, NT-1, VU-2, EN-2, and CR-1 species.

On the scientific side, this paper has a specific approach to research: comparative data in researching different sides of canyon, comprehensiveness of research: flora under the influence of different ecological factors and given new fitoecological provisional units; new association *Asplenio ruta-murariae-Saxifragetum aizoon* comb. nov. prov. and facies *Ceteratosum officinarum* comb. nov. prov.

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SAŽETAK

U periodu između 2013. i 2018. vršena su floristička istraživanja ekosistema stijena u Zaštićenom području „Bentbaša“, tj. kanjonu rijeke Miljacke. Ukupno je konstatovano 228 vrsta sa jednom podvrstom i jednom formom. Najveći broj vrsta konstatovan je iz familije *Asteraceae* sa 30 vrsta; najmnogobrojnije su vrste koje pripadaju vegetacijskim redovima *Brometalia erecti* i *Amphoricarpetalia*; od indikatorskih vrijednosti najveći broj vrsta pripada sekundarnom te primarnom tipu vegetacije; najznačajniji broj konstatovanih vrsta pripada ubjedljivo životnoj formi hemikriptofita a najbrojniji florni element je submediteranski. Najznačajnije vrste istraživnog područja su: *Thymus praecox* ssp. *jankae*, *Micromeria thymifolia*, *Asplenium trichomanes*, *Melica ciliata* i druge a dok su najrjeđe vrste: *Onosma stellulatum*, *Malcolmia illyrica*, *Ajuga chamaepithys*, *Frangula rupestris* i druge. U radu su dati i fenološki podaci za najznačajnije vrste. Na istraživnom području je zabilježeno osam vrsta sa „Spisak biljnih vrsta (Pteridophyta i Spermatophyta) za Crvenu knjigu Bosne i Hercegovine“ i to sa kategorijom ranjivih vrsta (V). Takođe, devet vrsta se nalaze na „Crvenoj listi flore FBiH“, zabilježenih u slijedećim kategorijama: DD-1, LC-2, NT-1, VU-2, EN-2 i CR-1 vrsta. Na kraju su dati i floristički podaci posebno za sjevernu i jugoistočnu stranu kanjona Miljacke sa svim relevantnim parametrima. Ovaj rad je imao specifičan pristup u istraživanju tokom kojeg su se uspjeli dobiti komparativni podaci o flori stijena različitih strana kanjona Miljacke, takođe je sveobuhvatno osvijetlio floru ovog područja pod uticajem različitih ekoloških faktora. Istraživanje je rezultiralo definisanjem dviju provisionalnih fitocenoloških jedinica na nivou asocijacije kao *Asplenio ruta-murariae-Saxifragetum aizoon* comb. nova prov. i *facies Ceteratosum officinarum* comb. nova prov.

Ključne riječi: flora, stijene, kanjon, Miljacka, Zaštićeno područje „Bentbaša“, hemikriptofite

APPENDIX

Table 1. The list of families with species found in the investigated area of the Miljacka canyon with data on: systematic and phytocoenological affiliation, indicator value, floral element, and life form.

The name of the species	Phytocoenological affiliation	Indicator value	Floral element	Life form	Distribution		
					N	SE	Both sides
I <i>Aspleniaceae</i>							
1. <i>Asplenium ruta-muraria</i>	Amp.	P	(no-)euras-smed,circ	H	+	+	+
2. <i>A. trichomanes</i>	Amp.	P	eurassubozean	H	+	+	+
3. <i>Ceterach officinarum</i>	Amp.	P	med-smed(-subatl)	H	+	+	+
II <i>Polypodiaceae</i>							
4. <i>Cystopteris fragilis</i>	Amp.	P	no-eurassubozean-pralp	H	-	+	-
5. <i>Polypodium vulgare</i>	F.	P	eurassubozean-smed	Ch	-	+	-
III <i>Ranunculaceae</i>							
6. <i>Clematis recta</i>	Q. p.	P	gemässkont(-smed)	P	+	-	-
7. <i>C. vitalba</i>	P. s.	PS	smed-subatl(circ)	P	+	+	+
8. <i>Helleborus odoratus</i>	P. s.	PS	din	H (G)	-	+	-
9. <i>Ranunculus bulbosus</i>	Arr.	S	smed-subatl	H (G)	+	-	-
IV <i>Papaveraceae</i>							
10. <i>Chelidonium majus</i>	Che.	T	euras(subozean)	H	+	-	-
11. <i>Papaver rhoeas</i>	Che.	T	euras-med	T	+	-	-

The name of the species	Phytocoenological affiliation	Indicator value	Floral element	Life form	Distribution		
					N	SE	Both sides
V Fagaceae							
12. <i>Quercus petraea</i>	Q. p.	P	subatl-smed	P	+	+	+
VI Betulaceae							
13. <i>Carpinus betulus</i>	Q. p.	P	gemässkont-smed	P	-	+	-
14. <i>C. orientalis</i>	Q. p.	P	balc-smed	P	+	-	-
15. <i>Ostrya carpinifolia</i>	Q. p.	P	osmed	P	+	+	+
VII Cannabaceae							
16. <i>Humulus lupulus</i>	Che.	T	euras-smed,circ	H	-	+	-
VIII Crassulaceae							
17. <i>Sedum acre</i>	S.-C.	S	(no-)eurassubozean (-smed)	Ch	+	+	+
18. <i>S. album</i>	S.-C.	S	(pralp)smed-subatl	Ch	+	+	+
19. <i>S. dasyphyllum</i>	Amp.	P	alp-pralp-smed	Ch	+	+	+
20. <i>S. maximum</i>	Amp.	P	osmed-gemässkont	H	+	+	+
21. <i>S. ochroleucum</i>	Amp.	P	med	Ch	+	+	+
22. <i>S. sexangulare</i>	Amp.	P	gemässkont-osmed	Ch	+	-	-
23. <i>Sempervivum tectorum</i>	Amp.	P	pralp	Ch	+	-	-
IX Saxifragaceae							
24. <i>Saxifraga aizoon</i>	Amp.	P	pralp-alp-arkt (subozean) circ	Ch	-	+	-
25. <i>S. rotundifolia</i>	F.	P	pralp	H	-	+	-
26. <i>S. tridactylites</i>	Che.	T	med-smed(-subatl)	T	+	+	+
X Rosaceae							
27. <i>Crataegus monogyna</i>	P. s.	PS	submed(-subatl)	P	+	+	+
28. <i>Fragaria vesca</i>	P. s.	PS	no-(eurassubozean)	H	-	+	-
29. <i>Geum urbanum</i>	F.	P	eurassubozean-smed	H	+	+	+
30. <i>Potentilla micrantha</i>	F.	P	smed	H	+	+	+
31. <i>P. recta</i>	B. e.	S	omed-kont	H	+	-	-
32. <i>P. tommasiniana</i>	S.-C.	S	s. o. eur	H	-	+	-
33. <i>P. domestica</i>	Che.	T	n-persia	P	+	-	-
34. <i>P. spinosa</i>	P. s.	PS	eurassubozean-smed	P	+	-	-
35. <i>Rosa canina</i>	P. s.	PS	eurassubozean-smed	P	+	+	+
36. <i>R. glauca</i>	P. s.	PS	pralp(-smed)	P	-	+	-
37. <i>Rubus caesius</i>	Ade.	PS	euras(subozean)-smed	P	+	-	-
38. <i>R. discolor</i>	P. s.	PS	(no-)subatl(-smed)	P	+	+	+
39. <i>Sanguisorba minor</i>	B. e.	S	smed	H	+	-	-
40. <i>S. muricata</i>	B. e.	S	med(-kont)	H	+	+	+
XI Fabaceae							
41. <i>Anthyllis vulneraria</i>	B. e.	S	smed-subatl	H	-	+	-
42. <i>Coronilla emerus</i> ssp. <i>emeroides</i>	Q. p.	P	o(smed)	P	+	+	+

The name of the species	Phytocoenological affiliation	Indicator value	Floral element	Life form	Distribution		
					N	SE	Both sides
43. <i>C. varia</i>	P. s.	SP	gemässkont-osmed	H	+	+	+
44. <i>Cytisus hirsutus</i>	Q. p.	P	osmed	P	-	+	-
45. <i>Dorycnium herbaceum</i>	B. e.	S	omed-smed	Ch	+	+	+
46. <i>Genista janauensis</i>	E.-P.	P	din-so-alp	P (Ch)	+	-	-
47. <i>G. sagittalis</i>	B. e.	S	subatl-smed(-pralp)	H	+	-	-
48. <i>G. tinctoria</i>	B. e.	S	eurassubozean(-smed)	P (Ch)	-	+	-
49. <i>Lathyrus pratensis</i>	Arr.	S	euras(subozean)-smed	H	+	+	+
50. <i>L. tuberosus</i>	B. e.	S	euraskont	H	+	-	-
51. <i>Lembotropis nigricans</i>	E.-P.	P	gemässkont-osmed	P	+	+	+
52. <i>Lotus corniculatus</i>	Arr.	S	eurassubozean-smed	H	-	+	-
53. <i>Medicago falcata</i>	B. e.	S	euras(kont)-smed	H	-	+	-
54. <i>M. lupulina</i>	B. e.	S	euras-smed	H (T)	+	+	+
55. <i>M. minima</i>	B. e.	S	med-smed	T	+	-	-
56. <i>Melilotus officinalis</i>	O.	T	eurassubozean(-smed)	H	+	-	-
57. <i>Ononis spinosa</i>	B. e.	S	smed	H (Ch)	+	-	-
58. <i>Trifolium campestre</i>	B. e.	S	smed-subatl	T	-	+	-
59. <i>Vicia cracca</i>	Arr.	S	no-euras	H	+	+	+
60. <i>V. sepium</i>	Arr.	S	eurassubozean	H	+	+	+
61. <i>V. tetrasperma</i>	Arr.	S	smed-eurassubozean	T	+	+	+
XII Anacardiaceae							
62. <i>Ailanthus altissima</i>	Che.	T	china	P	+	-	-
XIII Aceraceae							
63. <i>Acer campestre</i>	F.	P	smed-subatl	P	+	+	+
XIV Linaceae							
64. <i>Linum austriacum</i>	B. e.	S	osmed	H	-	+	-
65. <i>L. catharticum</i>	B. e.	S	eurassubozean-smed	T (H)	+	-	-
XV Geraniaceae							
66. <i>Geranium dissectum</i>	Che.	T	(med)smed-subatl	T	+	+	+
67. <i>G. molle</i>	Arr.	S	med-smed(-subatl)	T	+	+	+
68. <i>G. robertianum</i>	F.	P	eurassubozean-smed	H (T)	+	+	+
XVI Polygalaceae							
69. <i>Polygala comosa</i>	B. e.	S	eurasskont-smed	H	-	+	-
70. <i>P. vulgaris</i>	Arr.	S	subatl(-smed)	H (Ch)	-	+	-
XVI Celastraceae							
71. <i>Euonymus verucossus</i>	Q. p.	P	s. o. eur	P	+	+	+
XVII Rhamnaceae							
72. <i>Frangula rupestris</i>	Amp.	P	balc-apen	P	+	+	+

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					N	SE	Both sides
XIX Euphorbiaceae							
73. Euphorbia amygdaloides	F.	P	subatl-smed	H	-	+	-
74. E. cyparissias	B. e.	S	smed(-euras)	H	+	-	-
75. E. stricta	Che.	T	smed-gemässkont	T	+	-	-
XX Cornaceae							
76. Cornus sanguinea	P. s.	PS	osmed	P	+	+	+
XXI Araliaceae							
77. Hedera helix	Q. p.	P	subatl-smed	Ch (P)	+	+	+
XXII Apiaceae							
78. Athamanta haynaldii	Amp.	P	din	H	-	+	-
79. Bifora radians	O.	T	omed	T	+	-	-
80. Daucus carota	Arr.	S	eurassubozean-smed	H	-	+	-
81. Eryngium amethystinum	S.-C.	S	balc-apen	H	+	-	-
82. E. campestre	B. e.	S	med-smed	H	+	-	-
83. Heracleum sphondylium	F.	P	subatl	H	-	+	-
84. Myrrhis odorata	Ade.	SP	wpralp	H	+	-	-
85. Orlaya grandiflora	S.-C.	S	med-smed	T	+	-	-
86. Pastinaca sativa	Arr.	S	euras-smed	H	-	+	-
87. Peucedanum oreoselinum	Q. p.	P	gemässkont -smed(med)	H	-	+	-
88. Scandix pecten-veneris	B. e.	S	med-smed	T	+	-	-
89. Seseli rigidum	Amp.	P	s. o. din	H	-	+	-
90. Smyrniium perfoliatum	Q. p.	P	osmed	T	+	-	-
XXIII Hypericaceae							
91. Hypericum perforatum	B. e.	SP	eurassubozean -smed	H	+	+	+
XXIV Violaceae							
92. Viola arvensis	Che.	T	eurassubozean	T	-	+	-
XXV Cistaceae							
93. Helianthemum nummu- larium	B. e.	S	smed	Ch	+	+	+
XXVI Brassicaceae							
94. Alliaria officinalis	F.	PS	eurassubozean -smed	H	+	-	-
95. Alyssum murale	S.-C.	S	osmed	Ch	+	-	-
96. Arabis caucasica	Amp.	P	med-südasiat	H (Ch)	-	+	-
97. A. glabra	Ade.	SP	w(pralp)	Ch	+	+	+
98. A. hirsuta	A. f.	P	euras-smed,circ	H (T)	+	+	+
99. A. turitta	Q. p.	P	smed	H	+	+	+
100. Barbarea vulgaris	Che.	T	euras-smed	H	+	-	-
101. Erysimum linarifolium	Amp.	P	s. o. balc	H	+	+	+

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					N	SE	Both sides
102. <i>Malcolmia illyrica</i>	Amp.	P	balc	H	+	-	-
XXVII Resedaceae							
103. <i>Reseda lutea</i>	O.	T	smed-med	H	-	+	-
XXVIII Salicaceae							
104. <i>Populus tremula</i>	Q. r.-p.	PS	no-euras	P	-	+	-
105. <i>Salix caprea</i>	F.	P	no-euras	P	-	+	-
106. <i>S. purpurea</i>	S. p.	P	smed -eurassubozean	P	+	-	-
XXIX Primulaceae							
107. <i>Primula veris</i>	Arr.	S	euras-smed	H	-	+	-
XXX Malvaceae							
108. <i>Malva silvestris</i>	O.	T	smed-euras	H	+	-	-
XXXI Caryophyllaceae							
109. <i>Arenaria serpyllifolia</i>	Che.	T	euras-med,circ	T	+	-	-
110. <i>Cerastium arvense</i>	Arr.	S	eurassubozean -smed,circ	Ch	-	+	-
111. <i>C. caespitosum</i>	Che.	T	no-euras(subozean)	Ch (T)	+	+	+
112. <i>Dianthus kitaibelii</i>	Amp.	P	din	Ch	+	+	+
113. <i>Minuartia bosniaca</i>	Amp.	P	din	Ch	+	+	+
114. <i>Silene otites</i>	Q. p.	P	(gemäss)kont (-smed)	H	+	-	-
115. <i>S. vulgaris</i>	B. e.	S	no-euras-smed	H (Ch)	+	+	+
116. <i>Stellaria media</i>	Che.	T	no-euras-med	T	+	+	+
117. <i>Tunica saxifraga</i>	S.-C.	S	(o)smed	Ch	+	+	+
XXXII Chenopodiaceae							
118. <i>Chenopodium album</i>	Che.	T	no-euras(-med)	T	+	-	-
XXXIII Polygonaceae							
119. <i>Falopia convolvulus</i>	Che.	T	(no-)euras	T	+	-	-
120. <i>Rumex crispus</i>	Che.	T	eurassubozean-smed	H	+	-	-
XXXIV Rubiaceae							
121. <i>Asperula cynanchica</i>	B. e.	S	smed	H	-	+	-
122. <i>Galium aparine</i>	Che.	T	euras(subozean)	T	-	+	-
123. <i>G. corradaefolium</i>	Amp.	P	med	H	+	+	+
124. <i>G. purpureum</i>	S.-C.	S	balc	H	+	+	+
125. <i>G. verum</i>	B. e.	S	euras-smed	H	+	-	-
XXXV Caprifoliaceae							
126. <i>Lonicera caprifolium</i>	P. s.	PS	osmed	P	+	+	+
XXXVI Valerianaceae							
127. <i>Valeriana officinalis</i>	Ade.	SP	gemässkont (-osmed)	H	-	+	-

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					N	SE	Both sides
XXXVII Dipsacaceae							
128. <i>Scabiosa leucophylla</i>	S.-C.	S	din	H	+	+	+
XXXVIII Oleaceae							
129. <i>Fraxinus ornus</i>	Q. p.	P	osmed	P	+	+	+
130. <i>Ligustrum vulgare</i>	P. s.	PS	smed	P	+	+	+
131. <i>Syringa vulgaris</i>	Q. p.	P	s. o. eur	P	+	-	-
XXXIX Convolvulaceae							
132. <i>Calystegia sepium</i>	Che.	T	euras(subocean) -smed	G	+	-	-
133. <i>Convolvulus arvensis</i>	Che.	T	med-smed-euras	G (H)	-	+	-
XL Boraginaceae							
134. <i>Anchusa officinalis</i>	O.	T	gemässkont (-osmed)	H	+	-	-
135. <i>Echium vulgare</i>	O.	T	euras-smed	H	+	-	-
136. <i>Onosma stellulatum</i>	Amp.	P	din	H	+	-	-
XLI Scrophulariaceae							
137. <i>Digitalis ferruginea</i>	Q. p.	P	s. eur	H	+	-	-
138. <i>Euphrasia stricta</i>	B. e.	S	(eurassuboean) subatl (-smed)	T	-	+	-
139. <i>Melampyrum pratense</i>	F.	P	no-eurassuboean	T	-	+	-
140. <i>Scrophularia canina</i>	A. f.	P	smed	H	+	+	+
141. <i>Verbascum phlomoides</i>	O.	T	gemässkont-osmed	H	+	-	-
142. <i>V. thapsus</i>	O.	T	euras-smed	H	+	-	-
143. <i>Veronica acinifolia</i>	Che.	T	smed	T	+	-	-
144. <i>V. chamaedrys</i>	Arr.	S	no-eurassuboean	Ch	+	+	+
145. <i>V. hederifolia</i>	Che.	T	eurassuboean-smed	T	+	-	-
146. <i>V. jacquinii</i>	S.-C.	S	gemässkont	Ch	-	+	-
147. <i>V. persica</i>	Che.	T	sw-asien	T	+	-	-
XLII Plantaginaceae							
148. <i>Plantago lanceolata</i>	Arr.	S	eurassuboean	H	+	-	-
149. <i>P. media</i>	B. e.	S	euras(kont)-smed	H	+	+	+
XLIII Lamiaceae							
150. <i>Acinos arvensis</i>	S.-C.	S	smed-euras	T (Ch)	+	+	+
151. <i>A.hungaricus</i>	S.-C.	S	europkont	T (Ch)	+	-	-
152. <i>Ajuga chamaepitys</i>	F.-S.	T	med-smed	H (T)	+	-	-
153. <i>Ballota nigra</i>	Che.	T	osmed-gemässkont	H (Ch)	+	-	-
154. <i>Clinopodium vulgare</i>	P. s.	PS	euras-smed	H	-	+	-
155. <i>Lamiastrum galeobdolon</i>	F.	P	gemässkont	Ch	+	-	-
156. <i>Lamium purpureum</i>	Che.	T	(no-)euras-smed	T (H)	-	+	-
157. <i>Micromeri athymifolia</i>	Amp.	P	balc	Ch	+	+	+
158. <i>Origanum vulgare</i>	Q. p.	SP	euras-smed	H (Ch)	+	-	-

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					N	SE	Both sides
159. <i>Stachys recta</i>	B. e.	S	smed(-gemässkont)	H	+	+	+
160. <i>Teucrium chamaedrys</i>	B. e.	S	smed-med	Ch	+	+	+
161. <i>Thymus praecox</i> ssp. <i>jankae</i>	Amp.	P	balc	Ch	+	+	+
162. <i>T. serpyllum</i>	B. e.	S	europkont	Ch	-	+	-
XLIV Campanulaceae							
163. <i>Campanula cervicaria</i>	P. s.	SP	gemässkont(-smed)	H	+	-	-
164. <i>C. rapunculus</i>	B. e.	SP	smed-euras	H	-		-
165. <i>C. rotundifolia</i>	Amp.	P	(no-)eurassubozean	H	-	+	-
166. <i>C. rotundifolia</i> f. <i>albiflora</i>	Amp.	P	(no-)eurassubozean	H	-	+	-
167. <i>C. trachelium</i>	P. s.	PS	eurassubozean-smed	H	+	+	+
168. <i>Edraianthus jugoslavicus</i>	Amp.	P	s. o. balc	H	-	+	-
XLV Asteraceae							
169. <i>Achillea millefolium</i>	Arr.	S	no-eurassubozean	H (Ch)	+	-	-
170. <i>Anthemis tinctoria</i>	O.	T	euras(kont)smed	H	+	-	-
171. <i>Artemisia absinthium</i>	Art.	T	euraskont(-smed)	Ch (H)	+	-	-
172. <i>A. vulgaris</i>	Art.	T	eurassubozean	Ch (H)	+	-	-
173. <i>Carduus crispus</i>	O.	T	eurassubozean	H	+	+	+
174. <i>Centaurea rhenana</i>	S.-C.	S	s. o. kont	H	+	-	-
175. <i>C. scabiosa</i>	B. e.	S	eurassubozean-smed	H	-	+	-
176. <i>Chondrilla juncea</i>	Amp.	P	med-smed-kont	H	+	+	+
177. <i>Cirsium arvense</i>	Che.	T	no-euras-smed	G	+	-	-
178. <i>C. oleraceum</i>	Che.	T	euras(kont)	H	+	+	+
179. <i>Crepis biennis</i>	Arr.	S	gemässkont	H	+	-	-
180. <i>Crupina vulgaris</i>	S.-C.	S	smed	H	+	-	-
181. <i>Echinops sphaerocephalus</i>	O.	T	med-smed(-euras)	H	+	-	-
182. <i>Eupatorium cannabinum</i>	Ade.	SP	eurassubozean-smed	H	+	-	-
183. <i>Hieracium cymosum</i>	B. e.	S	no-gemässkont	H	+	-	-
184. <i>H. murorum</i>	F.	P	no-eurassubozean	H	+	+	+
185. <i>H. villosum</i>	Amp.	P	alp	H	-	+	-
186. <i>H. waldsteinii</i>	Amp.	P	din	H	+	+	+
187. <i>Hypochoeris radicata</i>	Arr.	S	subatl(-smed)	H	+	-	-
188. <i>Inula conyza</i>	Q. p.	P	smed(-euras)	H	+	+	+
189. <i>Leontodon crispus</i>	Amp.	P	balc	H	+	+	+
190. <i>Leucanthemum vulgare</i>	Arr.	S	eurassubozean	H	-	+	-
191. <i>Mycelis muralis</i>	F.	P	subatl-smed	H	-	+	-
192. <i>Picris hieracioides</i>	B. e.	S	euras(kont)-smed	H	+	+	+
193. <i>Sonchus arvensis</i>	Sec.	T	no-eurassubozean	H	+	+	+
194. <i>S. oleraceus</i>	Che.	T	euras-smed-med	T (H)	+	-	-
195. <i>Stenactis annua</i>	Che.	T	n-am	H	+	-	-
196. <i>Tanacetum parthenifolium</i>	O.	T	omed	H	+	-	-
197. <i>Taraxacum officinale</i>	Arr.	S	no-euras(subozean)	H	+	+	+
198. <i>Tussilago farfara</i>	Che.	T	no-euras-smed	G (H)	+	+	+

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					N	SE	Both sides
XLVI Liliaceae							
199. <i>Allium carinatum</i>	Amp.	P	smed(-subatl)	G	+	-	-
200. <i>A. sphaerocephalum</i>	Amp.	P	balc	G	+	+	+
XLVII Dioscoreaceae							
201. <i>Tamus communis</i>	Q. p.	PS	smed(atl)	G	-	+	-
XLVIII Cyperaceae							
202. <i>Carex humilis</i>	Q. p.	P	(euras)kont-smed	H	+	-	-
203. <i>C. silvatica</i>	F.	P	subatl(-smed)	H	-	+	-
XLIX Poaceae							
204. <i>Agropyron repens</i>	P. m.	T	no-euras	H (G)	+	+	+
205. <i>Alopecurus pratensis</i>	Arr.	S	no-euras	H	-	+	-
206. <i>Arrhenatherum elatius</i>	Arr.	S	subatl-smed	H	+	+	+
207. <i>Bromus erectus</i>	B. e.	S	smed	H	+	+	+
208. <i>B. sterilis</i>	Che.	T	smed	T	+	-	-
209. <i>Chrysopogon gryllus</i>	S.-C.	S	med-smed	H	-	+	-
210. <i>Cynosurus cristatus</i>	Arr.	S	subatl(-smed)	H	+	-	-
211. <i>Dactylis aschersoniana</i>	Q. p.	P	gemässkont	H	+	-	-
212. <i>D. glomerata</i>	Arr.	S	euras(-smed)	H	+	-	-
213. <i>Danthonia alpina</i>	S.-C.	S	osmed(-europkont)	H	-	+	-
214. <i>Festuca amethystina</i>	B. e.	S	opralp(gemässkont)	H	-	+	-
215. <i>F. rubra</i>	Arr.	S	no-euras,circ	H	-	+	-
216. <i>Hordeum murinum</i>	Che.	T	smed-med	H	+	-	-
217. <i>Koeleria pyramidata</i>	B. e.	S	subatl-smed	H	+	-	-
218. <i>Lolium perenne</i>	Arr.	S	subatl-smed	H	+	-	-
219. <i>Melica ciliata</i>	Amp.	P	smed	H	+	+	+
220. <i>M. nutans</i>	F.	P	no-euras(kont)	H (G)	-	+	-
221. <i>Milium effusum</i>	F.	P	eurassubozean	H	-	+	-
222. <i>Poa pratensis</i>	Arr.	S	euras(kont)(-smed)	H (G)	+	+	+
223. <i>P. trivialis</i>	Arr.	S	no-euras(subozean)	H (Ch)	+	+	+
224. <i>P. vivipara</i>	Arr.	S	euras(kont)(-smed)	H (G)	+	+	+
225. <i>Sesleria angustifolia</i>	Amp.	P	balc	H	-	+	-
226. <i>S. autumnalis</i>	Q. p.	P	balc	H	+	+	+
227. <i>S. ujkelyii</i>	Amp.	P	din	H	+	+	+
228. <i>Stipa calamagrostis</i>	Amp.	P	pralp-smed	H	+	+	+
TOTAL:					167	145	91
49 families					41	43	29
228 taxa							
18 phytocoenological orders					17	15	14

Abbreviations:

Abbreviations for indicator values: P – primary, PS – primary secondary, S – secondary, SP – secondary primary, and T – tertiary vegetation.

Abbreviations for phytocoenological orders arranged alphabetically: Ade. – *Adenostyletalia*, Amp. – *Amphoricarpetalia*, A. f. – *Arabidetalia flavescentis*, Arr. – *Arrhenatheretalia*, Art. – *Artemisietalia*, B. e. – *Brometalia erecti*, Che. – *Chenopodietalia*, E.-P. – *Erico-Pinetalia*, F. – *Fagetalia*, F.-S. – *Festuco-Sedetalia*, O. – *Onopordetalia*, P. m. – *Plantaginietalia maioris*, P. s. – *Prunetalias pinosae*, Q. p. – *Quercetalia pubescentis*, Q. r.-p. – *Quercetalia robori-petraeae*, S. p. – *Salicetalia purpureae*, S.-C. – *Scorzonero-Chrysopogonetalia*, Sec. – *Secalinetalia*.

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

Table 2. Taxonomic analysis of the flora of the entire investigated area

Taxa	Pteridophyta	Angiospermae		Total
		Dicotyledones	Monocotyledones	
Families	2	43	4	49
Genera	4	154	20	178
Species and forms	5	193	30	228
%	2.19	84.64	13.15	100

Table 3. The most important families of the entire investigated area

Families	Number of taxa	% of total
<i>Asteraceae</i>	30	13.15
<i>Poaceae</i>	25	10.96
<i>Fabaceae</i>	21	9.21
<i>Rosaceae</i>	14	6.14
<i>Lamiaceae</i>	13	5.70
<i>Apiaceae</i>	13	5.70
<i>Scrophulariaceae</i>	11	4.82
<i>Caryophyllaceae</i>	9	3.94

Table 4. Spectrum of floral elements for the entire investigated area and for individual sides of the investigated area

Floral element	An established number in the entire research area	Total number	Participation (in %)	North side			Southeastern side		
				An established number	Total number	Participation (in %)	An established number	Total number	Participation (in %)
din	8	10	4.38%	5	6	3.59%	6	7	4.82%
s. o. din	1			-			1		
din-so-alp	1			1			-		
balc	8	13	5.70%	7	11	6.58%	7	10	6.89%
s. o. balc	2			1			2		
balc-apen	2			2			1		
balc-smed	1			1			-		
s. eur	1	4	1.75%	1	3	1.79%	-	2	1.37%
s. o. eur	3			2			2		
alp	1	2	0.87%	-	1	0.59%	1	2	1.37%
alp-pralp-smed	1			1			1		
pralp	2	8	3.50%	1	4	2.39%	1	6	4.13%
wpralp	1			1			1		
w(pralp)	1			1			-		
pralp-alp-arkt(subocean)circ	1			-			1		
pralp-smed	1			1			1		
pralp(-smed)	1			-			1		
opralp(gemässkont)	1			-			1		
smed	13	48	21.05%	12	39	23.35%	8	33	22.75%
(pralp)smed-subatl	1			1			1		
(med)smed-subatl	1			1			1		
osmed	8			6			6		
osmed(-europkont)	1			-			1		
osmed-gemässkont	2			2			1		
smed(atl)	1			-			1		
smed(-subatl)	1			1			-		
smed-subatl	4			2			3		
smed-subatl.(circ)	1			1			1		
smed(-gemässkont)	1			1			1		
smed- gemässkont	1			1			-		
smed-med	3			2			2		
smed-euras	3			2			2		
smed(-euras)	2			2			1		
smed-eurassubozean	2			2			1		
o(smed)	1			1			1		
(o)smed	1			1			1		
submed(-subatl)	1			1			1		
omed	2			2			-		
omed-smed	1			1			1		
omed-kont	1			1			-		
med(-kont)	1			1			1		
med	2			2			2		

Floral element	An established number in the entire research area	Total number	Participation (in %)	North side			Southeastern side		
				An established number	Total number	Participation (in %)	An established number	Total number	Participation (in %)
med-smed	6	19	8.33%	5	17	10.17%	1	11	7.58%
med-smed- Euras	1			-			1		
med-smed(-Euras)	1			1			-		
med-smed-kont	1			1			1		
med-smed(-subatl)	2			3			3		
med-südasiat	1			-			1		
subatl	1	15	6.57%	-	9	5.38%	1	10	6.89%
subatl(-smed)	4			2			2		
subatl-smed	7			5			5		
(eurassubozean)subatl(-smed)	1			-			1		
(no-)subatl(-smed)	1			1			1		
subatl-smed(-pralp)	1			1			-		
Euras(kont)	1	31	13.59%	1	23	13.77%	1	16	11.03%
Euras(kont)smed	1			1			-		
Euras(kont)-smed	3			2			3		
Euras(kont)(-smed)	2			2			2		
Euras(subozean)	2			1			1		
Euras(subozean)-smed	3			3			1		
Euras(-smed)	1			1			-		
Euras-smed	10			6			4		
Euras-smed.circ	2			1			2		
Euras-smed-med	1			1			-		
Euras-med	1			1			-		
Euras-med.circ	1			1			-		
(no-)Euras	1			1			-		
(no-)Euras-smed	1			-			1		
(no-)Euras-smed.circ	1			1			1		
no-Euras(-med)	1	23	10.08%	1	15	8.98%	-	19	13.10%
no-Euras-med	1			1			1		
no-Euras-smed	3			3			2		
no-Euras	5			2			5		
no-Euras.circ	1			-			1		
no-Euras(subozean)	3			3			3		
no-Euras(kont)	1			-			1		
no-Eurassubozean-pralp	1			-			1		
no-Eurassubozean	5			4			4		
no-(Eurassubozean)	1			-			1		
no-gemässkont	1			1			-		
eurassubozean	8	29	12.71%	5	19	11.37%	6	21	14.48%
eurassubozean-smed	15			12			10		
eurassubozean-smed.circ	1			-			1		
eurassubozean(-smed)	2			1			1		
(no-)eurassubozean	2			-			2		
(no-)eurassubozean(-smed)	1			1			1		
euraskont(-smed)	1	3	1.31%	1	2	1.19%	-	1	0.68%
euraskont	1			1			-		
euraskont-smed	1			-			1		
(gemäss)kont(-smed)	1	5	2.19%	1	4	2.39%	-	1	0.68%
(Euras)kont-smed	1			1			-		
s. o. kont	1			1			-		
europkont	2			1			1		
gemässkont	4	14	6.14%	3	10	5.98%	1	6	4.13%
gemässkont-osmed	4			4			2		
gemässkont-smed	1			-			1		
gemässkont-smed(med)	1			-			1		
gemässkont(-osmed)	2			1			1		
gemässkont(-smed)	2			2			-		
n-persien	1	1	0.43%	1	1	0.59%	-	-	-
china	1	2	0.87%	1	2	1.19%	-	-	-
sw-asien	1			1			-		
n-am	1	1	0.43%	1	1	0.59%	-	-	-
Total number of floral elements: 17				17			14		
Total number of individual floral elements: 103				82			75		
TOTAL:	228	228	100%	167	167	100%	145	145	100%

Vascular aquatic macrophytes of Hutovo Blato Nature Park (Bosnia and Herzegovina)

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Scientific paper

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Abstract: A detailed study of aquatic macrophytes in the area of Nature Park Hutovo Blato was made during the vegetation seasons from 1998 to 2020. In total, 172 plant taxa from 44 families were presented in the list, out of which 16 are newly discovered, where the presence of 10 previously reported taxa was not confirmed. The families with the highest number of taxa were Cyperaceae with 26 taxa (15.12%), followed by Poaceae (15 taxa, 8.82%). The predominant life forms are eucochlorophytes and uliginosophytes with 30 and 28 taxa respectively (17.44% and 16.28%). The chorological spectrum shows a strong prevalence of widespread plants (63 taxa; 36.63%).

Keywords: biodiversity, Mediterranean, vascular plants, wetlands

INTRODUCTION

The Hutovo Blato wetland is situated 20 km inland from the Adriatic Sea in southern Bosnia and Herzegovina. This area was classified as a Nature Park in 1995. It was listed in the Ramsar Convention as an internationally protected wetland in 2001. The total area of Hutovo Blato Park covers 74 km².

Hutovo Blato is partially crypto-depressing, topographically situated on the left bank of the river Neretva, about 5 km southeast of the town of Čapljina. Except on the NW side, the area is completely closed off with karst-mountains. With a limestone ridge called Ostrvo, which descends gradually from the point of Budisavina towards the northwest up to the river Krupa, Hutovo Blato is divided into two morphological units, which in recent times do not have a hydrographic functional connection. Gornje Blato is still a natural morphological unit, but since 1973 due to a manmade dam, Donje or Svitavsko Blato has been turned into Svitavsko Lake. Gornje Blato has retained its natural features and it consists of five separate lakes, namely: Deransko, Škrka, Jelim, Drijen, and Orah (Fig. 1). They are connected by canals and the river Krupa. The river Krupa also drains the hydrological system of Hutovo Blato into the river Neretva (Spahić, 1986).

The geology consists mostly of Cretaceous limestone and Eocene flysh (Hrvatović, 2006). According to Slišković et al. (1962), Eocene flysh occurs only in a narrow zone between

Cretaceous limestones, particularly in the area of Donje Blato. The climate is subMediterranean, with short mild winters with abundant rainfall and long hot summers. With its geographic location and great openness toward the Neretva valley and the sea, the aquatic complex and its surroundings have very prominent Mediterranean influences. The mean annual temperature is 14.6°C (data for the nearest station of Ljubuški for the period 1971-2000, recorded by the Federal Hydrometeorological Institute of the Bosnia and Herzegovina. The average annual rainfall is 1333 mm. The driest month is July with 41 mm of rainfall. With an average of 185 mm, the most precipitation falls in December. The warmest month of the year is July, with an average monthly temperature above 23°C. January has the lowest average temperature of the year, around or above 5°C. The two principal types of ecosystems predominate in the park, the aquatic (60% of the total surface area of the park) and the terrestrial (Jasprica & Carić, 2002). (Fig. 1)

Information about the plant life of Hutovo Blato can be gathered from different works on the topic (Bajić, 1954, 1977; Riter-Studnička, 1975; Bajić & Riter-Studnička, 1978; Lakušić et al., 1982; Bjelčić, 1985, 1988; Lovrić & Rac, 1988; Jasprica & Carić, 2002; Jasprica & Buntić, 2003; Jasprica et al., 2003; Šilić, 2006; Jasprica, 2007, 2009; Hafner et al., 2013; Maslo, 2014). Although there is no published systematic checklist of the vascular flora of the Hutovo Blato Nature Park, according to



Figure 1. Location of the researched area. 1. Škrka 2. Jelim 3. Drijen 4. Orah 5. Deransko and 6. Svitavsko Lake, 7. Krupa River (map by Spahić 1986)

all acquired literature data (see References), and my own field observations, the preliminary list of the vascular flora of Hutovo Blato consists of 793 taxa.

According to Jasprica (2009), the Hutovo Blato aquatic vegetation consists of three ecologically distinguishable vegetation types:

- Free-floating communities that cover the surface of stagnant waters and the edges of poorly flowing streams (Lemnetea).
- The submerged plants and plants rooted in the bottom, the vegetational organs of which develop near or at the water surface (Potametea).
- Helophytic marshes, the park's dominant vegetation (*Phragmites australis*-*Caricetea elatae*).

In total, 45 plant communities (associations) within 16 vegetation classes were documented in the park (Jasprica, 2009).

MATERIALS AND METHODS

Aquatic macrophytes are aquatic photosynthetic organisms, large enough to be seen with the naked eye, that actively grow permanently or periodically submerged below, floating on, or growing up through the water surface (Chambers et al., 2007). Only vascular macrophytes (Pteridophyta and Spermatophyta) were analysed in this work (except trees and shrubs). Even plant species which occur in ephemeral waterbodies (seasonally filled and refilled waters, such as floodplains and temporary ponds) are included in this work.

This study is based on all acquired literature data and my own field investigations carried out from the spring of 1998 to the end of 2020. The nomenclature follows the Euro-Med checklist (EURO+MED, 2020).

In the list of vascular flora (Appendix 1), taxa were listed in the alphabetic order. Designations for: family, life form, chorotype, endemic/threatened status, invasion status, residence time, origin, and first records are provided. The

life-form categories follow Hejný (1957, 1971) and Hejný & Segal (1998) (Appendix 1). Data on the life-forms were taken mostly from the available literature (Hejný, 1957, 1971; Hejný & Husak, 1978; Hejný & Segal, 1998; Jasprica, 2007) (Appendix 1). The analysis of the chorological types was made according to Horvatić (1963) and Horvatić et al. (1976/1968). To indicate the degree of naturalization of a taxon, I used the terms casual, naturalized and invasive, following the definition of Richardson et al. (2000), elaborated by Pyšek et al. (2004) (Appendix 1). Archaeophytes and neophytes were differentiated depending on their introduction before or after 1492/1500 AD., respectively. Abbreviations for endangered taxa are given according to Đug et al. (2013).

RESULTS

The list of the macrophyte flora of the Nature Park Hutovo Blato contains a total of 172 taxa, which is 21.69% of the complete flora of the park (793 taxa). They are classified into 98 genera and 44 families. Families with the highest number of taxa (species and subspecies) were Cyperaceae with 26 taxa (15.12%), followed by Poaceae (15 taxa, 8.82%). The most abundant genera are *Carex* (9 taxa), *Potamogeton* (7 taxa), *Ranunculus* (7 taxa), and *Cyperus* (5 taxa) (Tab. 1). The floristic diversity of aquatic macrophytes of Hutovo Blato Nature Park is compared to that reported for the selected wetlands in Bosnia and Herzegovina (Tab. 2), (Fig. 2).

An analysis of the life forms of the flora of Hutovo Blato (Fig. 2) shows the dominance of euochtophytes with 30 (17.44%), uliginosphytes 28 taxa (16.28%), hydroochtophytes 18 taxa (10.47%), and pelocototherophytes 17 taxa (9.88%). These four groups of life forms together make up more than half of all taxa of macrophytes (54.07%) and they belong to helophytic marshes vegetation (*Phragmites australis*-*Caricetea elatae*) which is, according to Jasprica (2009), the park's dominant

Table 1. The most abundant families and genera of the vascular macrophyte flora of Hutovo Blato

Families	No. of taxa	% of total flora (172)	Genera	No. of taxa	% of total flora (172)
Cyperaceae	26	15.12	<i>Carex</i>	9	5.23
Poaceae	15	8.82	<i>Potamogeton</i>	7	4.07
Compositae	12	6.98	<i>Ranunculus</i>	7	4.07
Lamiaceae	10	5.81	<i>Cyperus</i>	5	2.91
Total	172	100.00	Total	172	100.00

Table 2. A comparison of the floristic diversity of aquatic macrophytes between Hutovo Blato Nature Park and the selected wetlands in Bosnia and Herzegovina.

Wetland	No. of taxa	Reference
HutovoBlato Nature Park	172	
Bardača	100	Kovačević (2015)
BuškoBlato	42	Šilić & Abadžić (1989)
VelikaTišina	129	Bjelčić (1954)

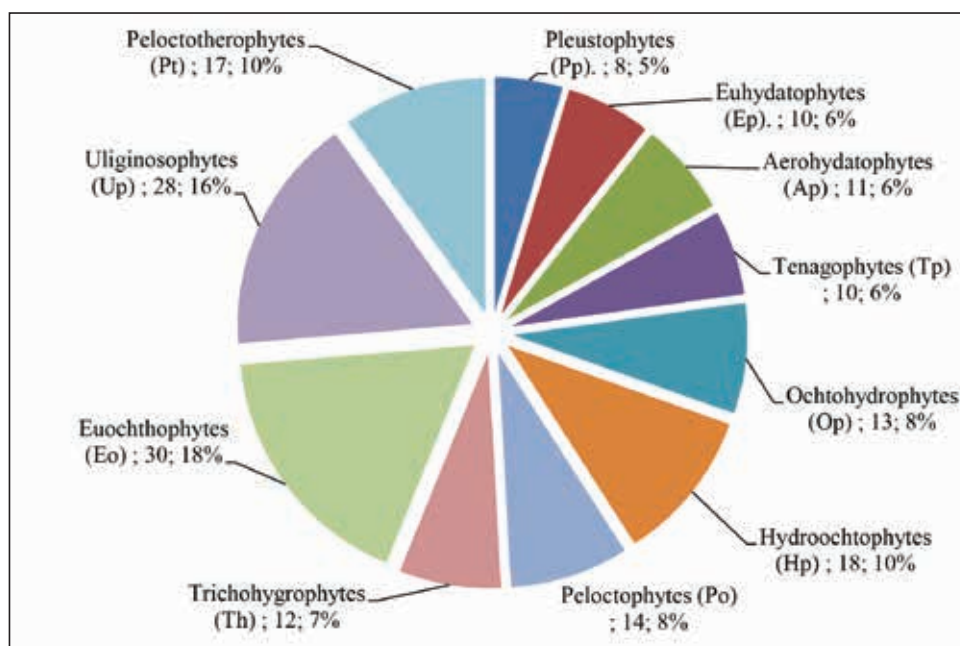


Figure 2. Life form spectrum of the macrophytes in Hutovo Blato

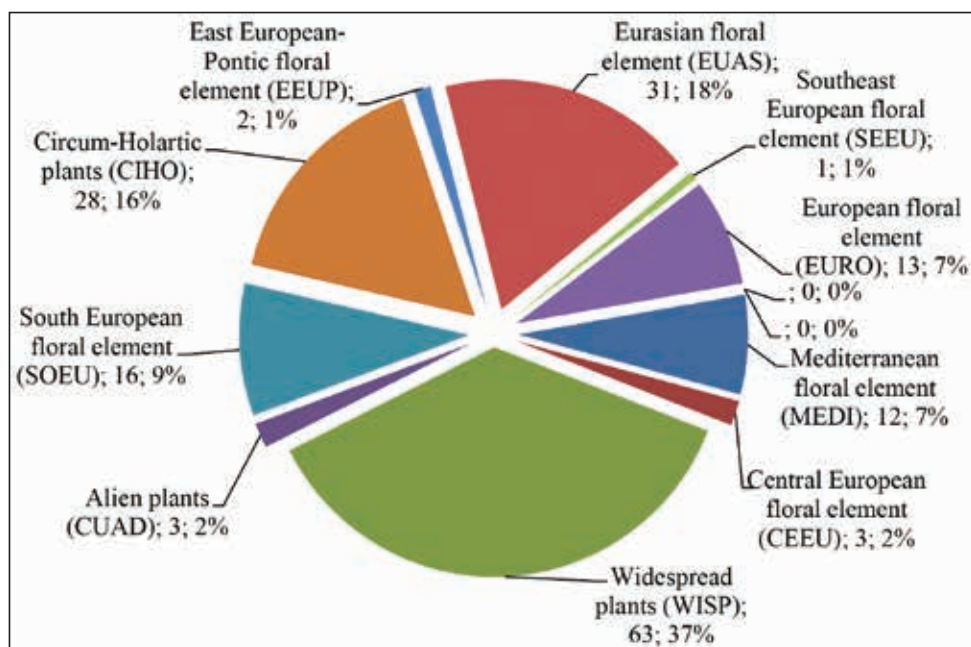


Figure 3. The chorological spectrum of the vascular macrophytes flora of Hutovo Blato

category. The least abundant life form is pleustophytes with only 8 taxa (4.65%).

In the chorological spectrum (Fig. 3), widespread plants are dominant (63 taxa; 36.63%), followed by the Eurasian floral element and Circum-Holarctic plants, 31 respective 28 taxa (18.02% and 16.28%). It is important to stress that the South-east European floral element is represented by only one species. Only three alien species were recorded in the area of the nature park (*Bidens frondosa*, *Elodea canadensis* and *Paspalum*

distichum) and all were recently included in the Preliminary list of invasive alien plant species (IAS) in Bosnia and Herzegovina (Maslo, 2016b). Only one taxon has the status of endemic plant (*Rorippa lippizensis*) and 17 taxa (9.88%) are considered to be threatened (Šilić, 1996; Đug et al. 2013), (Fig. 3).



Figure 4. Some threatened taxa of the vascular macrophytes flora of Hutovo Blato: **a.** *Baldellia ranunculoides* (L.) Parl. **b.** *Butomus umbellatus* L. **c.** *Hippuris vulgaris* L. **d.** *Hydrocharis morsus-ranae* L. **e.** *Hydrocotyle vulgaris* L. **f.** *Lathyrus palustris* L. **g.** *Ludwigia palustris* (L.) Elliott. **h.** *Nymphaea alba* L. **i.** *Utricularia australis* R.Br. (Photo: Semir Maslo).

DISCUSSION AND CONCLUSIONS

Although the flora of the Nature Park Hutovo Blato is relatively well studied, no comprehensive check-list of vascular flora has existed so far. In the researched area, a total of 793 vascular plant taxa were recorded. Even the aquatic ecosystem predominates in the park, (60% of the total surface area of the park) (Jasprica & Carić, 2002), only 172 plant taxa (21.69% of the total flora) were recognized as macrophytes.

Altogether, 16 taxa were recorded for the first time in the area: *Alisma lanceolatum*, *Alopecurus rendlei*, *Carex cuprina*, *Carex vesicaria*, *Carex vridula*, *Chaiturus marrubiastrum*, *Cirsium creticum*, *Epilobium hirsutum*, *Inula britannica*, *Lathyrus palustris*, *Mentha longifolia*, *Ranunculus circinatus*, *Rorippa lippizensis*, *Rumex aquaticus*, *Sonchus arvensis* subsp. *uliginosus*, and *Teucrium scordium* subsp. *scordioides*. Out of the 156 macrophytes previously registered for the Hutovo Blato area, 10 taxa were not confirmed by this research (*Epilobium palustre*, *Isolepis setacea*, *Jacobaea paludosa*, *Marsilea quadrifolia*, *Pulicaria vulgaris*, *Ranunculus ophioglossifolius*, *Ranunculus sceleratus*, *Sagittaria sagittifolia*, *Triglochin palustris* and *Utricularia vulgaris*). Some unconfirmed species probably exist on the researched area but were overlooked. Others probably disappeared during the last 120 years due to anthropogenic impact.

According to a proposal for the Red Book of the flora of Bosnia and Herzegovina (Šilić, 1996) and the Red list of the

flora in the Federation of Bosnia and Herzegovina (Đug et al. 2013), 42 taxa of the total flora (5.30%) are considered to be threatened in the area of Nature Park Hutovo Blato. Even the majority of endangered species are also present on rocky grasslands but 17 taxa of macrophytes belong to some threat category: 2 Critically endangered (CR) taxa: *Baldellia ranunculoides*, *Ludwigia palustris*; 1 Endangered (EN) taxon: *Hottonia palustris*; 9 Vulnerable (VU) taxa: *Hippuris vulgaris*, *Hydrocharis morsus-renae*, *Marsilea quadrifolia*, *Nuphar lutea*, *Nymphaea alba*, *Sagittaria sagittifolia*, *Thelypteris palustris*, *Utricularia vulgaris*, *Veronica anagalloides*; 1 Least concern (LC) taxon: *Botrys umbellatus*. Additionally, 4 taxa are regarded as Data deficient (DD): *Hydrocotyle vulgaris*, *Lathyrus palustris*, *Utricularia australis*, *Zannichella palustris*.

The anthropogenic influence on the biodiversity of macrophytes in the area has been highly expressed in the last 60 years. Despite major past changes in the Hutovo Blato area, as part of Nereva River Delta, it is still one of the most important areas for biodiversity conservation on the eastern Adriatic coast.

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SAŽETAK

U razdoblju između 1998. i 2020. godine izvršena su floristička istraživanja makrofita na području Parka prirode Hutovo Blato. U rezultatima su navedene ukupno 172 biljne svojte iz 44 porodice, od kojih se 17 prvi put navodi za istraženo područje, dok 10 prethodno zabilježenih svojti nije potvrđeno u ovom istraživanju. Porodice s najvećim brojem svojta su Cyperaceae (15,12%) i Poaceae (8,82%). Euhoftiti su dominantni životni oblik (17,44%) dok su biljke širokog rasprostranjenja najzastupljenije (36,63%).

Ključne riječi: bioraznolikost, Mediteran, vaskularne biljke, vodena staništa

APPENDIX 1.

Vascular aquatic macrophytes of Hutovo Blato Nature Park: taxonomy, life form, chorotype, endemic/threatened status, invasion status, residence time, origin, and first record (If the author of the first record is not cited, the species is quoted here for the first time). Legend: Pp-pleustophytes, Ep-Euhydatophytes, Ap-Aerohydatophytes, Tp-Tenagophytes, Op-Ochtohydrophytes, Hp-Hydroochtophytes, Po-Pelocotophytes,

Th-Trichohygrophytes, Eo-Euochtophytes, Up-Uliginosophytes, Pt-Pelocototherophytes; end-endemic species; CR-Critically Endangered, EN-Endangered, VU-Vulnerable, NT-Near Threatened, LC-Least Concern, DD-Data Deficient; CAS-Casual taxa; NAT-Naturalized non-invasive taxa; INV-Invasive taxa; arc-archaeophytes, neo-neophytes; Am-N, North America.

Taxon	Family	Life-form	Chorological types	Threatened taxa	Alien plants (CUAD)			1 st record/author
					Invasion status	Residence time	Origin	
<i>Agrostis stolonifera</i> L.	Poaceae	Th	CIHO					Bajić & Riter Studnička 1978
<i>Alisma lanceolatum</i> With.	Alismataceae	Hp	CIHO					
<i>Alisma plantago-aquatica</i> L.	Alismataceae	Hp	WISP					Bajić & Riter Studnička 1978
<i>Alopecurus geniculatus</i> L.	Poaceae	Eo	EUAS					Lakušić et al 1982
<i>Alopecurus rendlei</i> Eig.	Poaceae	Eo	SOEU					
<i>Althaea officinalis</i> L.	Malvaceae	Up	EEUP					Malý 1910
<i>Anacamptis laxiflora</i> (Lam.) R. M. Bateman, Pridgeon & M. W. Chase	Orchidaceae	Eo	MEDI					Jasprica & Carić 2002
<i>Anacamptis palustris</i> (Jacq.) R. M. Bateman, Pridgeon & M. W. Chase subsp. <i>palustris</i>	Orchidaceae	Eo	EURO					Jasprica & Carić 2002
<i>Atriplex prostrata</i> DC.	Chenopodiaceae	Pt	WISP					Bajić 1954
<i>Baldellia nunculoide s(L.)</i> Parl.	Alismataceae	Hp	CIHO	CR				Bajić 1954
<i>Berula erecta</i> (Huds.) Coville	Apiaceae	Hp	CIHO					Bajić & Riter Studnička 1978
<i>Bidens cernuus</i> L.	Compositae	Pt	EUAS					Bajić & Riter Studnička 1978
<i>Bidens frondosus</i> L.	Compositae	Pt	CUAD		INV	neo	Am-N	Maslo 2014
<i>Bidens tripartitus</i> L.	Compositae	Pt	EUAS					Bajić & Riter Studnička 1978
<i>Bolboschoenus glaucus</i> (Lam.) S. G. Sm.	Cyperaceae	Hp	WISP					Maslo et al 2019
<i>Butomus umbellatus</i> L.	Butomaceae	Hp	EUAS	LC				Bajić & Riter Studnička 1978
<i>Callitriche palustris</i> L.	Plantaginaceae	Tp	WISP					Beck 1927
<i>Callitriche stagnalis</i> Scop.	Plantaginaceae	Tp	EUAS					Bjelčić 1985
<i>Caltha palustris</i> L.	Ranunculaceae	Hp	WISP					Malý 1919
<i>Calystegia sepium</i> (L.) R.Br.	Convolvulaceae	Eo	WISP					Bajić & Riter Studnička 1978
<i>Carex cuprina</i> (Heuff.) A. Kern.	Cyperaceae	Eo	SOEU					
<i>Carex distans</i> L.	Cyperaceae	Eo	EURO					Jasprica & Carić 2002
<i>Carex divisa</i> Huds.	Cyperaceae	Eo	SOEU					Jasprica & Carić 2002

Taxon	Family	Life -form	Chorological types	Threatened taxa	Alien plants (CUAD)			1 st record/author
					Invasion status	Residence time	Origin	
<i>Carex elata</i> All. subsp. <i>elata</i>	Cyperaceae	Eo	EURO					Bajić & Riter Studnička 1978
<i>Carex hirta</i> L.	Cyperaceae	Th	EUAS					Lakušić et al 1982
<i>Carex pseudocyperus</i> L.	Cyperaceae	Up	CIHO					Bajić & Riter Studnička 1978
<i>Carex riparia</i> Curtis	Cyperaceae	Eo	EUAS					Bjelčić 1988
<i>Carex vesicaria</i> L.	Cyperaceae	Eo	CIHO					
<i>Carex viridula</i> Michx.	Cyperaceae	Eo	CIHO					
<i>Ceratophyllum demersum</i> L.	Ceratophyllaceae	Pp	WISP					Bajić & Riter Studnička 1978
<i>Ceratophyllum submersum</i> L.	Ceratophyllaceae	Pp	WISP					Bajić & Riter Studnička 1978
<i>Chaiturus marrubiastrum</i> (L.) Ehrh. ex Rchb.	Lamiaceae	Eo	EEUP					
<i>Cirsium creticum</i> (Lam.) d'Urv.	Compositae	Up	CIHO					
<i>Cladium mariscus</i> (L.) Pohl	Cyperaceae	Op	WISP					Beck 1903
<i>Crypsis alopecuroides</i> (Piller & Mitterp.) Schrad.	Poaceae	Po	MEDI					Bajić 1954
<i>Crypsis schoenoides</i> (L.) Lam.	Poaceae	Po	MEDI					Bajić 1954
<i>Cyperus flavescens</i> L.	Cyperaceae	Po	WISP					Bajić 1954
<i>Cyperus fuscus</i> L.	Cyperaceae	Tp	WISP					Bajić 1954
<i>Cyperus longus</i> L.	Cyperaceae	Op	SOEU					Bajić 1954
<i>Cyperus michelianus</i> (L.) Link	Cyperaceae	Po	SOEU					Bajić 1954
<i>Cyperus serotinus</i> Rottb.	Cyperaceae	Op	CIHO					Bajić 1954
<i>Eleocharis acicularis</i> (L.) Roem. & Schult.	Cyperaceae	Tp	WISP					Bajić 1954
<i>Eleocharis ovata</i> (Roth) Roem. & Schult.	Cyperaceae	Po	CIHO					Malý 1910
<i>Eleocharis palustris</i> (L.) R. Br.	Cyperaceae	Hp	WISP					Bajić & Riter Studnička 1978
<i>Eleocharis quinqueflora</i> (Hartmann) O. Schwarz	Cyperaceae	Po	EURO					Bajić & Riter Studnička 1978
<i>Elodea canadensis</i> Michx.	Hydrocharitaceae	Ep	CUAD		INV	neo	Am-N	Jasprica & Carić 2002
<i>Epilobium hirsutum</i> L.	Onagraceae	Eo	EUAS					
<i>Epilobium palustre</i> L.	Onagraceae	Pt	CIHO					Bajić & Riter Studnička 1978
<i>Epilobium parviflorum</i> Schreb.	Onagraceae	Eo	EUAS					Beck 1927
<i>Equisetum palustre</i> L.	Equisetaceae	Pt	CIHO					Bajić & Riter Studnička 1978
<i>Euphorbia palustris</i> L.	Euphorbiaceae	Up	WISP					Fiala 1893
<i>Fimbristylis bisumbellata</i> (Forssk.) Bubani	Cyperaceae	Po	MEDI					Malý 1910
<i>Galium elongatum</i> C. Presl	Rubiaceae	Up	SOEU					Malý 1910
<i>Galium palustre</i> L.	Rubiaceae	Up	WISP					Bajić & Riter Studnička 1978

Taxon	Family	Life -form	Chorological types	Threatened taxa	Alien plants (CUAD)			1 st record/author
					Invasion status	Residence time	Origin	
<i>Glyceria fluitans</i> (L.) R. Br.	Poaceae	Hp	WISP					Bjelčić 1988
<i>Glyceria maxima</i> (Hartm.) Holmb.	Poaceae	Op	EUAS					Bjelčić 1988
<i>Gratiola officinalis</i> L.	Plantaginaceae	Up	WISP					Beck et al 1967
<i>Hippuris vulgaris</i> L.	Plantaginaceae	Hp	CIHO	VU				Ritter Studnička 1975
<i>Hottonia palustris</i> L.	Primulaceae	Ap	EURO	EN				Beck et al 1967
<i>Hydrocharismorsus-ranae</i> L.	Hydrocharitaceae	Pp	EUAS	VU				Bajić 1954
<i>Hydrocotyle vulgaris</i> L.	Apiaceae	Eo	WISP	DD				Bajić 1954
<i>Hypericum tetrapterum</i> Fr.	Clusiaceae	Eo	EUAS					Malý 1910
<i>Inula britannica</i> L.	Compositae	Eo	EUAS					
<i>Iris pseudacorus</i> L.	Iridaceae	Eo	EUAS					Bajić & Riter Studnička 1978
<i>Isolepis setacea</i> (L.) R. Br.	Cyperaceae	Po	EURO					Bajić 1954
<i>Jacobaea erratica</i> (Bertol.) Fourr.	Compositae	Up	MEDI					Malý 1910
<i>Jacobaea paludosa</i> (L.) G. Gaertn. & al.	Compositae	Up	CEEU					Bajić & Riter Studnička 1978
<i>Juncus anceps</i> Laharpe	Juncaceae	Up	EURO					Bajić & Riter Studnička., 1978
<i>Juncus articulatus</i> L.	Juncaceae	Tp	CIHO					Malý 1910
<i>Juncus bufonius</i> L.	Juncaceae	Po	WISP					Bajić & Riter Studnička 1978
<i>Juncus compressus</i> Jacq.	Juncaceae	Th	WISP					Bajić & Riter Studnička 1978
<i>Juncus subnodulosus</i> Schrank	Juncaceae	Up	WISP					Bajić & Riter Studnička 1978
<i>Laphangium luteoalbum</i> (L.) Tzvelev	Compositae	Po	WISP					Beck et al 1983
<i>Lathyrus palustris</i> L.	Fabaceae	Up	CIHO	DD				
<i>Leersia oryzoides</i> (L.) Sw.	Poaceae	Pt	WISP					Bajić & Riter Studnička 1978
<i>Lemna minor</i> L.	Lemnaceae	Pp	WISP					Bajić & Riter Studnička 1978
<i>Lemnatisulca</i> L.	Lemnaceae	Pp	WISP					Bajić 1954
<i>Leucojum aestivum</i> L.	Amaryllidaceae	Eo	SOEU					Fiala 1896
<i>Lotus angustissimus</i> L.	Fabaceae	Tp	SOEU					Malý 1912
<i>Lotus pedunculatus</i> Cav.	Fabaceae	Tp	EURO					Lakušić et al 1982
<i>Lotus tenuis</i> Willd.	Fabaceae	Tp	WISP					Bajić 1954
<i>Ludwigia palustris</i> (L.) Elliott	Onagraceae	Tp	WISP	CR				Bajić & Riter Studnička 1978
<i>Lycopus europaeus</i> L.	Lamiaceae	Eo	EUAS					Bajić & Riter Studnička 1978
<i>Lysimachianumularia</i> L.	Primulaceae	Th	EURO					Beck et al 1967

Taxon	Family	Life -form	Chorological types	Threatened taxa	Alien plants (CUAD)			1 st record/author
					Invasion status	Residence time	Origin	
<i>Lysimachia vulgaris</i> L.	Primulaceae	Eo	EUAS					Bajić & Riter Studnička 1978
<i>Lythrum hyssopifolia</i> L.	Lythraceae	Po	WISP					Bajić 1954
<i>Lythrum salicaria</i> L.	Lythraceae	Eo	WISP					Beck 1927
<i>Marsilea quadrifolia</i> L.	Marsileaceae	Tp	CIHO	VU				Malý 1905
<i>Mentha aquatica</i> L.	Lamiaceae	Eo	WISP					Riter Studnička 1975
<i>Mentha arvensis</i> L.	Lamiaceae	Th	CIHO					Bjelčić 1988
<i>Mentha longifolia</i> (L.) L.	Lamiaceae	Up	WISP					
<i>Mentha pulegium</i> L.	Lamiaceae	Th	EUAS					Bajić 1954
<i>Molinia caerulea arundinacea</i> Schrank	Poaceae	Op	EUAS					Bajić & Riter Studnička 1978
<i>Myosotis scorpioides</i> L.	Boraginaceae	Eo	CIHO					Beck 1967
<i>Myriophyllum spicatum</i> L.	Haloragaceae	Ap	WISP					Bajić & Riter Studnička 1978
<i>Myriophyllum verticillatum</i> L.	Haloragaceae	Ap	CIHO					Beck 1927
<i>Najas marina</i> L.	Najadaceae	Ep	WISP					Bajić 1954
<i>Najas minor</i> All.	Najadaceae	Ep	WISP					Bajić 1954
<i>Nasturtium officinale</i> W. T. Aiton	Brassicaceae	Eo	WISP					Bajić & Riter Studnička 1978
<i>Nuphar lutea</i> (L.) Sm.	Nymphaeaceae	Ap	EUAS	VU				Beck 1909
<i>Nymphaea alba</i> L.	Nymphaeaceae	Ap	EUAS	VU				Fiala 1893
<i>Nymphoides peltata</i> (S. G. Gmelin) Kuntze	Menyanthaceae	Ap	CIHO					Bajić & Riter Studnička 1978
<i>Oenanthe aquatica</i> (L.) Poir.	Apiaceae	Hp	EUAS					Malý 1910
<i>Oenanthe fistulosa</i> L.	Apiaceae	Hp	WISP					Lakušić et al 1982
<i>Oenanthe silaifolia</i> M. Bieb.	Apiaceae	Hp	SOEU					Malý 1919
<i>Oxybasis glauca</i> (L.) S. Fuentes & al.	Chenopodiaceae	Pp	WISP					Bajić & Riter Studnička 1978
<i>Paspalum distichum</i> L.	Poaceae	Tp	CUAD		INV	neo	Am-N	Bajić 1954
<i>Persicaria amphibia</i> (L.) Delarbre	Polygonaceae	Ap	EUAS					Fiala 1893
<i>Persicaria dubia</i> (Stein) Fourr.	Polygonaceae	Pt	EURO					Malý 1912
<i>Persicaria hydropiper</i> (L.) Delarbre	Polygonaceae	Pt	CIHO					Bajić & Riter Studnička 1978
<i>Persicaria lapathifolia</i> (L.) Delarbre	Polygonaceae	Pt	EUAS					Bajić & Riter Studnička 1978
<i>Persicaria maculosa</i> Gray	Polygonaceae	Pt	WISP					Jasprica & Carić 2002
<i>Peucedanum palustre</i> (L.) Moench	Apiaceae	Op	EURO					Bajić & Riter Studnička 1978
<i>Phalaris aquatica</i> L.	Poaceae	Eo	MEDI					Maslo 2016a
<i>Phalaroides arundinacea</i> (L.) Rauschert	Poaceae	Eo	CIHO					Malý 1919

Taxon	Family	Life-form	Chorological types	Threatened taxa	Alien plants (CUAD)			1 st record/author
					Invasion status	Residence time	Origin	
<i>Phragmites australis</i> (Cav.) Steud.	Poaceae	Op	WISP					Bajić & Riter Studnička 1978
<i>Plantago altissima</i> L.	Plantaginaceae	Po	SOEU					Bajić 1954
<i>Plantago major</i> subsp. <i>intermedia</i> (Gilib.) Lange	Plantaginaceae	Po	CIHO					Bajić 1954
<i>Poa trivialis</i> subsp. <i>sylvicola</i> (Guss.) H.Lindb.	Poaceae	Po	MEDI					Lakušić et al 1982
<i>Polypogonmon speliensis</i> (L.) Desf.	Poaceae	Pt	WISP					Bajić & Riter Studnička 1978
<i>Potamogeton acutifolius</i> Link	Potamogetonaceae	Ep	CEEU					Bajić & Riter Studnička 1978
<i>Potamogeton crispus</i> L.	Potamogetonaceae	Ep	WISP					Fiala 1893
<i>Potamogeton lucens</i> L.	Potamogetonaceae	Ep	WISP					Malý 1919
<i>Potamogeton natans</i> L.	Potamogetonaceae	Ap	WISP					Fiala 1893
<i>Potamogeton nodosus</i> Poir.	Potamogetonaceae	Ap	WISP					
<i>Potamogeton perfoliatus</i> L.	Potamogetonaceae	Ep	WISP					Jasprica et al 2003
<i>Potamogeton pusillus</i> L.	Potamogetonaceae	Ep	WISP					Bajić & Riter Studnička 1978
<i>Potentilla reptans</i> L.	Rosaceae	Th	WISP					Lakušić et al 1982
<i>Pulicaria dysenterica</i> (L.) Bernh.	Compositae	Up	SOEU					Lakušić et al 1982
<i>Pulicaria vulgaris</i> Gaertn	Compositae	Pt	SOEU					Bajić 1954
<i>Ranunculus circinatus</i> Sibth.	Ranunculaceae	Ap	CIHO					
<i>Ranunculus lingua</i> L.	Ranunculaceae	Up	CIHO					Malý 1910
<i>Ranunculus ophioglossifolius</i> Vill.	Ranunculaceae	Up	SOEU					Bajić 1954
<i>Ranunculus repens</i> L.	Ranunculaceae	Th	WISP					Lakušić et al 1982
<i>Ranunculus sardous</i> Crantz	Ranunculaceae	Th	WISP					Beck 1914
<i>Ranunculus sceleratus</i> L.	Ranunculaceae	Pt	EUAS					Bajić & Riter Studnička 1978
<i>Ranunculus trichophyllus</i> Chaix	Ranunculaceae	Ap	EURO					Bajić & Riter Studnička 1978
<i>Rorippa amphibia</i> (L.) Besser	Brassicaceae	Hp	EUAS					Fiala 1896
<i>Rorippa lippizensis</i> (Wulfen) Rchb.	Brassicaceae	Th	SEEU					
<i>Rorippa sylvestris</i> (L.) Besser	Brassicaceae	Th	EUAS					Bajić & Riter Studnička 1978
<i>Rumex aquaticus</i> L.	Polygonaceae	Up	EUAS					
<i>Rumex crispus</i> L.	Polygonaceae	Pt	WISP					Lakušić et al 1982
<i>Rumex hydrolapathum</i> Huds.	Polygonaceae	Up	EURO					Jasprica et al 2003
<i>Sagittaria sagittifolia</i> L.	Alismataceae	Hp	EUAS	VU				Fiala 1896
<i>Samolus valerandi</i> L.	Primulaceae	Up	WISP					Beck et al 1967

Taxon	Family	Life -form	Chorological types	Threatened taxa	Alien plants (CUAD)			1 st record/author
					Invasion status	Residence time	Origin	
<i>Schoenoplectus lacustris</i> subsp. <i>glaucus</i> (Sm.) Bech.	Cyperaceae	Hp	WISP					Bajić 1954
<i>Schoenoplectus lacustris</i> (L.) Palla subsp. <i>lacustris</i>	Cyperaceae	Op	WISP					Beck 1903
<i>Schoenoplectus riqeter</i> (L.) Palla	Cyperaceae	Hp	SOEU					Bajić & Riter Studnička 1978
<i>Scirpoides holoschoenus</i> (L.) Soják	Cyperaceae	Op	MEDI					Bajić & Riter Studnička 1978
<i>Scutellaria galericulata</i> L.	Lamiaceae	Eo	CIHO					Malý 1910
<i>Sium latifolium</i> L.	Apiaceae	Hp	CEEU					Malý 1910
<i>Solanum dulcamara</i> L.	Solanaceae	Up	WISP					Becket al 1967
<i>Sonchus arvensis</i> subsp. <i>uliginosus</i> (M. Bieb.) Nyman	Compositae	Up	WISP					
<i>Sparganium erectum</i> L.	Sparganiaceae	Op	EUAS					Malý 1910
<i>Sparganium neglectum</i> Beeby	Sparganiaceae	Op	CIHO					Bajić & Riter Studnička 1978
<i>Spirodela polyrhiza</i> (L.) Schleid.	Lemnaceae	Pp	WISP					Bjelčić 1988
<i>Stachys palustris</i> L.	Lamiaceae	Up	CIHO					Malý 1910
<i>Stuckenia pectinata</i> (L.) Börner	Potamogetonaceae	Ep	WISP					Bajić 1954
<i>Taraxacum palustre</i> (Lyons) Symons	Compositae	Pt	EUAS					Jasprica et al 2003
<i>Teucrium scordium</i> subsp. <i>scordioides</i> (Schreb.) Arcang.	Lamiaceae	Up	MEDI					
<i>Teucrium scordium</i> L. subsp. <i>scordium</i>	Lamiaceae	Up	EUAS					Becket al 1950
<i>Thelypteris palustris</i> Schott	Thelypteridaceae	Up	WISP	VU				Bajić & Riter Studnička 1978
<i>Trifolium fragiferum</i> L.	Fabaceae	Pt	WISP					Bajić & Riter Studnička 1978
<i>Triglochin palustris</i> L.	Juncaginaceae	Eo	WISP					Bajić 1954
<i>Typha angustifolia</i> L.	Typhaceae	Op	WISP					Bajić & Riter Studnička 1978
<i>Typha latifolia</i> L.	Typhaceae	Op	WISP					Beck 1903
<i>Utricularia australis</i> R.Br.	Lentibulariaceae	Pp	MEDI	DD				Bjelčić 1988
<i>Utricularia vulgaris</i> L.	Lentibulariaceae	Pp	MEDI	VU				Beck et al 1950
<i>Veronica anagallis - aquatica</i> L.	Plantaginaceae	Up	SOEU					Becket al 1967
<i>Veronica anagalloides</i> Guss.	Plantaginaceae	Up	SOEU	VU				Bajić & Riter Studnička 1978
<i>Veronica beccabunga</i> L.	Plantaginaceae	Up	MEDI					Bajić & Riter Studnička 1978
<i>Zannichellia palustris</i> L.	Zannichelliaceae	Ep	WISP	DD				Bajić 1954

Chorological types, according to Horvatić (1963) and Horvatić et al. (1976/1968).

- Mediterranean floral element (MEDI)
- Illyrian-Balkan floral element (ILBA)
- South European floral element (SOEU)
- East European-Pontic floral element (EEUP)
- Southeast European floral element (SEEU)
- Central European floral element (CEEU)
- European floral element (EURO)
- Eurasian floral element (EUAS)
- Circum-Holarctic plants (CIHO)
- Widespread plants (WISP)
- Alien plants (CUAD)

Categories of life forms, modified according to Hejný (1957, 1971).

- Pleustophytes (**Pp**). They are usually a non-rooted group of species occupying the water level. Rooting in the soil occurs only temporarily during the limosalecophase.
- Euhydatophytes (**Ep**). They are a group of species attached to the soil by roots, sporadically by rhizomes. Only submerged leaves are formed. Generative organs develop in the water medium or immediately above the water level.
- Aerohydatophytes (**Ap**). They are a group of species attached to the soil by rhizomes or roots and capable of passing through their life cycle in the hydrophase, littoral, and limosalecophases. These plants develop submerged and floating leaves and generative organs are usually aerial.
- Tenagophytes (**Tp**). They are a group of plants permanently attached to the soil by fine roots and capable of passing through their full life cycle in the littoral and limosalecophases. These plants develop submerged, floating and aerial leaves and generative organs are formed in both water and air.
- Ochtohydrophytes (**Op**). They are a group of plants attached to the soil and capable of passing through their life cycle in the littoral, limosal, and terrestrial ecophases, partly also in the hydrophase. They develop submerged, floating and aerial leaves. Generative organs are usually aerial.
- Hydroochtophytes (**Hp**). They are a group of species attached to the soil by rhizomes or roots and capable of passing through their life cycle in the hydrophase, littoral, limosal, and terrestrial ecophases. They develop aerial or, sporadically, floating leaves.

- Peloctophytes (**Po**). They are a group of species attached to the soil by caespitous roots, and capable of passing through their life cycle in the limosal and terrestrial ecophases. Only areal leaves are developed. The plants survive flooding in anabiosis as generative diaspores.
- Trichohygrophytes (**Th**). They are a group of species adapted to different habitats. Germination, flowering, and maturation of the seed take place in the terrestrial ecophase when the soil is still moist. A long limoseecophase offers favourable conditions and a secondary flooding is tolerated.
- Euochtophytes (**EO**). They are a group of plants which occurs in the littoral ecophase, with a short hydrophase, while the limose phase and the terrestrial phase are prolonged. Only aerial leaves are developed.
- Uliginosophytes (**Up**). Germination and initial growth take place in the littoral ecophase, which is short, or the limoseecophase. The biggest part of the development occurs in the limoseecophase and partly in the terrestrial ecophase.
- Peloctotherophytes (**Pt**). Germination and initial growth take place between limosal and terrestrial ecophases. The greatest part of the development occurs in the terrestrial ecophase. Their growing season is very short. They are a group of species which inhabit ruderal habitats, wet fields, and river banks.

Categories depending on the degree of naturalization: casual taxa (CAS.), naturalized non-invasive taxa (NAT.), and naturalized invasive taxa (INV.) according to Richardson et al. (2000) and Pyšek et al. (2004).

- CASUAL (TRANSIENT, EPHEMERAL) PLANTS. Alien plants that may flourish and even reproduce occasionally in an area, but which do not form self-replacing populations, and which rely on repeated introductions for their persistence.
- NATURALIZED PLANTS. Alien plants that reproduce consistently and sustain populations over many life cycles without direct intervention by humans; they often recruit offspring freely, usually close to adult plants, and do not necessarily invade natural, semi-natural or human-made ecosystems.
- INVASIVE PLANTS (PLANT INVADERS). Naturalized plants that produce reproductive offspring, often in very large numbers, at considerable distances from parent plants, and thus have the potential to spread over a large area.

Sensitivity assessment and extinction risk of amphibians (Chordata: Vertebrata: Amphibia) in Bosnia and Herzegovina

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Abstract: In this paper, we present the sensitivity assessment of amphibians of Bosnia and Herzegovina according to DELH (Distributional, Ecological, Life History) data based on 17 parameters. Most sensitive species of amphibians in Bosnia and Herzegovina are: *Proteus anguinus*, *Salamandra atra*, and *Triturus dobrogicus*, due the specific ecology and small habitat range. Nine amphibian taxa are considered to be moderately sensitive, while nine species probably belong to the low sensitivity group. Results indicate that Caudata are a much more threatened taxonomic group when compared to Anurans.

Keywords: conservation, DELH, Caudata, Anura, Life History, Distribution, Ecology

INTRODUCTION

Amphibians are undoubtedly the world's most endangered class of vertebrates. One-third of them (up to ca. 2000 species) are under direct threat of global extinction (Stuart et al., 2004), and the extinction rate is 25–45 times larger than normal (Malcolm, 2007). Due to their skin sensitivity, amphibians cannot endure many anthropogenic factors (often in combined functioning): habitat devastation, pollution, infectious diseases, climate change, invasive species, and excessive feeding exploitation or pet trade (e.g., Alford et al., 2001; Halliday, 2001; Collins & Strofer, 2003; Malcolm, 2007; Foden et al., 2013). Although these factors are identifiable in Bosnia and Herzegovina, the situation is further hampered by the lack of statutory protection of species, the inefficient exercise of existing law regulations and difficult political divisions in the country, which finally result in a small number of protected areas (0,67% Bosnia and Herzegovina territory: BH-CHM, 2010). Bosnia and Herzegovina with its 23 amphibian species (≈65% of total batrachofauna in the Balkans) is an important area in Southern Europe regarding amphibian diversity (Lelo et al., 2015; Lelo & Zimić, 2020) and proper evaluation of the sensitivity of those species at the national level is required.

In addition to the IUCN concept, species sensitivity assessment can be done based on ecological, biological, geographical, and anthropological parameters – so-called DELH (en. Distribution, Ecology, Life History) variables (Filippi & Luiselli, 2000). They elaborated DELH methodology and applied it for the first time in the sensitivity assessment of snakes in Italy. Soon afterwards, Andreone and Luiselli (2000) applied the same concept to the sensitivity assessment of Italian batrachofauna. So far, DELH assessments in Balkans were carried out on vipers (Jelić et al., 2013), and soon afterwards on the assessment of the reptiles (Tomović et al., 2015) and amphibians (Vukov et al., 2015) in Serbia. It was also applied in Vujanović & Jelić (2015), where the overall fauna of Croatia and Bosnia and Herzegovina was presented as a unique entity.

So far, some of the extinction risk assessments (according to IUCN) for amphibian species in Bosnia and Herzegovina were provided in Škrijelj et al. (2013) for the Federation of B&H, and in Anonymous (2012) for the Republic of Srpska, where a simple catalogue of species is listed without specific details. Therefore, the goal of this study was to determine the sensitivity index of all amphibian taxa within the territory of Bosnia and Herzegovina by using DELH methodology.

MATERIAL AND METHODS

The sensitivity assessment methodology applied here used a combination of parameters described in: Andreone & Luiselli (2000), Vujanović et al. (2015), and Vukov et al. (2015), with minimal modifications (Tab. 1). All variables were divided into three to four categories: 0 (min. risk) to 2 or 3 (max. risk). If data was not found or was unknown, this data was analysed by subjective assessment of the author. We used decimals in specific cases: (a) if a taxon showed traits of two parameters and/or (b) if data was unknown – the average value of existing data was used. By using the described approach, every taxon of interest showed its own sensitivity index by considering the average value of indices of all tested parameters (n=17) (Tab. 1). Based on the acquired sensitivity index, all taxa were divided into four categories: very sensitive (1.5–2.0: VS), sensitive (1–1.5: SE), near sensitive (0.9–1.00: NS), and low sensitivity (0–0.9: LS). Geographic parameters were determined based on the latest data on amphibian species distribution in Bosnia and Herzegovina (Lelo et al., 2015; Lelo & Zimić, 2020) compared to global distribution charts (Arntzen & Sparreboom, 1989; Gasc et al., 1997; Wielstra et al., 2013; IUCN, 2015). Used anthropogenic, ecological, and biological data parameters were adopted from: Fachbach (1990), Arnold et al. (1992), Greven (1998), Arnold & Ovenden (2002), Slavens (2003), Cogalniceanu & Miaud (2004), Pisanets et al. (2005), Vukov et al. (2006), Lelo (2007), Arntzen et al. (2009a, 2009b), Vitt & Caldwell (2009), Jelić et al. (2012), Zimić (2013, 2014, 2015), and Šunje et al. (2015).

Pelophylax kurtmuelleri and *P. shqipericus* were treated as not applicable for this study due to a recent discovery of species (Zimić et al., 2020) and their unresolved origin (Tab. 2).

RESULTS

Average values of sensitivity indices of amphibians in Bosnia and Herzegovina varied from 1.82 (*Proteus anguinus*) to 0.53 (*Bufo bufo* and *Rana dalmatina*). Three species (14%) were considered as very sensitive, six species (29%) as sensitive, three (14%) as near sensitive, whereas nine (43%) were considered to be of low sensitivity (Tab. 2).

Table 1. Sensitivity assessment indices for each set of examined parameters: geographical (■), biological (■) and ecological (■)

VARIABLES		RISK	ELABORATION
DB	Distribution Breadth	0	present in 50-100% area of Bosnia and Herzegovina
		1	present in 10-50% area of Bosnia and Herzegovina
		2	present in 5-10% area of Bosnia and Herzegovina
		3	present in <5% area of Bosnia and Herzegovina
ED	Elevational Distribution	0	present 0-2000 m asl
		1	present above 1000 m asl (high altitudes)
		2	present to 1000 m asl (hills)
		3	present to 200 m asl (restricted to plains)
E	Endemicity	0	0-10% of global distribution is in Bosnia and Herzegovina
		1	10-50% of global distribution is in Bosnia and Herzegovina
		2	50-80% of global distribution is in Bosnia and Herzegovina
		3	80-100% of global distribution is in Bosnia and Herzegovina
HF	Habitat Fragmentation	0	fragmentation 0-20%
		1	fragmentation 20-50%
		2	fragmentation 51-75%
		3	fragmentation >75%
PP	Peripheral Populations	0	peripheral populations non-existent
		1	global distribution boundary in BiH
		2	two peripheral boundaries (parallel)*
		3	completely isolated population(s)*
BD	Body Dimensions; SVL (Snout-to-Vent Length) measuring used	0	< 5cm of max. Size
		1	6-10 cm of max. size
		2	10-15 cm of max. Size
		3	> 16 cm of max size
RM	Reproductive mode	0	ovuliparity*
		1	oviparity*
		2	ovoviviparity*
		3	viviparity
EN	Eggs/Offspring Number	0	>200
		1	50-200
		2	10-50
		3	1-10
MA	Maximum Age	0	>15 years of lifespan
		1	11-15 years of lifespan
		2	6-10 years of lifespan
		3	>5 years of lifespan
LC	Life Cycle	0	finishes with complete metamorphosis
		1	finishes with facultative neoteny
		2	finishes with obligatory neoteny
FR	Frequency of Reproduction	0	more than 3 times a year
		1	2-3 times a year
		2	once a year
		3	once every few years
HB	Habitat Breadth: (sub)Mediterranean, montane, continental, pannonic	0	found in all four regions
		1	found in three regions
		2	found in two regions
		3	found in one region

AHR	Aquatic Habitat for Reproduction	0	aquatic habitat not required
		1	temporary or permanent water habitats
		2	only temporary water habitats
		3	water habitats rich in oxygen or slow streams
AI	Anthropogenic Impact: exploitation/harvesting, mortality on roads, purposeful killing, pet commerce	0	non existent
		1	one factor exists
		2	two or more factors exist*
AH	Adaptability to altered Habitats	0	very adaptable (found in urban areas)
		1	adaptable (found in suburban areas)
		2	ill-adaptable (mildly altered habitat)
		3	inadaptable taxon (only found in natural habitats)
HT	Habits	0	underground activity
		1	aquatic activity
		2	terrestrial/aquatic activity
		3	terrestrial activity
A	*Activity	0	nocturnal
		1	nocturnal and diurnal
		2	just diurnal

Table 2. Sensitivity assessment index results according to DELH: ■ very sensitive (>1.5), ■ sensitive (1.2-1.5), ■ near sensitive (1.00-1.20), ■ low sensitivity (<1.00), and not applicable (NA); data categories are elaborated in Table 1.

TAXON	DB	E	ED	HF	PP	BD	RM	EN	MA	LC	FR	HB	AHR	AI	AH	HT	A	DELH index
<i>Proteus anguinus</i>	2	2	3	3	1	3	1.5	2	0	2	1.5	3	3	1	3	0	0	1.82
<i>Salamandra atra</i>	3	0	1	0	3	1	3	3	1	0	3	3	0	0	3	3	1	1.65
<i>Triturus dobrogicus</i>	3	0	3	3	1	1	1	1	2	1	2	3	1	1	2	2	1	1.65
<i>Lissotriton graecus</i>	1	0	3	2	1	0	1	1	2	1	2	3	2	1	2	0.5	1.5	1.50
<i>Bombina bombina</i>	2	0	3	3	1	0	0	1	0	0	1	3	1	1	1	3	2	1.29
<i>Rana graeca</i>	0	1	0	2	2	1	0	0	3	0	2	2	3	1	3	0	2	1.29
<i>Triturus macedonicus</i>	0	1	2	3	1	1	1	1	1	1	2	1	2	1	2	1	1	1.29
<i>Triturus carnifex</i>	3	0	2	1.5	1	1	1	1	1	1	2	1.5	1	1	1	1	1	1.24
<i>Pelobates fuscus</i>	2	0	3	3	1	1	0	0	2	0	2	3	2	1	2	0	0	1.29
<i>Pelophylax lessonae</i>	2	0	2	0	1	1	0	0	2	0	2	3	2	1	1	1	1	1.12
<i>Ichthyosaura alpestris</i>	0	1	0	1	2	0	1	1	0	1	2	2	2	1	2	0.5	1	1.03
<i>Lissotriton vulgaris</i>	0	0	2	2	1	0	1	1	2	1	2	2	2	1	2	1	0	1.00
<i>Pelophylax kl. esculentus</i>	1	0	1.5	0	1	2	0	0	1	0	2	2	2	1	1	0	2	0.97
<i>Salamandra salamandra</i>	0	0	0	1	0	2	2	1	0	0	2	0	2	1	2	1	1	0.88
<i>Bombina variegata</i>	0	1	0	1	1	0	0	1	0	0	1	1	1	1	1	3	2	0.82
<i>Rana temporaria</i>	0	0	2	1	1	1	0	0	1	0	0	1	2	1	1	1	0	0.71
<i>Hyla arborea</i>	0	0	2	0	0	0	0	0	2	0	2	0	2	0	1	1	1	0.65
<i>Bufo viridis</i>	0	0	0	0	0	3	0	0	0	0	2	0	1	1	1	1	1	0.59
<i>Pelophylax ridibundus</i>	0	0	0	0	0	2	0	0	1	0	2	0	2	1	0	0	2	0.59
<i>Rana dalmatina</i>	0	0	0	0	0	1	0	0	2	0	2	0	2	0	1	1	0	0.53
<i>Bufo bufo</i>	0	0	0	0	0	3	0	0	0	0	2	0	1	1	1	1	0	0.53
<i>Pelophylax kurtmuelleri</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NA
<i>Pelophylax shqipericus</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NA

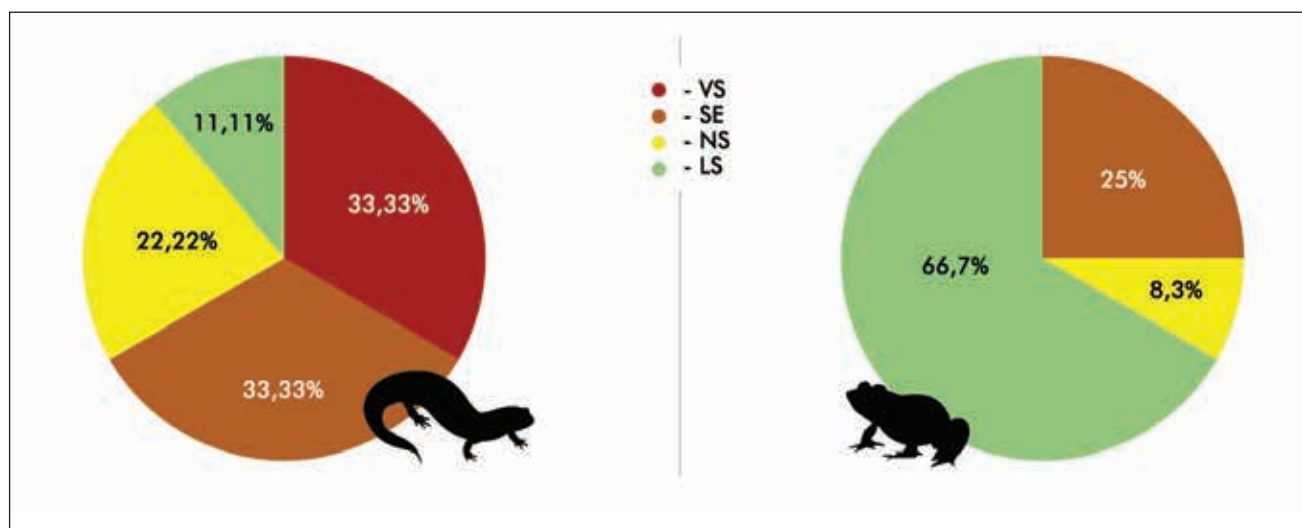


Figure 1. Sensitivity of Caudata (left) and Anura (right) in Bosnia and Herzegovina

DISCUSSION

Results have shown that Caudata in Bosnia and Herzegovina are far more sensitive than Anura. Just one species within Caudata was assigned as not threatened (*S. salamandra*) while all other tailed amphibians were part of a group of sensible taxa suggesting the need for specific conservation attention. On the other hand, there were no Anuran species categorized in the category of very sensitive ones (VS). Eight species of Anura were considered as not threatened (LS), while four taxa were marked as sensitive (SE) or near sensitive (NS) and thus also in need of conservation actions: *B. bombina*, *R. graeca*, *P. fuscus*, and *P. lessonae* (Fig. 1).

A comparison of sensitivity assessment performed for the overall territory of Bosnia and Herzegovina and Croatia (Vujanović & Jelić, 2015), to this one, performed only in Bosnia and Herzegovina territory, revealed minor differences between the two areas and, generally, slightly higher conservation status of amphibians in Bosnia and Herzegovina. For *P. anguinus*, the degree of sensitivity was nearly the same in both areas. Minor differences (0.1 for the total territory of BiH and Croatia versus 0.2 only for Bosnia and Herzegovina territory) were mainly noted for the species that have marginal distribution in Bosnia and Herzegovina: *T. dobrogicus*, *T. carnifex*, *P. fuscus*, *B. bombina*, *P. lessonae*, and *L. vulgaris*. Slightly larger differences were noted for *S. atra* (1.36 vs. 1.62). The reason lies in the fact that ecologically, populations in Bosnia and Herzegovina are very different from populations in Croatia (Šunje et al., 2015) and have very restricted horizontal-vertical distribution (Šunje et al., 2015). The largest difference was noted for *L. vulgaris* (0.57 – 1.00), and it can be explained through the use of a different approach: the amphibian sensitivity assessment of Bosnia and Herzegovina and Croatia (Vujanović et al., 2015) also included *L.*

graecus, which has somewhat different biology and ecology (see Frost, 2015). *Lissotriton graecus* was not a part of the sensitivity assessment of *L. vulgaris* in Bosnia and Herzegovina (this study). The most sensitive amphibians in Serbia according to DELH are *S. atra* and *T. dobrogicus* (Vukov et al., 2015) – which coincides with the results of this research. The only significant irregularity was also noted with *L. vulgaris* probably due to its larger range in Serbia.

CONCLUSIONS

Amphibian sensitivity assessment according to DELH can provide an accurate assessment of the vulnerability level of taxa.

Three amphibian species in Bosnia and Herzegovina are very sensitive (*P. anguinus*, *S. atra* and *T. dobrogicus*) (VS). Six taxa (29%) were marked as sensitive (SE), three (14%) as near sensitive (NS), while nine species (43%) showed low sensitivity (LS).

Tailed amphibians were much more sensitive than anurans. Only one species had low sensitivity index: *Salamandra salamandra*. All other tailed amphibians were considered sensitive taxa (very sensitive, sensitive, or near sensitive). In anurans, there were no highly sensitive taxa; eight species were assigned as having low sensitivity, while four taxa were considered sensitive or near sensitive.

Regionally, DELH statuses of amphibian species in Bosnia and Herzegovina largely coincided with Croatia and Serbia, with a difference in categorization of *L. vulgaris*.

All sensitive species with an index over 0.99 should be subjected to protection measures and special conservation actions as being assigned very sensitive (VS) according to DELH criteria.

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SAŽETAK

Vodozemci su nedvojbeno najugroženija klasa kičmenjaka na svijetu, a trećina vrsta je pod izravnom prijetnjom globalnog izumiranja. Zbog osjetljivog kožnog sistema, vodozemci ne podnose mnoge antropogene pritiske poput: konverzije staništa, zagađenja, zaraznih bolesti, klimatskih promjena, invazivnih vrsta i dr. Iako se ovi čimbenici mogu identificirati u Bosni i Hercegovini, situacija je dodatno otežana nedostatkom zakonske zaštite vrsta, neučinkovito provođenje postojećih zakonskih propisa, teške političke podjele u zemlji, koje u konačnici rezultiraju malim brojem zaštićenih područja. Danas je poznato da u Bosni i Hercegovini (BiH) trenutno živi 23 vrste (i 24 podvrste) vodozemaca, a procjene osjetljivosti/ugroženosti su slabo rađene. U ovom radu data je procjena osjetljivosti i rizika izumiranja vodozemaca BiH na bazi ekoloških, bioloških, geografskih i antropoloških varijabli (DELH procjena) na temelju 17 različitih parametara. Rezultati ukazuju da su najranjivije i najugroženije vrste *Proteus anguinus* (čovječija ribica), *Salamandra atra* (alpski daždevnjak) i *Triturus dobrogicus* (dunavski krestasti vodenjak), zbog specifične ekologije i malog areala rasprostranjenosti. Devet taksona vodozemaca smatra se ranjivim, a 10 vrsta vjerojatno nije ugroženo. Rezultati ujedno ukazuju na to, da su repati vodozemci znatno senzibilnija skupina u odnosu na bezrepate vodozemce. Svi taksoni koji imaju indeks osjetljivosti preko 0.99 (60% bosanskohercegovačkih vodozemaca) trebaju se smatrati veoma senzitivnima, te zahtijevaju adekvatnu zaštitu i posebne konzervacijske programe.

Ključne riječi: očuvanje, DELH, Caudata, Anura, životna istorija, distribucija, ekologija

A new site of the March mushroom (*Hygrophorus marzuolus* (Fr.) Bres.) in Sarajevo Canton, Bosnia and Herzegovina

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Scientific paper

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Abstract: The diversity of mushrooms in Bosnia and Herzegovina has been poorly studied. On the other hand, Bosnia and Herzegovina is one of the largest exporters of edible wild mushrooms in Europe. This paper aims to present a new site of a high-quality and edible mushroom—the March mushroom (*Hygrophorus marzuolus* (Fr.) Bres.), which is, on the other hand, a rare and protected species in many European countries. The new site was recorded in Sarajevo Canton. This site also represents the lowest altitude site for this mushroom in Bosnia and Herzegovina. However, it should be emphasized that the population of the March mushroom was only recorded in the sunniest part of the planted Scots pine forest.

Keywords: March mushroom, biodiversity, mushrooms, locality, forest

INTRODUCTION

The biodiversity of fungi in Bosnia and Herzegovina has been poorly studied. Unfortunately, there is only little recent data available, even for the most widespread mushrooms, let alone some rare and not so well-known species. This is the case with the March mushroom. There is only a limited number of publications regarding the distribution of this mushroom in Bosnia and Herzegovina. Focht (1979) mentions the Kasindol site near Sarajevo. The same author (Focht, 1992) gives information about the presence of this species in eastern Bosnia as well. It should also be noted that this mushroom is not easily noticed in nature because it fruits partially or completely under a layer of needles and soil in spring, compared to common edible mushrooms that fruit in autumn (Božac, 2003).

The March mushroom belongs to a group of high-quality edible mushrooms. According to Canduso (1997), it has the following characteristics: cap 30-120 (150) mm, hemispherical, convex, waxy, convex plane, irregular, brown gray, brown, slate-light grey, blackish. The stem is cylindrical, stocky, compressed, curved, gibbous, very irregular, firm, full, then it has a fistulous cavity, especially at the base, pale grey or whitish. The flesh is tenacious, fibrous, consistent throughout the carpophore, white-greyish, grey, hygrophanous; it has a light

smell of withered roses and tastes pleasant. Gills are broadly adnate, sinuous, thick, spaced apart, subdecurrent, whitish, white-greyish, grey, waxy. Spore prints are white.

March mushroom is widespread in Europe, North Africa (Morocco), and North America, but it has not been recorded in Northern Europe and the area of evergreen vegetation of the Mediterranean part of Europe (Tkalčec et al., 2008).

It should be emphasized that the March mushroom is a protected species in many European countries, e.g., in Croatia it has a status of endangered species (Tkalčec et al., 2008); in Montenegro, it is on the preliminary Red List (Perić et al., 2001), and in Bosnia and Herzegovina, it also has the status of the endangered species (Đug et al., 2013).

MATERIAL AND METHODS

Sporocarps of the target species (March mushroom) were traced in the field during its fructification season in the year 2018. Sporocarps were identified following Focht (1992). For each March mushroom collection site, a phytocoenological record was made following the Braun-Blanquet (1932) method. The floral elements, life forms, indicator values, and phytocoenological affiliation of plants were provided accord-

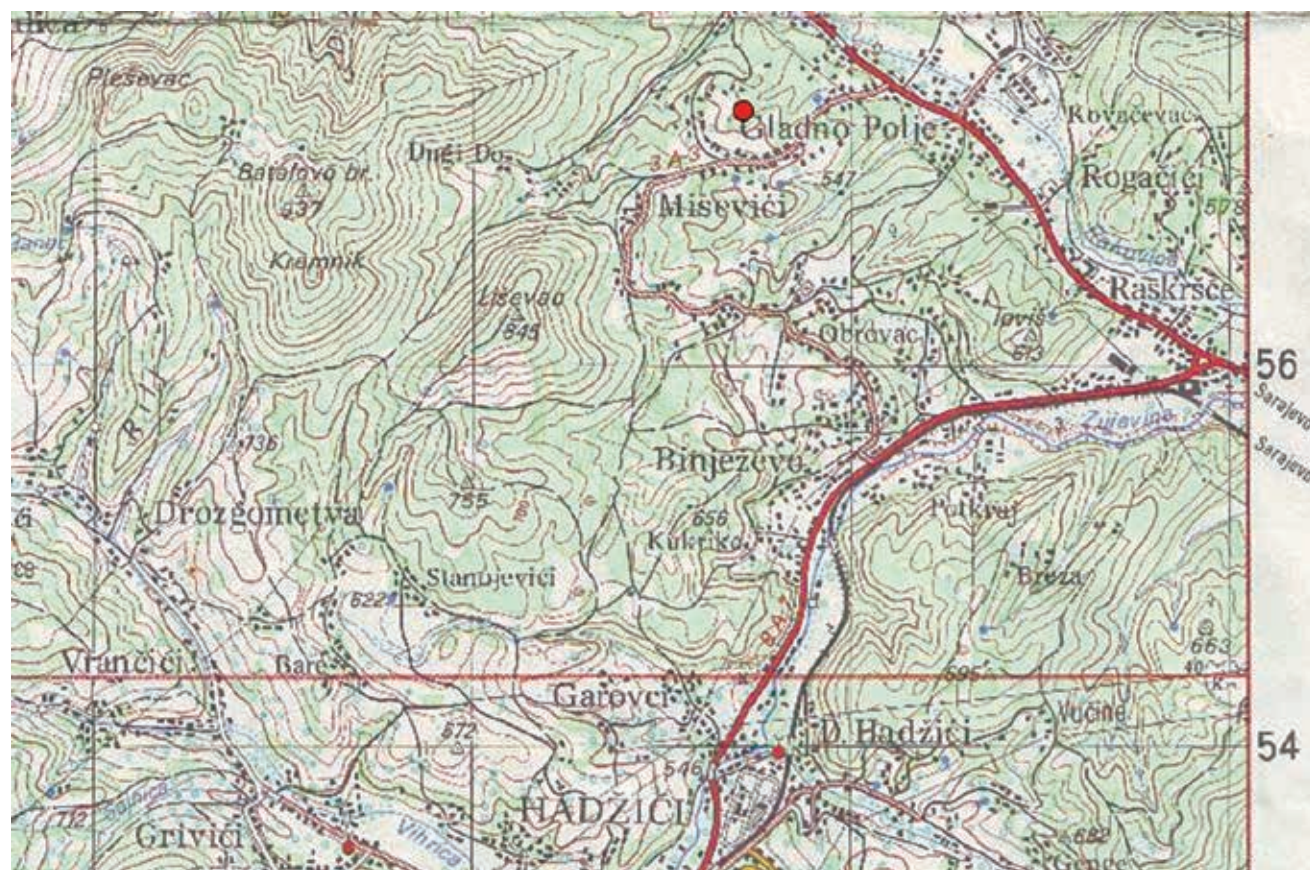


Figure 1. Geographical position of the studied site (Adopted from the map of the Military Geographical Institute 1982).

ing to Oberdorfer (2001) and Pavlović-Murarspahić (1995). In addition to the March mushroom, other mushrooms, found in the studied area, i.e., on the record, are included in the registered (Tab. 1). The number of mushrooms in the table was provided according to Tortić & Lisiewska (1971): + one sample, ++ few samples, and +++ many samples.

The altitude was recorded using the "Magelan eXplorist 500" GPS device. The terrain inclination was determined with the clinometer from the "Recta DP 6 GLOBAL" compass.

According to Jovanović et al. (1978), this region, with regard to the geological age, belongs to the Mesozoic period, specifically the Upper Cretaceous period, and as far as tectonics, it belongs to the transitional zone (Čičić, 1984). Geographically, the explored site is located to the west of Sarajevo and between N 43° 51' 18.94" and E 18° 12' 15.37".

ABBREVIATIONS:

Abbreviations for phytocoenological affiliation:

Arr. – *Arrhenatheretalia*, Bet. – *Betuletalia*, E.-P. – *Erico-Pinetalia*, F. – *Fagetalia*, Mol. – *Molinietalia*, N.-C. – *Nardo-Calunetalia*, Q. p. – *Quercetalia pubescentis*, Q. r.-p. – *Quercetalia robori-petraeae*, P. s. – *Prunetalia spinosae*, Pte. – *Pteridaceae*, V.-P. – *Vaccinio-Piceetalia*.

Abbreviations for indicator values:

P – primary, PS – primary secondary, S – secondary, SP – secondary primary

Abbreviations for life forms:

P – *phanerophyta*, H – *hemicriptophyta*, Ch – *chamaephyta*, G – *geophyta* and Ch (Pn) – *chamaephyta (nanophanerophyta)*

Abbreviations in the phytocoenological table: I. v. – indicator value, F. e. – floral element, F. p. – phytocoenological affiliation, L. f. – life form.

RESULTS AND DISCUSSION

In the researched terrain, March mushrooms were found in several separate groups. Some of them were covered with leaves and soil and were difficult to find.

Table 1. Phytocoenological table of the field vegetation

Locality	Donji Miševići				
Altitude	535m				
Exposition	S-SW				
Inclination (°)	20-30°				
Geological basis	Marl limestone				
Soil type	Rendzina				
General coverage (%)	100%				
Image size	200 m				
Date	10 April 2018				
Image number	1				
Phytocenosis	Scots pine planted forest				
Floristic composition:					
Tree layer up to 25 m:					
		I. v.	F. e.	F. p.	L. f.
<i>Pinus sylvestris</i> L.	3.3	P	no-euraskont(-smed)	E.-P.	P
Tree layer up to 5 m:					
<i>Pinus sylvestris</i> L.	3.3	P	no-euraskont(-smed)	E.-P.	P
<i>Quercus petraea</i> (Matt.) Lieb.	+1	P	subatl-smed	Q. p.	P
Tree layer up to 3 m:					
<i>Carpinus betulus</i> L.	2.2	P	gemässkont(-smed)	Q. p.	P
<i>Quercus petraea</i> (Matt.) Lieb.	1.1	P	subatl-smed	Q. p.	P
<i>Prunus avium</i> L.	+2	P	subatl-smed	F.	P
<i>Acer tataricum</i> L.	+2	P	sarm.	F.	P

<i>A. pseudoplatanus</i> L.	+1	P	subatl-smed(-pralp)	F.	P
<i>Sorbus torminalis</i> (L.) Cr.	+1	P	smed	F.	P
<i>Populus tremula</i> L.	+1	PS	no-euras	Q.r.-p.	P
<i>Rhamnus frangula</i> L.	+1	P	no-eurassubozean	Q. r.-p.	P
<i>Pinus sylvestris</i> L.	+1	P	no-euraskont(-smed)	E.-P.	P
Bush layer:					
<i>Carpinus betulus</i> L.	2.2	P	gemässkont(-smed)	Q. p.	P
<i>Rubus hirtus</i> W. K.	1.1	PS	subatl	F.	P
<i>Sorbus torminalis</i> (L.) Cr.	+2	P	smed	F.	P
<i>Fagus sylvatica</i> L.	+2	P	subatl(-smed)	F.	P
<i>Calluna vulgaris</i> (L.) Hull.	+2	SP	no-eurassubozean	N.-C.	Ch(Pn)
<i>Betula pendula</i> Roth	+2	P	no-eurassubozean	Bet.	P
<i>Lembotropis nigricans</i> Griseb.	+2	P	gemässkont-osmed	E.-P.	P
<i>Pyrus pyrastrer</i> Burgsd.	+1	P	smed(-gemässkont)	F.	P
<i>Corylus avellana</i> L.	+1	P	subatl-smed (euras-subozean)	Q. p.	P
<i>Crataegus monogyna</i> Jacq.	+1	PS	submed(-subatl)	P. s.	P
<i>Evonymus europaea</i> L.	+1	PS	subatl-smed	F.	P
Herbaceous plant layer:					
<i>Mycelis muralis</i> (L.) Dum.	1.1	P	subatl-smed	F.	H
<i>Veronica officinalis</i> L.	1.1	P	no-eurassubozean	V.-P.	Ch
<i>Pteridium aquilinum</i> (L.) Kuhn	1.1	SP	(no)eurassubozean	Pte.	G
<i>Festuca gigantea</i> (L.) Vill.	1.1	P	euras(subozean)	F.	H
<i>Carex silvatica</i> Huds.	1.1	P	subatl(-smed)	F.	H
<i>Anemone nemorosa</i> L.	1.1	P	eurassubozean	F.	G
<i>Galium silvaticum</i> L.	+2	P	gemässkont(-smed)	F.	G
<i>Viola silvestris</i> Lam.	+2	P	subatl-smed	F.	H
<i>Inula britannica</i> L.	+2	S	euraskont-smed	Mol.	H
<i>Polygonatum odoratum</i> (Mill.) Druce	+2	P	euras(kont)	Q. p.	G
<i>Taraxacum officinale</i> Web. in Wigg.	+1	S	no-euras(subozean)	Arr.	H
<i>Platanthera bifolia</i> (L.) Rich.	+1	P	no-eurassubozean	F.	G
Moss layer					
<i>Polytrichum commune</i> L.	1.1				
Fungi					
<i>Hygrophorus marzuolus</i> (Fr.) Bres.	+++				
<i>Strobilurus stephanocystis</i> (Hora) Sing.	++				
<i>S. tenacellus</i> (Pers. ex Fr.) Singer	++				
<i>Mycena galericulata</i> (Scop. & Fr.) Gray	++				
<i>Urnula craterium</i> (Schw.) Fr.	+				

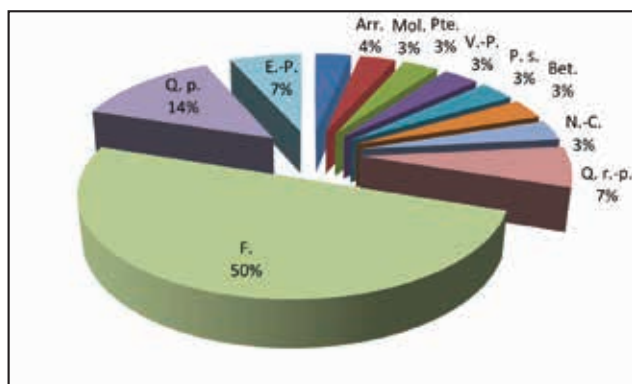


Figure 2. Phytocoenological affiliation of species in the ecosystem of the studied Scots pine forest (shown in percentages)

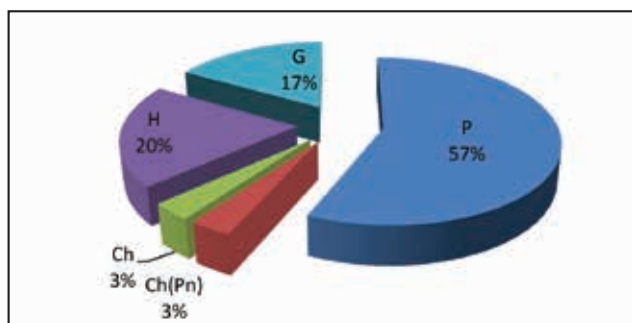


Figure 4. Ratio of life forms in the ecosystem of the studied Scots pine forest (shown in percentages)

As for the phytocoenological affiliation of the species in the studied ecosystem, most species belong to the order of *Fagetalia*. The order of *Quercetalia pubescentis* also has high values (Fig. 2). Of the indicator values, the largest number belongs to the primary and primary secondary species (Fig. 3). In the ratio of life forms, the most common are phanerophytes and chemicryptophytes (Fig. 4). The largest number of species in the studied area belongs to the Subatlantic floral element.

The March mushroom is mostly found in the mountain region, and this site currently has the lowest recorded altitude for their habitat in Bosnia and Herzegovina. Mushrooms are recorded only in the part of the forest, oriented towards the S-SW, which is under extensive solar insolation. The March mushroom has been found in a planted forest of Scots pine (*Pinus sylvestris* L.). Otherwise, this area is clima zonally determined by the natural forest of *Quercetalia pubescentis* order. Table 2 shows that the largest number of species belongs to the Subatlantic and Nordic eurassubozean floral elements.

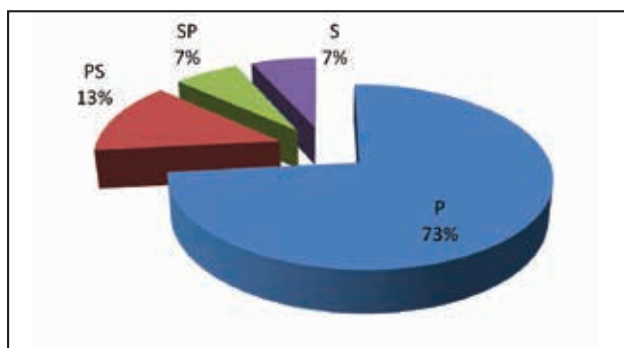


Figure 3. Ratio of indicator values in the studied area (shown in percentages)

Table 2. Relations of floral elements in the studied Scots pine forest

Floral element	Individual values	Total	%
smed	1		
smed(-gemässkont)	1		
submed(-subatl)	1		
	Σ	3	10
subatl	1		
subatl(-pralp)	1		
subatl(-smed)	1		
subatl(-smed)	1		
subatl-smed	5		
subatl-smed (euras-subozean)	1		
	Σ	10	33
euras(subozean)	1		
euras(kont)	1		
	Σ	2	7
no-euras	1		
no-eurassubozean	5		
no-euras(subozean)	1		
no-euraskont(-smed)	1		
	Σ	8	27
(no)eurassubozean	1		
eurassubozean	1		
	Σ	2	7
euraskont-smed	1		
	Σ	1	3
gemässkont-osmed	2		
gemässkont(smed)	1		
	Σ	3	10
sarm	1		
	Σ	1	3
Total	30	30	100%

CONCLUSIONS

1. This is the first record of the March mushroom found at lower altitudes in Canton Sarajevo.
2. The collection site is located in the area of the planted forest of Scots pine (*Pinus sylvestris* L.) in Donji Miševići.
3. Mushrooms were recorded at the lowest known altitude for this species in Bosnia and Herzegovina.
4. Mushrooms were found only in the sunny part of the forest with exposition towards S-SW.

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Figure 5. March mushroom (*Hygrophorus marzuolus*) in the ecosystem of the planted Scots pine (*Pinus sylvestris* L.) forest



Figure 6. The appearance of the planted Scots pine forest ecosystem in which March mushroom was recorded

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Figure 1:

Topographic map 1: 50 000 (TK 50) Sarajevo 1 (525-1) – The second edition 1982, Military Geographical Institute, Belgrade

SAŽETAK

Diverzitet gljiva u BiH je vrlo slabo istražen. S druge strane, BiH je jedan od najvećih izvoznika samoniklih gljiva u Evropi. Ovaj rad ima za cilj da opiše novi lokalitet za jednu vrlo kvalitetnu i jestivu gljivu a sa druge strane rijetku i u mnogim zemljama Evrope zaštićenu vrstu. Ovo je novi lokalitet ove gljive a ujedno i lokalitet na najnižoj nadmorskoj visinina kojoj je ova gljiva zabilježena u BiH. Takođe, treba istaći i da je riječ o sađenoj šumi bijelog bora i da je populacija martovke zabilježena samo na najsunčanijem dijelu šume.

Ključne riječi: Martovka, biodiverzitet, gljive, lokalitet, šuma

Endemic and endangered plant taxa in the collection of Otto Blau

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Review article

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Abstract: The analysis of material from the herbarium collection of Otto Blau (SARA) collected in Bosnia and Herzegovina confirmed the presence of 41 endemic species, 33 of which have a defined conservation status in the Federation of Bosnia and Herzegovina and 6 taxa are listed in the European Red List of endangered species.

According to the guidelines and criteria of the International Union for Conservation of Nature, a total of 99 species and subspecies of different conservation statuses have been identified at the local and 274 taxa at the European level.

Keywords: Herbarium, Bosnia and Herzegovina, SARA, distribution, IUCN

INTRODUCTION

During his diplomatic stay (1861-1872), Dr. Otto Blau traveled through the mountains and canyons of Bosnia and Herzegovina and collected extremely valuable plant material from which he made a botanical collection. He entrusted the taxonomic and systematic processing of the material to one of the eminent botanists of the time, Paul Friedrich Ascherson, who raised the amateur collection to the level of scientific, and this data was partly used for creating floristic works (Ascherson & Kanitz, 1877; Blau, 1887; Beck, 1903-1927; Beck & Maly, 1950; Beck et al., 1967, 1974, 1983), monographs (Šilić, 1979), Red Lists of Flora of Bosnia and Herzegovina (Šilić, 1992-1996; Đug et al., 2013), etc.

Small and unique herbarium collections owned by the National Museum of BiH are a valuable source of information for interdisciplinary research aimed at extending knowledge about taxonomy, phytogeography, ecology, evolution, and biodiversity of the flora of Bosnia and Herzegovina.

The data from old herbarium collections is often considered dubious or inaccurate, but it is often taken as relevant to the species distribution, especially when determining one of the endangered categories, which in that case has only relative significance.

Given that complete data on the contents of Blau's herbarium has not been cited previously, this paper should point to the findings on endemic and endangered plant species and their distribution in Bosnia and Herzegovina and provide an opportunity to verify or confirm the long-established sites for future floristic research.

MATERIALS AND METHODS

The data used in this paper is taken from the original collection of Otto Blau and the accompanying catalog which is deposited in the Herbarium of the National Museum of Bosnia and Herzegovina (SARA).

The collection contains 2503 inventory units (B&H, Montenegro) which were collected in the 1868-1872 period. The analysis included 1404 species and lower systematic categories of *Pteridophyta* and *Spermatophyta* from the territory of Bosnia and Herzegovina (Lagumdžija, 2020).

The classification sequence of taxa in the paper is consistent with the *Flora Europaea* (Tutin et al., I-V, 1964-1980). The systematic status and scientific names of the species have been revised according to Euro+Med (2006) and The Plant List.

The endemic character and general distribution range were determined according to the available literature sources (Bjelčić and Šilić, 1971; Šilić et al., 1986; Bjelčić, 1987; Šilić, 1990, 2002; Šilić and Abadžić, 1991; Stevanović et al., 2003, Redžić et al., 2008; Šoljan et al., 2009, 2014b; Stupar et al., 2011; Mišić & Šoljan, 2014; Šoljan et al., 2014a; Lubarda et al., 2014; Bjelčić & Šoljan, 2015; Šilić and Šoljan, 2018).

An overview of rare and endangered species with IUCN categorization is given according to the current Red List of wild species and subspecies of plants, animals and fungi of the Federation of Bosnia and Herzegovina (the Official Gazette of the Federation of BiH, 7/14) with abbreviations: **EX** (Extinct), **EW** (Extinct in The Wild), **CR** (Critically Endangered), **VU** (Vulnerable), **NT** (Near Threatened), **LC** (Least Concern), **DD** (Data Deficient) and **NE** (Not Evaluated). This information is accompanied by the current status for Europe according to the IUCN Red List (IUCN 2021) with categories: **EX** (Extinct), **EW** (Extinct in The Wild), **RE** (Regionally Extinct), **CR** (Critically Endangered), **EN** (Endangered), **VU** (Vulnerable), **NT** (Near Threatened), **LC** (Least Concern), **DD** (Data Deficient), **NA** (Not Applicable) and **NE** (Not Evaluated).

RESULTS AND DISCUSSION

The taxonomic and chorological analysis of Otto Blau's collection showed that it contains 348 species and subspecies from the territory of Bosnia and Herzegovina. Some of them, in addition to endemic status, also belong to one of the threatened categories (Tab. 1).

Out of 450 officially recognized endemic plant species of the vascular flora of Bosnia and Herzegovina (Redžić et al., 2008), Blau's collection contains stenoendemic taxa (*Alyssum moellendorffianum* Asch. ex Beck; *Melampyrum trichocalycinum* Vandas; *Campanula hofmannii* (Pant.) Greuter & Burdet; *Edraianthus niveus* Beck) and 37 endemic species of different ranges of distribution:

- Trans-regional endemics (**TRE**) - 16 (Stevanović et al., 2003);
- Regional endemics (**RE**) - 17 (Stevanović et al., 2003);
- Balkan-Apennine endemics - 2;
- Alpine-Dinaric endemics - 1;
- Dinaric-Apennine endemics - 1.

Of the total number of listed endemic taxa of the Blau's collection (41), 33 were assessed as threatened in Bosnia and Herzegovina (the Official Gazette of the Federation of BiH, 7/14): **CR** (Critically Endangered) - 1, **EN** (Endangered) - 8, **VU** (Vulnerable) - 11, **NT** (Near Threatened) - 4, **LC** (Least Concern) - 7, **DD** (Data Deficient) - 2 (Fig. 1).

Six endemic species of Bosnia and Herzegovina are listed in the international Red List of threatened species: Near Threatened (**NT**) - 1 and Least Concern (**LC**) - 5 taxa.

Endemic species, such as *Cerastium malyi* (Georgiev) Niketić, *Drypis spinosa* L., *Clinopodium thymifolium* (Scop.) Kuntze, *Thymus praecox* subsp. *janka* (Čelak.) Jalas *Helictotrichon blavii* (Asch. & Janka) C. E. Hubb., *Digitalis laevigata* Walds. & Kit. and *Saxifraga blavii* (Engl.) Beck were not listed as threatened taxa in the Red lists.

The analysis of the total number of species and lower systematic categories in the collection of Otto Blau originating

Table 1. Data on sites, endemic and Red List status for the species on the Blau's collection

No.	Family according to the original collection data	Taxon name according to the original collection data	Family according to Euro+Med PlantBase and the Plant List	Taxon name according to Euro+Med PlantBase and the Plant List	Locality	Endemic status and general range	Red List status in FB&H	European Red List
1	Lycopodiaceae	<i>Lycopodium annotinum</i> L.	Lycopodiaceae	<i>Lycopodium annotinum</i> L.	Hranisava			LC
2	Lycopodiaceae	<i>Lycopodium clavatum</i> L.	Lycopodiaceae	<i>Lycopodium clavatum</i> L.	Trebević			LC
3	Equisetaceae	<i>Equisetum hyemale</i> L.	Equisetaceae	<i>Equisetum hyemale</i> L.	the Krupa river valley, near Pazarić			LC
4	Equisetaceae	<i>Equisetum palustre</i> L.	Equisetaceae	<i>Equisetum palustre</i> L.	Hreša, the valley of Mošćanica, Lukavica, lake (Herzegovina)			LC
5	Equisetaceae	<i>Equisetum arvense</i> L.	Equisetaceae	<i>Equisetum arvense</i> L.	Sarajevo field			LC
6	Polypodiaceae	<i>Notholaena marantae</i> R. Br.	Pteridaceae	<i>Paragymnopteris marantae</i> (L.) K. H. Shing	Maglaj		EN	NT
7	Polypodiaceae	<i>Aspidium thelypteris</i> (L.) Sw.	Thelypteridaceae	<i>Thelypteris palustris</i> Schott	lake (Herzegovina), Pliva		VU	LC
8	Polypodiaceae	<i>Asplenium trichomanes</i> L.	Aspleniaceae	<i>Asplenium trichomanes</i> L.	Igman, Fojnica, Paljev do			LC
9	Polypodiaceae	<i>Asplenium viride</i> Huds.	Aspleniaceae	<i>Asplenium viride</i> Huds.	Trebević, Treskavica, Zec			LC
10	Polypodiaceae	<i>Asplenium adianthum-nigrum</i> L.	Aspleniaceae	<i>Asplenium adianthum-nigrum</i> L.	Igman, Trebević			LC
11	Polypodiaceae	<i>Asplenium septentrionale</i> Hoffm.	Aspleniaceae	<i>Asplenium septentrionale</i> (L.) Hoffm.	Fojnica		VU	LC
12	Polypodiaceae	<i>Scolopendrium vulgare</i> Sm.	Aspleniaceae	<i>Phyllitis scolopendrium</i> (L.) Newm.	Stari grad, Lapišnica, Trebević			LC
13	Polypodiaceae	<i>Cystopteris filix-fragilis</i> (L.) Bernh.	Athyriaceae	<i>Cystopteris fragilis</i> (L.) Bernh.	Trebević, Igman			LC
14	Polypodiaceae	<i>Blechnum spicant</i> Roth	Blechnaceae	<i>Blechnum spicant</i> (L.) Roth	Valley of the Bistrica river, Zec, Kiseljak			LC
15	Coniferae	<i>Abies alba</i> Mill.	Pinaceae	<i>Abies alba</i> Mill.	Ozren, Zec			LC
16	Coniferae	<i>Pinus laricio</i> Poir. var. <i>austriaca</i>	Pinaceae	<i>Pinus nigra</i> J. F. Arnold	Surroundings of Sarajevo, Borci			LC
17	Coniferae	<i>Pinus sylvestris</i> L.	Pinaceae	<i>Pinus sylvestris</i> L.	Stari grad			LC
18	Coniferae	<i>Pinus mugo</i> Turra	Pinaceae	<i>Pinus mugo</i> Turra	Trebević, Vranica			LC
19	Coniferae	<i>Juniperus communis</i> L.	Cupressaceae	<i>Juniperus communis</i> L.	Sarajevo, Ravno			LC
20	Salicaceae	<i>Salix fragilis</i> L.	Salicaceae	<i>Salix fragilis</i> Sm.	Sarajevo field, Ilidža, Koševo, Dobrinjka			LC
21	Salicaceae	<i>Salix alba</i> L.	Salicaceae	<i>Salix alba</i> L.	Sarajevo, Trebević, Lepenica, Kiseljak			LC
22	Salicaceae	<i>Salix triandra</i> L.	Salicaceae	<i>Salix triandra</i> L.	Valley of Miljacka			LC
23	Salicaceae	<i>Salix cinerea</i> L.	Salicaceae	<i>Salix cinerea</i> L.	Trebević, Hreša, Ilidža			LC
24	Salicaceae	<i>Salix caprea</i> L.	Salicaceae	<i>Salix caprea</i> L.	Mošćanica, Igman			LC
25	Salicaceae	<i>Salix incana</i> Schrk.	Salicaceae	<i>Salix eleagnos</i> Scop.	Valley of the Neretva, Trešanica, Borci, Konjic			LC
26	Salicaceae	<i>Salix purpurea</i> L.	Salicaceae	<i>Salix purpurea</i> L.	Trebević, he valley of the Košava, canyon of the Miljacka, surroundings of Sarajevo, Ilidža, the valley of the Željeznica			LC
27	Salicaceae	<i>Populus alba</i> L.	Salicaceae	<i>Populus alba</i> L.	Canyon of Miljacka, the valley of the Bosna, Kobilja glava			LC

No.	Family according to the original collection data	Taxon name according to the original collection data	Family according to Euro+Med PlantBase and the Plant List	Taxon name according to Euro+Med PlantBase and the Plant List	Locality	Endemic status and general range	Red List status in FB&H	European Red List
28	Salicaceae	<i>Populus tremula</i> L.	Salicaceae	<i>Populus tremula</i> L.	Surroundings of Sarajevo, Hum			LC
29	Salicaceae	<i>Populus nigra</i> L.	Salicaceae	<i>Populus nigra</i> L.	Canyon of Miljacka			DD
30	Amentaceae	<i>Betula pendula</i> Roth	Betulaceae	<i>Betula verrucosa</i> Ehrh.	Trebević, Hrid, Romanija			LC
31	Amentaceae	<i>Alnus glutinosa</i> Gartn.	Betulaceae	<i>Alnus glutinosa</i> (L.) Gaertn.	Surroundings of Sarajevo, Dobrinjka, Zujjevina			LC
32	Amentaceae	<i>Alnus incana</i> (L.) DC.	Betulaceae	<i>Alnus incana</i> (L.) Moench	Lapišnica, the valley of the Željčeznica			LC
33	Amentaceae	<i>Carpinus betulus</i> L.	Corylaceae	<i>Carpinus betulus</i> L.	Stari grad, Bijele vode, Ivan			LC
34	Amentaceae	<i>Ostrya carpinifolia</i> Scop.	Corylaceae	<i>Ostrya carpinifolia</i> Scop.	Stari grad			LC
35	Amentaceae	<i>Corylus avellana</i> L.	Corylaceae	<i>Corylus avellana</i> L.	Surroundings of Sarajevo, Klanac, Kalinovik			LC
36	Amentaceae	<i>Corylus colurna</i> L.	Corylaceae	<i>Corylus colurna</i> L.	Lipite, Konjic, around Jablaničko lake, Mostar		EN	LC
37	Amentaceae	<i>Castanea sativa</i> Mill.	Fagaceae	<i>Castanea sativa</i> Mill.	Grdonj, Bradina			LC
38	Amentaceae	<i>Quercus cerris</i> L.	Fagaceae	<i>Quercus cerris</i> L.	Dobro polje, Dumboš, canyon of the Neretva, Bijele vode			LC
39	Amentaceae	<i>Quercus sessiliflora</i> Salisb.	Fagaceae	<i>Quercus petraea</i> (Matt.) Liebl.	Trebević			LC
40	Amentaceae	<i>Quercus pubescens</i> Willd.	Fagaceae	<i>Quercus pubescens</i> Willd.	Igman			LC
41	Urticaceae	<i>Celtis australis</i> L.	Ulmaceae	<i>Celtis australis</i> L.	Mostar, Bjela			LC
42	Urticaceae	<i>Humulus lupulus</i> L.	Cannabaceae	<i>Humulus lupulus</i> L.	Sarajevo			LC
43	Urticaceae	<i>Urtica dioica</i> L.	Urticaceae	<i>Urtica dioica</i> L.	Sarajevo			LC
44	Santalaceae	<i>Thesium ebracteatum</i> Hayne	Santalaceae	<i>Thesium ebracteatum</i> Hayne	Trebević			LC
45	Loranthaceae	<i>Viscum album</i> L.	Loranthaceae	<i>Viscum album</i> L. subsp. <i>album</i>	Hrid			LC
46	Polygonaceae	<i>Polygonum aviculare</i> L.	Polygonaceae	<i>Polygonum aviculare</i> L.	Sarajevo			LC
47	Polygonaceae	<i>Polygonum persicaria</i> L.	Polygonaceae	<i>Persicaria maculosa</i> Gray	Sarajevo field			LC
48	Polygonaceae	<i>Polygonum nodosum</i> Pers.	Polygonaceae	<i>Polygonum lapathifolium</i> L.	Fojnica, Kiseljak, Pliva			LC
49	Polygonaceae	<i>Polygonum bistorta</i> L.	Polygonaceae	<i>Polygonum bistorta</i> L.	Lopata mt.			LC
50	Polygonaceae	<i>Polygonum amphibium</i> L.	Polygonaceae	<i>Polygonum amphibium</i> L.	Sarajevo			LC
51	Polygonaceae	<i>Rumex alpinus</i> L.	Polygonaceae	<i>Rumex alpinus</i> L.	Hranisava			LC
52	Chenopodeae	<i>Beta vulgaris</i> L.	Chenopodiaceae	<i>Beta vulgaris</i> L. subsp. <i>vulgaris</i>	Sarajevo			LC
53	Caryophylleae	<i>Cerastium moesiacum</i> Friv.	Caryophyllaceae	<i>Cerastium malyi</i> (Georgiev) Niketić	Trebević, Treskavica	trans-regional Balkan endemic		
54	Caryophylleae	<i>Herniaria glabra</i> L.	Caryophyllaceae	<i>Herniaria glabra</i> L.	Bratač (Nevesinje)			LC
55	Caryophylleae	<i>Silene sendtneri</i> Boiss.	Caryophyllaceae	<i>Silene sendtneri</i> Boiss.	Vučija luka-Ozren, Trebević, valley of the Mošćanica, Zec mt. Treskavica, Inač mt.	trans-regional Balkan endemic	LC	LC

No.	Family according to the original collection data	Taxon name according to the original collection data	Family according to Euro+Med PlantBase and the Plant List	Taxon name according to Euro+Med PlantBase and the Plant List	Locality	Endemic status and general range	Red List status in FB&H	European Red List
56	Caryophyllaceae	<i>Heliosperma tommasinii</i> (Vis.) Gris.	Caryophyllaceae	<i>Silene tommasinii</i> Vis.	Fojnica	regional endemic	VU	
57	Caryophyllaceae	<i>Drypis spinosa</i> L.	Caryophyllaceae	<i>Drypis spinosa</i> L.	Treskavica	Balkan-Apennine endemic		
58	Caryophyllaceae	<i>Saponaria officinalis</i> L.	Caryophyllaceae	<i>Saponaria officinalis</i> L.	Sarajevo, Fojnica, Višnjevo			LC
59	Caryophyllaceae	<i>Dianthus plumarius</i> L. var. <i>petraeus</i> W. K.	Caryophyllaceae	<i>Dianthus petraeus</i> Walds. & Kit.	Mt. Trebević, canyon of the Miljacka		LC	LC
60	Ranunculaceae	<i>Eranthis hiemalis</i> L.	Ranunculaceae	<i>Eranthis hiemalis</i> (L.) Salisb.	Usora		CR	
61	Ranunculaceae	<i>Trollius europaeus</i> L.	Ranunculaceae	<i>Trollius europaeus</i> L.	Treskavica, Vitovlje (Travnik)		LC	LC
62	Ranunculaceae	<i>Actaea spicata</i> L.	Ranunculaceae	<i>Actaea spicata</i> L.	Trebević, Bjelašnica, Igman, Busovača, valley of the Lašva			LC
63	Ranunculaceae	<i>Caltha palustris</i> L.	Ranunculaceae	<i>Caltha palustris</i> L.	Valley of the Bosna		CR	LC
64	Ranunculaceae	<i>Anemone narcissiflora</i> L.	Ranunculaceae	<i>Anemonastrum narcissiflorum</i> (L.) Holub	Treskavica		VU	
65	Ranunculaceae	<i>Hepatica triloba</i> Chaix	Ranunculaceae	<i>Hepatica nobilis</i> Mill.	Surroundings of Sarajevo, Trebević		VU	LC
66	Ranunculaceae	<i>Pulsatilla alpina</i> (L.) Del.	Ranunculaceae	<i>Pulsatilla alpina</i> (L.) Delarbre	Zec mt.		VU	
67	Ranunculaceae	<i>Pulsatilla vulgaris</i> All.	Ranunculaceae	<i>Pulsatilla vulgaris</i> Mill.	Surroundings of Rogatica			NT
68	Ranunculaceae	<i>Ranunculus repens</i> L.	Ranunculaceae	<i>Ranunculus repens</i> L.	Kobilja glava			LC
69	Ranunculaceae	<i>Ranunculus lingua</i> L.	Ranunculaceae	<i>Ranunculus lingua</i> L.	Jezero near Jajce			LC
70	Ranunculaceae	<i>Ranunculus aquatilis</i> L.	Ranunculaceae	<i>Ranunculus aquatilis</i> L.	Dobrinja near Sarajevo, along the Miljacka river			LC
71	Ranunculaceae	<i>Thalictrum flavum</i> L.	Ranunculaceae	<i>Thalictrum flavum</i> L.	Papraske, Fojnica, Maglaj		EN	LC
72	Berberideae	<i>Berberis vulgaris</i> L.	Berberideae	<i>Berberis vulgaris</i> L.	Sarajevo			LC
73	Nymphaeaceae	<i>Nuphar luteum</i> (L.) Sm.	Nymphaeaceae	<i>Nuphar lutea</i> (L.) Sm.	Dobož		VU	LC
74	Papaveraceae	<i>Papaver rhoeas</i> L.	Papaveraceae	<i>Papaver rhoeas</i> L.	Sarajevo			LC
75	Papaveraceae	<i>Chelidonium majus</i> L.	Papaveraceae	<i>Chelidonium majus</i> L.	Sarajevo			LC
76	Papaveraceae	<i>Corydalis leiosperma</i> Contr. = <i>Corydalis ochroleuca</i> Koch subsp. <i>leiosperma</i> (Contr.) Hayek	Papaveraceae	<i>Pseudofumaria alba</i> subsp. <i>leiosperma</i> (P. Contrath) Lidén	Stari grad, Lapišnica	trans-regional Balkan endemic	EN	
77	Cruciferae	<i>Nasturtium austriacum</i> Crtz.	Brassicaceae	<i>Rorippa austriaca</i> (Crantz) Besser	Canyon of the Miljacka			LC
78	Cruciferae	<i>Nasturtium silvestre</i> (L.) R. Br.	Brassicaceae	<i>Rorippa sylvestris</i> (L.) Besser	Sarajevo, Vranduk			LC
79	Cruciferae	<i>Nasturtium lippizense</i> (Wulf.) DC.	Brassicaceae	<i>Rorippa lippizensis</i> (Wulfen) Rchb.	Sarajevo, Igman, Konjic, Borci			LC
80	Cruciferae	<i>Cardamine amara</i> L.	Brassicaceae	<i>Cardamine amara</i> L.	Along the Bosna river			LC
81	Cruciferae	<i>Cardamine pratensis</i> L.	Brassicaceae	<i>Cardamine pratensis</i> L.	Along the Bosna river			LC
82	Cruciferae	<i>Dentaria trifolia</i> W. K.	Brassicaceae	<i>Cardamine trifolia</i> L.	Trebević, Pazarić		EN	

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83	Cruciferae	<i>Alyssum moellendorffianum</i> Asch.	Brassicaceae	<i>Alyssum moellendorffianum</i> Asch. ex Beck	Valley of Trešanica, Borci	stenoendemic	EN	
84	Cruciferae	<i>Lepidium campestre</i> (L.) R. Br.	Brassicaceae	<i>Lepidium campestre</i> (L.) W. T. Aiton	Sarajevo, Reljevo			LC
85	Cruciferae	<i>Draba aizoides</i> (L.) R. Br.	Brassicaceae	<i>Draba aizoides</i> L.	Stari grad, Hranisava, Trebević		EN	
86	Cruciferae	<i>Brassica oleracea</i> L.	Brassicaceae	<i>Brassica oleracea</i> L.	Sarajevo			DD
87	Cruciferae	<i>Brassica rapa</i> L.	Brassicaceae	<i>Brassica rapa</i> L.	Sarajevo			DD
88	Cruciferae	<i>Brassica nigra</i> L.	Brassicaceae	<i>Brassica nigra</i> (L.) W. D. J. Koch	Ivan mt.			LC
89	Crassulaceae	<i>Sempervivum heuffelii</i> Schott	Crassulaceae	<i>Jovibarba heuffelii</i> (Schott) Á. Löve & D. Löve	Stari grad, Zec mt., Vučja bara, Višnjevo		NT	
90	Crassulaceae	<i>Sedum acre</i> L.	Crassulaceae	<i>Sedum acre</i> L.	Trebević			LC
91	Crassulaceae	<i>Saxifraga adscendens</i> var. <i>blavii</i> Engler	Saxifragaceae	<i>Saxifraga blavii</i> (Engl.) Beck	Trebević, Dobra voda, Romanija	regional endemic		
92	Rubiaceae	<i>Chrysosplenium alternifolium</i> L.	Saxifragaceae	<i>Chrysosplenium alternifolium</i> L.	Valley of the Bosna, Trebević, valley of the Krupa			LC
93	Hypericaceae	<i>Parnassia palustris</i> L.	Parnassiaceae	<i>Parnassia palustris</i> L.	Trebević, Bijele vode			LC
94	Rosaceae	<i>Spiraea cana</i> W. K.	Rosaceae	<i>Spiraea cana</i> Walld. & Kit.	Dobra voda-Stari grad, canyon of the Miljacka, Ilovača along the valley of the Željeznica			DD
95	Rosaceae	<i>Ulmaria filipendula</i> L.	Rosaceae	<i>Filipendula ulmaria</i> (L.) Maxim.	Sarajevo field			LC
96	Rosaceae	<i>Dryas octopetala</i> L.	Rosaceae	<i>Dryas octopetala</i> L.	Treskavica		VU	
97	Rosaceae	<i>Geum urbanum</i> L.	Rosaceae	<i>Geum urbanum</i> L.	Sarajevo, the valley of the Mošćanica, Igman, Porim, Borci			LC
98	Rosaceae	<i>Geum molle</i> Vis.	Rosaceae	<i>Geum molle</i> Vis. & Pančić	Trebević, Glasinac, Romanija		DD	
99	Rosaceae	<i>Fragaria vesca</i> L.	Rosaceae	<i>Fragaria vesca</i> L.	Central Bosnia			LC
100	Rosaceae	<i>Fragaria moschata</i> Duchesne	Rosaceae	<i>Fragaria moschata</i> Duchesne	Sarajevo, Hrid			LC
101	Rosaceae	<i>Pyrus communis</i> L.	Rosaceae	<i>Pyrus communis</i> L.	Sarajevo			LC
102	Rosaceae	<i>Pyrus torminalis</i> (L.) Ehrh.	Rosaceae	<i>Sorbus torminalis</i> (L.) Crantz	Igman			LC
103	Rosaceae	<i>Pyrus aria</i> (L.) Ehrh.	Rosaceae	<i>Sorbus aria</i> (L.) Crantz	Stari grad, Paljev do, Poljine, Igman, Pazarić			LC
104	Rosaceae	<i>Prunus spinosa</i> L.	Rosaceae	<i>Prunus spinosa</i> L.	Sarajevo			LC
105	Rosaceae	<i>Prunus avium</i> L.	Rosaceae	<i>Prunus avium</i> L.	Valley of the Miljacka, Igman, Treskavica			LC
106	Rosaceae	<i>Prunus mahaleb</i> L.	Rosaceae	<i>Prunus mahaleb</i> L.	Canyon of the Neretva near Bijela			LC
107	Papilionaceae	<i>Cytisus tommasinii</i> Vis.	Fabaceae	<i>Cytisus tommasinii</i> Vis.	Ilovitza, Zelenitza	trans-regional Balkan endemic	VU	
108	Papilionaceae	<i>Cytisus ramentaceus</i> Sieb.	Fabaceae	<i>Petteria ramentacea</i> (Sieber) C. Presl	Jablanica, Pakračić, Prenj, Bijela, Blagaj	regional endemic	NT	LC
109	Papilionaceae	<i>Genista sylvestris</i> Scop. var. <i>dalmatica</i> Beck	Fabaceae	<i>Genista sylvestris</i> Scop. subsp. <i>dalmatica</i> (Bartl.) H. Lindb.	Borci	regional endemic	LC	

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110	Papilionaceae	<i>Vicia orobus</i> DC.	Fabaceae	<i>Vicia orobus</i> DC.	Treskavica			LC
111	Papilionaceae	<i>Vicia oroboides</i> Wulfen	Fabaceae	<i>Vicia oroboides</i> Wulfen	Bjelašnica, Dobra voda-Trebević		LC	LC
112	Papilionaceae	<i>Vicia sepium</i> L.	Fabaceae	<i>Vicia sepium</i> L.	Trebević, Bjela near Konjic, surroundings of Konjic			LC
113	Papilionaceae	<i>Vicia grandiflora</i> Scop.	Fabaceae	<i>Vicia grandiflora</i> Scop.	Bradina, valley of Trešanica, Konjic			LC
114	Papilionaceae	<i>Vicia pannonica</i> Jacqu.	Fabaceae	<i>Vicia pannonica</i> Crantz	Sarajevo			LC
115	Papilionaceae	<i>Vicia sativa</i> L.	Fabaceae	<i>Vicia sativa</i> L.	Surroundings of Sarajevo, Konjic			LC
116	Papilionaceae	<i>Lathyrus tuberosus</i> L.	Fabaceae	<i>Lathyrus tuberosus</i> L.	Surroundings of Sarajevo, valley of the Miljacka			LC
117	Papilionaceae	<i>Lathyrus sylvestris</i> sensu auct.	Fabaceae	<i>Lathyrus sylvestris</i> L.	Trebević			LC
118	Papilionaceae	<i>Lathyrus latifolius</i> L.	Fabaceae	<i>Lathyrus latifolius</i> L.	Trebević, Igman, Višnjevo			LC
119	Papilionaceae	<i>Pisum sativum</i> L.	Fabaceae	<i>Pisum sativum</i> L.	Sarajevo			LC
120	Papilionaceae	<i>Melilotus albus</i> L.	Fabaceae	<i>Melilotus albus</i> Medik	Valley of Bosna, Blažuj, near Jablanica			LC
121	Papilionaceae	<i>Melilotus officinalis</i> Desv.	Fabaceae	<i>Melilotus officinalis</i> (L.) Lam.	Surroundings of Sarajevo, Dupovci, Ravno, Fojnica			LC
122	Papilionaceae	<i>Medicago lupulina</i> L.	Fabaceae	<i>Medicago lupulina</i> L.	Trebević			LC
123	Papilionaceae	<i>Medicago arabica</i> L.	Fabaceae	<i>Medicago arabica</i> (L.) Huds.	Sarajevo field, Mošćanica			LC
124	Papilionaceae	<i>Medicago minima</i> L.	Fabaceae	<i>Medicago minima</i> (L.) L.	Sarajevo, Bendbaša			LC
125	Papilionaceae	<i>Trifolium repens</i> L.	Fabaceae	<i>Trifolium repens</i> L.	Sarajevo, Blažuj			LC
126	Papilionaceae	<i>Trifolium hybridum</i> L.	Fabaceae	<i>Trifolium hybridum</i> L.	Valley of Bosna			LC
127	Papilionaceae	<i>Trifolium arvense</i> L.	Fabaceae	<i>Trifolium arvense</i> L.	Valley of Košava			LC
128	Papilionaceae	<i>Trifolium incarnatum</i> L.	Fabaceae	<i>Trifolium incarnatum</i> L.	Grdonj			LC
129	Papilionaceae	<i>Trifolium pratense</i> L.	Fabaceae	<i>Trifolium pratense</i> L. var. <i>pratense</i>	Sarajevo, valley of the Mošćanica, Treskavica			LC
130	Papilionaceae	<i>Trifolium noricum</i> Wulf.	Fabaceae	<i>Trifolium noricum</i> Wulfen	Treskavica		NT	
131	Papilionaceae	<i>Trifolium alpestre</i> L.	Fabaceae	<i>Trifolium alpestre</i> L.	Vučija luka, Ozren, Blažuj			LC
132	Papilionaceae	<i>Lotus corniculatus</i> L.	Fabaceae	<i>Lotus corniculatus</i> L.	Valley of the Miljacka, Reljevo, surroundings of Sarajevo, Zec mt., Mostarsko blato, Porim			LC
133	Geraniaceae	<i>Geranium sanguineum</i> L.	Geraniaceae	<i>Geranium sanguineum</i> L.	Trebević, Borije			LC
134	Zygophyllaceae	<i>Tribulus terrestris</i> L.	Zygophyllaceae	<i>Tribulus terrestris</i> L. subsp. <i>terrestris</i>	Blagaj			LC
135	Rutaceae	<i>Dictamnus albus</i> L.	Rutaceae	<i>Dictamnus albus</i> L.	Reljevo, Crno vrelo-Grabovica			LC
136	Polygalaceae	<i>Polygala alpestris</i> Rchb.	Polygalaceae	<i>Polygala alpestris</i> Rchb.	Zec mt.		EN	
137	Terebinthaceae	<i>Rhus cotinus</i> L.	Anacardiaceae	<i>Cotinus coggygria</i> Scop.	Stari grad, canyon of the Miljacka, Lapišnica, Borci			LC
138	Aceraceae	<i>Acer platanoides</i> L.	Sapindaceae	<i>Acer platanoides</i> L.	Igman, Bijele vode			LC
139	Aceraceae	<i>Acer campestre</i> L.	Sapindaceae	<i>Acer campestre</i> L.	Trebević, Igman, Višnjevo			LC

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140	Aceraceae	<i>Acer tataricum</i> L.	Sapindaceae	<i>Acer tataricum</i> L.	Sarajevo, Pazarić			LC
141	Aceraceae	<i>Acer pseudoplatanus</i> L.	Sapindaceae	<i>Acer pseudoplatanus</i> L.	Ozren, Igman, Poljine, Paljev do			LC
142	Aceraceae	<i>Acer obtusatum</i> W.K.	Sapindaceae	<i>Acer obtusatum</i> Willd.	Igman			LC
143	Aceraceae	<i>Acer hircanum</i> f. <i>intermedium</i> non Pax	Sapindaceae	<i>Acer hircanum</i> subsp. <i>intermedium</i> (Pantić) Borm.	Stari grad (Sarajevo)	regional endemic	EN	
144	Aceraceae	<i>Acer monspessulanum</i> L.	Sapindaceae	<i>Acer monspessulanum</i> L.	Ivan mt., Gacko			LC
145	Hippocastanaceae	<i>Aesculus hippocastanum</i> L.	Sapindaceae	<i>Aesculus hippocastanum</i> L.	Sarajevo			VU
146	Aquifoliaceae	<i>Ilex aquifolium</i> L.	Aquifoliaceae	<i>Ilex aquifolium</i> L.	Trebević		VU	LC
147	Celastraceae	<i>Euonymus europaeus</i> L.	Celastraceae	<i>Euonymus europaeus</i> L.	Sarajevo, Lapišnica, Kiseljak, Bijela			LC
148	Staphyleaceae	<i>Staphylea pinnata</i> L.	Staphyleaceae	<i>Staphylea pinnata</i> L.	Sarajevo			LC
149	Rhamnaceae	<i>Frangula alnus</i> Mill.	Rhamnaceae	<i>Frangula alnus</i> Mill.	Hranisava, Dobra voda, Vučja bara, Ravno			LC
150	Vitaceae	<i>Vitis vinifera</i> L.	Vitaceae	<i>Vitis vinifera</i> L.	Zujevina, Svrakov potok - Novoselje near Banjaluka			LC
151	Tiliaceae	<i>Tilia argentea</i> Desf.	Malvaceae	<i>Tilia tomentosa</i> Moench	Ivan mt., Bijela near Grabovica, valley of Neretva, Banjaluka			LC
152	Tiliaceae	<i>Tilia platyphylloides</i> Scop.	Malvaceae	<i>Tilia platyphylloides</i> Scop.	Igman, Ivan mt.			LC
153	Malvaceae	<i>Althaea officinalis</i> L.	Malvaceae	<i>Althaea officinalis</i> L.	Maglaj			LC
154	Thymelaeaceae	<i>Daphne mezereum</i> L.	Thymelaeaceae	<i>Daphne mezereum</i> L.	Trebević, Igman			LC
155	Hypericaceae	<i>Hypericum quadrangulum</i> L.	Clusiaceae	<i>Hypericum tetrapterum</i> Fr.	Zec mt.			LC
156	Violaceae	<i>Viola odorata</i> L.	Violaceae	<i>Viola odorata</i> L.	Sarajevo, Trebević, Vrelo Bosne			LC
157	Violaceae	<i>Viola tricolor</i> L.	Violaceae	<i>Viola tricolor</i> L.	Trebević, Fojnica			LC
158	Violaceae	<i>Viola arvensis</i> Murr.	Violaceae	<i>Viola arvensis</i> Murray	Sarajevo			LC
159	Violaceae	<i>Viola calcarata</i> var. <i>zoysii</i> Wulfen	Violaceae	<i>Viola calcarata</i> subsp. <i>zoysii</i> (Wulfen) Murb.	Treskavica	Alpine-Dinaric endemic	VU	
160	Lythraceae	<i>Lythrum salicaria</i> L.	Lythraceae	<i>Lythrum salicaria</i> L.	Sarajevo, Dobra voda - Trebević			LC
161	Lythraceae	<i>Lythrum hyssopifolia</i> L.	Lythraceae	<i>Lythrum hyssopifolia</i> L.	Busovača			LC
162	Haloragaceae	<i>Myriophyllum spicatum</i> L.	Haloragaceae	<i>Myriophyllum spicatum</i> L.	Lake in Herzegovina, Plivsko lake near Jajce, Sana near Prijedor, along the Bosna river			LC
163	Haloragaceae	<i>Hippuris vulgaris</i> L.	Plantaginaceae	<i>Hippuris vulgaris</i> L.	Lake near Jajce		VU	LC
164	Cornaceae	<i>Cornus mas</i> L.	Cornaceae	<i>Cornus mas</i> L.	Trebević, Bijele vode, Igman			LC
165	Araliaceae	<i>Hedera helix</i> L.	Araliaceae	<i>Hedera helix</i> L.	Igman			LC
166	Umbelliferae	<i>Sanicula europaea</i> L.	Apiaceae	<i>Sanicula europaea</i> L.	Trebević, Dobra voda, Bijele vode, Pazarić			LC
167	Umbelliferae	<i>Eryngium palmatum</i> Pantić & Vis.	Apiaceae	<i>Eryngium palmatum</i> Pantić & Vis.	Igman	trans-regional Balkan endemic	DD	

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168	Umbelliferae	<i>Berula angustifolia</i> (R.) Koch	Apiaceae	<i>Berula erecta</i> (Huds.) Coville	Dobrinjka, the valley of the Pliva, lake in Herzegovina			LC
169	Umbelliferae	<i>Pancicia serbica</i> Vis.	Apiaceae	<i>Pancicia serbica</i> Vis.	Glog near Drijevac, Vučija bara, Trebević, Treskavica	trans-regional Balkan endemic	EN	
170	Umbelliferae	<i>Bupleurum ranunculoides</i> L.	Apiaceae	<i>Bupleurum ranunculoides</i> L.	Treskavica		DD	
171	Umbelliferae	<i>Peucedanum longifolium</i> Walld. & Kit.	Apiaceae	<i>Peucedanum longifolium</i> Walld. & Kit.	Gacko		EN	
172	Ericaceae	<i>Pyrola rotundifolia</i> L.	Ericaceae	<i>Pyrola rotundifolia</i> L.	Trebević		DD	
173	Ericaceae	<i>Calluna vulgaris</i> (L.) Salisb.	Ericaceae	<i>Calluna vulgaris</i> (L.) Hull	Trebević, Mokro, Vjetrenica			LC
174	Ericaceae	<i>Arctostaphylos uva-ursi</i> (L.) Spreng.	Ericaceae	<i>Arctostaphylos uva-ursi</i> (L.) Spreng.	Trebević			LC
175	Ericaceae	<i>Vaccinium myrtillus</i> L.	Ericaceae	<i>Vaccinium myrtillus</i> L.	Trebević, Ozren			LC
176	Primulaceae	<i>Primula elatior</i> (L.) Jacq.	Primulaceae	<i>Primula elatior</i> (L.) Hill	Trebević, Igman, Hranisava, Bjelašnica, Treskavica			LC
177	Primulaceae	<i>Primula longiflora</i> L.	Primulaceae	<i>Primula halleri</i> J. F. Gmel.	Treskavica		CR	
178	Primulaceae	<i>Soldanella alpina</i> L.	Primulaceae	<i>Soldanella alpina</i> L.	Zec mt.		LC	
179	Primulaceae	<i>Cyclamen neapolitanum</i> Ten.	Primulaceae	<i>Cyclamen hederifolium</i> Aiton	Grabovica, Jablanica, Porim		CR	
180	Primulaceae	<i>Cyclamen europaeum</i> L.	Primulaceae	<i>Cyclamen purpurascens</i> Mill.	Trebević, Ivan mt., Bijela, Grabovica, Maglaj		LC	LC
181	Primulaceae	<i>Lysimachia vulgaris</i> L.	Primulaceae	<i>Lysimachia vulgaris</i> L.	Valley of the Bosna river			LC
182	Primulaceae	<i>Lysimachia nummularia</i> L.	Primulaceae	<i>Lysimachia nummularia</i> L.	Kobilja glava			LC
183	Jasminaceae	<i>Fraxinus ornus</i> L.	Oleaceae	<i>Fraxinus ornus</i> L.	Sarajevo, Poljine, Paljev do, Hranisava, Kalinovik, Grabovica			LC
184	Jasminaceae	<i>Fraxinus excelsior</i> Scop.	Oleaceae	<i>Fraxinus excelsior</i> L.	Trebević, Ravno			NT
185	Gentianaceae	<i>Erythraea centaurium</i> (L.) Pers.	Gentianaceae	<i>Centaurium erythraea</i> Rafn	Valley of Košava, Igman			LC
186	Gentianaceae	<i>Gentiana symphyandra</i> Murb.	Gentianaceae	<i>Gentiana lutea</i> L. subsp. <i>symphyandra</i> (Murb.) Hayek	Treskavica	trans-regional Balkan endemic	EN	
187	Gentianaceae	<i>Gentiana pneumonanthe</i> L.	Gentianaceae	<i>Gentiana pneumonanthe</i> L.	Kobilja glava, Dobra voda			LC
188	Gentianaceae	<i>Gentianella ciliata</i> L.	Gentianaceae	<i>Gentianella ciliata</i> (L.) Borkh.	Ozren, Trebević		DD	
189	Gentianaceae	<i>Gentianella crispata</i> Vis.	Gentianaceae	<i>Gentianella crispata</i> (Vis.) Holub	Trebević, Bijele vode, Ravno	Balkan-Apenine endemic	VU	
190	Boraginaceae	<i>Onosma stellulata</i> Walld. & Kit.	Boraginaceae	<i>Onosma stellulata</i> Walld. & Kit.	Stari grad, Hrid, Lapišnica, Borci, Bjelašnica, Pazarić	regional endemic	LC	
191	Boraginaceae	<i>Moltkia petraea</i> (Tratt.) Gris.	Boraginaceae	<i>Moltkia petraea</i> (Tratt.) Griseb.	Crno vrelo-Grabovica	trans-regional Balkan endemic	NT	

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192	Boraginaceae	<i>Pulmonaria officinalis</i> L.	Boraginaceae	<i>Pulmonaria officinalis</i> L.	Sarajevo and surroundings			LC
193	Boraginaceae	<i>Symphytum officinale</i> L.	Boraginaceae	<i>Symphytum officinale</i> L.	Sarajevo and surroundings			LC
194	Boraginaceae	<i>Myosotis palustris</i> (L.) W. K.	Boraginaceae	<i>Myosotis scorpioides</i> L.	Canyon of the Miljacka			LC
195	Verbenaceae	<i>Verbena officinalis</i> L.	Verbenaceae	<i>Verbena officinalis</i> L.	Sarajevo field, Crno vrelo-Grabovica, Mostar field			LC
196	Labiatae	<i>Ajuga pyramidalis</i> L.	Lamiaceae	<i>Ajuga pyramidalis</i> L.	Treskavica		LC	
197	Labiatae	<i>Teucrium arduinii</i> L.	Lamiaceae	<i>Teucrium arduinii</i> L.	Grabovica	regional endemic	LC	
198	Labiatae	<i>Teucrium chamaedrys</i> L.	Lamiaceae	<i>Teucrium chamaedrys</i> L.	Trebević, Igman, Mostar			LC
199	Labiatae	<i>Marrubium vulgare</i> L.	Lamiaceae	<i>Marrubium vulgare</i> L.	Valley of Bistrica			NT
200	Labiatae	<i>Leonurus cardiaca</i> L.	Lamiaceae	<i>Leonurus cardiaca</i> L.	Lepenica, Kokorina			LC
201	Labiatae	<i>Ballota nigra</i> Link	Lamiaceae	<i>Ballota nigra</i> L.	Sarajevo and surroundings			LC
202	Labiatae	<i>Stachys anisochila</i> Vis. & Panč.	Lamiaceae	<i>Stachys anisochila</i> Vis. & Panč.	Konjic	trans-regional Balkan endemic	LC	LC
203	Labiatae	<i>Stachys palustris</i> L.	Lamiaceae	<i>Stachys palustris</i> L.	Gorica			LC
204	Labiatae	<i>Nepeta cataria</i> L.	Lamiaceae	<i>Nepeta cataria</i> L.	Kobilja glava, Vogošća-Koševo, Vranduk			LC
205	Labiatae	<i>Glechoma hederacea</i> L.	Lamiaceae	<i>Glechoma hederacea</i> L.	Grdonj			LC
206	Labiatae	<i>Glechoma hirsuta</i> W.K.	Lamiaceae	<i>Glechoma hirsuta</i> Waldst. & Kit.	Canyon of the Miljacka, Vogošća, Zujevin, valley of the Lašva			DD
207	Labiatae	<i>Prunella vulgaris</i> L.	Lamiaceae	<i>Prunella vulgaris</i> L.	Sarajevo			LC
208	Labiatae	<i>Melissa officinalis</i> L.	Lamiaceae	<i>Melissa officinalis</i> L.	Tisovac			LC
209	Labiatae	<i>Satureja hortensis</i> L.	Lamiaceae	<i>Satureja hortensis</i> L.	Sarajevo			DD
210	Labiatae	<i>Satureja cuneifolia</i> Ten.	Lamiaceae	<i>Satureja cuneifolia</i> Ten.	Blagaj, surroundings of Nevesinje			LC
212	Labiatae	<i>Calamintha thymifolia</i> Rchb.	Lamiaceae	<i>Clinopodium thymifolium</i> (Scop.) Kuntze	Trebević, Grdonj, Lapišnica, valley of the Željeznica, Vranduk, Crna rijeka, Grabovica, Jablanica	regional endemic		
213	Labiatae	<i>Hyssopus officinalis</i> L.	Lamiaceae	<i>Hyssopus officinalis</i> L.	Pojline, Paljev do			DD
214	Labiatae	<i>Origanum vulgare</i> L.	Lamiaceae	<i>Origanum vulgare</i> L.	Trebević			LC
215	Labiatae	<i>Thymus janikae</i> Čelak	Lamiaceae	<i>Thymus praecox</i> subsp. <i>janikae</i> (Čelak.) Jales	Canyon of the Miljacka	trans-regional Balkan endemic		
216	Labiatae	<i>Thymus serpyllum</i> L.	Lamiaceae	<i>Thymus serpyllum</i> L.	Trebević			LC
217	Labiatae	<i>Lycopus europaeus</i> L.	Lamiaceae	<i>Lycopus europaeus</i> L.	Blažuj, Lukavica, Busovača			LC
218	Labiatae	<i>Lycopus exaltatus</i> L.	Lamiaceae	<i>Lycopus exaltatus</i> L. f.	Reljevo			LC
219	Labiatae	<i>Mentha pulegium</i> L.	Lamiaceae	<i>Mentha pulegium</i> L.	Reljevo, Kokorina			LC

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220	Labiatae	<i>Mentha aquatica</i> L.	Lamiaceae	<i>Mentha aquatica</i> L.	Sarajevo field, lake (Herzegovina)			LC
221	Labiatae	<i>Salvia officinalis</i> L.	Lamiaceae	<i>Salvia officinalis</i> L.	Valley of the Neretva, Crno vrelo-Grabovica, Bijela			LC
223	Scrophulariaceae	<i>Gratiola officinalis</i> L.	Plantaginaceae	<i>Gratiola officinalis</i> L.	Mostarsko blato			LC
224	Scrophulariaceae	<i>Scrophularia scopoli</i> Hoppe	Scrophulariaceae	<i>Scrophularia scopoli</i> Hoppe	Banjaluka, valley of Sana, near Prijedor, Bjelašnica, Stari grad, Fojnica		DD	
225	Scrophulariaceae	<i>Scrophularia nodosa</i> L.	Scrophulariaceae	<i>Scrophularia nodosa</i> L.	Valley of Bosna, Ivan mt.			LC
226	Scrophulariaceae	<i>Digitalis ambigua</i> Murray	Plantaginaceae	<i>Digitalis grandiflora</i> Mill.	Stari grad, Blažuj, Bijele vode, Kalinovik			LC
227	Scrophulariaceae	<i>Digitalis laevigata</i> Walds. & Kit.	Plantaginaceae	<i>Digitalis laevigata</i> Walds. & Kit.	Crno vrelo - Grabovica	trans-regional Balkan endemic		
228	Scrophulariaceae	<i>Veronica satyroides</i> Vis.	Plantaginaceae	<i>Veronica satyroides</i> Vis.	Hranisava	regional endemic	EN	
229	Scrophulariaceae	<i>Veronica aphylla</i> L.	Plantaginaceae	<i>Veronica aphylla</i> L.	Treskavica		VU	
230	Scrophulariaceae	<i>Veronica beccabunga</i> L.	Plantaginaceae	<i>Veronica beccabunga</i> L.	Lapišnica			LC
231	Scrophulariaceae	<i>Melampyrum trichocalycinum</i> Vandas	Orobanchaceae	<i>Melampyrum trichocalycinum</i> Vandas	Grabovica	stenoendemic	VU	
232	Scrophulariaceae	<i>Pedicularis foliosa</i> L.	Orobanchaceae	<i>Pedicularis hoermanniana</i> K.Maly	Trebević, Treskavica	trans-regional Balkan endemic	VU	
233	Scrophulariaceae	<i>Pedicularis leucodon</i> Griseb.	Orobanchaceae	<i>Pedicularis leucodon</i> Griseb.	Treskavica		VU	
234	Globulariaceae	<i>Globularia cordifolia</i> L.	Plantaginaceae	<i>Globularia cordifolia</i> L.	Stari grad, valley of the Miliacka, Trebević, Zec			LC
235	Rubiaceae	<i>Asperula odorata</i> L.	Rubiaceae	<i>Galium odoratum</i> (L.) Scop.	Ozren, Hranisava, Bijele vode, Gradina, Romanija, Zec			LC
236	Rubiaceae	<i>Galium verum</i> L.	Rubiaceae	<i>Galium verum</i> L.	Sarajevo field, Trebević, Kokorina, Ravno			LC
237	Plantaginaceae	<i>Plantago major</i> L.	Plantaginaceae	<i>Plantago major</i> L.	Sarajevo field, Kokorina			LC
238	Plantaginaceae	<i>Plantago gentianoides</i> Sibth. & Sm.	Plantaginaceae	<i>Plantago gentianoides</i> Sibth. & Sm.	Treskavica		EN	
239	Caprifoliaceae	<i>Sambucus nigra</i> L.	Viburnaceae	<i>Sambucus nigra</i> L.	Sarajevo			LC
240	Caprifoliaceae	<i>Lonicera alpigena</i> L.	Caprifoliaceae	<i>Lonicera alpigena</i> L.	Dobra voda, Poljane, Paljev do, Krupa, Pazarić, Višnjevo			LC
241	Caprifoliaceae	<i>Lonicera nigra</i> L.	Caprifoliaceae	<i>Lonicera nigra</i> L.	Dobra voda, Poljane, Paljev do			LC
242	Dipsacaceae	<i>Cephalaria pastricensis</i> Hayek	Dipsacaceae	<i>Cephalaria pastricensis</i> Dorfl. & Hayek	Kokorina kod Gacka	trans-regional Balkan endemic	VU	
243	Dipsacaceae	<i>Scabiosa graminifolia</i> L.	Dipsacaceae	<i>Scabiosa graminifolia</i> L.	Borci, valley of the Trešnica, Prenj, Grabovica		NT	
244	Dipsacaceae	<i>Scabiosa silenifolia</i> Walds. & Kit.	Dipsacaceae	<i>Scabiosa silenifolia</i> Walds. & Kit.	Treskavica	Dinaric-Apennine endemic		

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245	Campanulaceae	<i>Symphylandra hofmannii</i> Pant.	Campanulaceae	<i>Campanula hofmannii</i> (Pant.) Greuter & Burdet	Busovača, Vranduk, valley of the Lašva, Fojnica, Srebrenik, Maglaj, valley of the Ugar river	stenoendemic	NT	
246	Campanulaceae	<i>Campanula trichocalycina</i> Ten.	Campanulaceae	<i>Asyneuma trichocalycinum</i> (Ten.) K. Malý	Treskavica	trans-regional Balkan endemic	NT	
247	Campanulaceae	<i>Phyteuma orbiculare</i> L.	Campanulaceae	<i>Phyteuma orbiculare</i> L.	Treskavica, Zec mt., Bila, Borci		LC	
248	Campanulaceae	<i>Phyteuma sieberi</i> Spreng.	Campanulaceae	<i>Phyteuma sieberi</i> Spreng.	Zec mt.		VU	
249	Campanulaceae	<i>Hedraeanthus dalmaticus</i> Bartl.	Campanulaceae	<i>Edraianthus dalmaticus</i> (A.DC.) A.DC.	Stari grad, Trebević, Lapišnica, Glog	regional endemic	VU	
250	Campanulaceae	<i>Hedraeanthus serpyllifolius</i> (Vis.) DC.	Campanulaceae	<i>Edraianthus serpyllifolius</i> (Vis.) A.DC.	Treskavica	regional endemic	LC	
251	Campanulaceae	<i>Hedraeanthus niveus</i> Beck	Campanulaceae	<i>Edraianthus niveus</i> Beck	Zec mt.	stenoendemic	EN	
252	Synantheraceae	<i>Solidago virgaurea</i> L.	Compositae	<i>Solidago virgaurea</i> L.	Stari grad, Trebević, Romanija, Poljane, Paljev do, Kalinovik, Busovača			LC
253	Synantheraceae	<i>Bellidistrum michelii</i> Cass.	Compositae	<i>Bellidistrum michelii</i> Cass.	Treskavica		EN	
254	Synantheraceae	<i>Inula helenium</i> L.	Compositae	<i>Inula helenium</i> L.	Valley of the Bosna			LC
255	Synantheraceae	<i>Telekia speciosa</i> (Schreb.) Baumg.	Compositae	<i>Telekia speciosa</i> (Schreb.) Baumg.	Valley of the Dusina, Romanija		VU	
256	Synantheraceae	<i>Bidens tripartita</i> L.	Compositae	<i>Bidens tripartita</i> L.	Stari grad, surroundings of Sarajevo, Kiseljak			LC
257	Synantheraceae	<i>Achillea clavennae</i> L.	Compositae	<i>Achillea clavennae</i> L.	Treskavica		VU	
258	Synantheraceae	<i>Achillea linguata</i> W. K.	Compositae	<i>Achillea linguata</i> Walds. & Kit.	Zec mt.		VU	
259	Synantheraceae	<i>Achillea millefolium</i> L.	Compositae	<i>Achillea millefolium</i> L.	Vučja luka, Kotorina			LC
260	Synantheraceae	<i>Matricaria chamomilla</i> L.	Compositae	<i>Matricaria chamomilla</i> L.	Sarajevo field			LC
261	Synantheraceae	<i>Chrysanthemum cinerariifolium</i> (Trev.) Vis.	Compositae	<i>Tanacetum cinerariifolium</i> (Trev.) Sch. Bip.	Crno vrelo-Grabovica, Mostar field, Porim	trans-regional Balkan endemic	VU	LC
262	Synantheraceae	<i>Artemisia vulgaris</i> L.	Compositae	<i>Artemisia vulgaris</i> L.	Sarajevo			LC
263	Synantheraceae	<i>Petasites albus</i> (L.) Gaertn.	Compositae	<i>Petasites albus</i> (L.) Gaertn.	Stari grad, canyon of the Miljacka			LC
264	Synantheraceae	<i>Petasites kablíkianus</i> Tsch.	Compositae	<i>Petasites kablíkianus</i> Bercht.	Stari grad		EN	
265	Synantheraceae	<i>Arnica montana</i> L.	Compositae	<i>Arnica montana</i> L.	Vučja luka (Ozren), Zec mt.		VU	LC
266	Synantheraceae	<i>Centaurea kotschyana</i> Heuff.	Compositae	<i>Centaurea kotschyana</i> W. D. J. Koch	Treskavica		VU	
267	Synantheraceae	<i>Centaurea punctata</i> Vis.	Compositae	<i>Centaurea glaberrima</i> Tausch	Near Blagaj, Prenj	regional endemic	EN	
268	Synantheraceae	<i>Centaurea cyanus</i> L.	Compositae	<i>Centaurea cyanus</i> L.	Sarajevo field			LC
269	Synantheraceae	<i>Cichorium intybus</i> L.	Compositae	<i>Cichorium intybus</i> L.	Surroundings of Sarajevo			LC
270	Synantheraceae	<i>Lactuca saligna</i> L.	Compositae	<i>Lactuca saligna</i> L.	Foča, Mostarsko polje			LC

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271	Synanthraceae	<i>Mulgedium pancici</i> Vis.	Compositae	<i>Lactuca pancicii</i> (Vis.) N. Kilian & Greuter	Treskavica	trans-regional Balkan endemic	VU	LC
272	Synanthraceae	<i>Crepis blavii</i> Ascher.	Compositae	<i>Crepis pannonica</i> subsp. <i>blavii</i> (Asch.) M. A. Fisch. & D. Dimitrova	Paljev do-Bakračuša	regional endemic	DD	
273	Synanthraceae	<i>Hieracium waldsteinii</i> Tausch	Compositae	<i>Hieracium waldsteinii</i> Tausch	Valley of the Mošćanica, Višnjevo, Gacko, Lipnik near Gacko		EN	
274	Alismataceae	<i>Alisma plantago-aquatica</i> L.	Alismataceae	<i>Alisma plantago-aquatica</i> L.	Surroundings of Sarajevo			LC
275	Najadaceae	<i>Potamogeton lucens</i> L.	Potamogetonaceae	<i>Potamogeton lucens</i> L.	Lake near Jajce			LC
276	Najadaceae	<i>Potamogeton perfoliatus</i> L.	Potamogetonaceae	<i>Potamogeton perfoliatus</i> L.	Sana near Prijedor			LC
277	Najadaceae	<i>Potamogeton pusillus</i> L.	Potamogetonaceae	<i>Potamogeton pusillus</i> L.	Along the Bosna and Miljacka rivers			LC
278	Najadaceae	<i>Potamogeton crispus</i> L.	Potamogetonaceae	<i>Potamogeton crispus</i> L.	Ilidža			LC
279	Liliaceae	<i>Tofieldia calyculata</i> (L.) Wh.	Tofieldiaceae	<i>Tofieldia calyculata</i> (L.) Wahlenb.	Treskavica		VU	
280	Liliaceae	<i>Veratrum album</i> L.	Melanthiaceae	<i>Veratrum album</i> L.	Igman			LC
281	Liliaceae	<i>Colchicum visianii</i> Parl.	Colchicaceae	<i>Colchicum haynaldii</i> Heuff.	Stari grad (Sarajevo)		CR	
282	Liliaceae	<i>Erythronium dens-canis</i> L.	Liliaceae	<i>Erythronium dens-canis</i> L.	Trebević, Prača, Igman, Blažuj		LC	LC
283	Liliaceae	<i>Lilium martagon</i> L.	Liliaceae	<i>Lilium martagon</i> L.	Trebević		LC	LC
284	Liliaceae	<i>Scilla bifolia</i> L.	Asparagaceae	<i>Scilla bifolia</i> L.	Sarajevo, Igman, Reljevo			LC
285	Liliaceae	<i>Scilla pratensis</i> W. K.	Asparagaceae	<i>Chouardia litardierei</i> (Breistr.) Speta	Sarajevo, Borci	regional endemic	VU	NT
286	Liliaceae	<i>Allium ursinum</i> L.	Amaryllidaceae	<i>Allium ursinum</i> L.	Pazaric			LC
287	Liliaceae	<i>Allium carinatum</i> (L.) Koch	Amaryllidaceae	<i>Allium carinatum</i> L.	Trebević, Lukavica, valley of the Željeznica, Vranduk, Ivan mt., Konjic			LC
288	Liliaceae	<i>Allium scorodoprasum</i> L.	Amaryllidaceae	<i>Allium scorodoprasum</i> L.	Valley of Košava, Trebević			LC
289	Smilacae	<i>Convallaria majalis</i> L.	Asparagaceae	<i>Convallaria majalis</i> L.	Trebević		NT	LC
290	Smilacae	<i>Asparagus acutifolius</i> L.	Asparagaceae	<i>Asparagus acutifolius</i> L.	Mostar field, Pakračić-Blagaj			LC
291	Smilacae	<i>Asparagus officinalis</i> L.	Asparagaceae	<i>Asparagus officinalis</i> L.	Mokro			LC
292	Smilacae	<i>Paris quadrifolia</i> L.	Melanthiaceae	<i>Paris quadrifolia</i> L.	Surroundings of Sarajevo			LC
293	Smilacae	<i>Ruscus aculeatus</i> L.	Asparagaceae	<i>Ruscus aculeatus</i> L.	Mostar, Crna rijeka-Grabovica		VU	LC
294	Smilacae	<i>Ruscus hypoglossum</i> L.	Asparagaceae	<i>Ruscus hypoglossum</i> L.	Bjelašnica, towards Kreševo		VU	LC
295	Amaryllidaceae	<i>Galanthus nivalis</i> L.	Amaryllidaceae	<i>Galanthus nivalis</i> L.	Trebević, Igman		NT	NT
296	Amaryllidaceae	<i>Narcissus poeticus</i> L.	Amaryllidaceae	<i>Narcissus poeticus</i> L.	Sarajevo			LC
297	Iridaceae	<i>Iris bosniaca</i> Beck	Iridaceae	<i>Iris reichenbachii</i> Heuff.	Trebević	regional endemic	LC	

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298	Iridaceae	<i>Iris pseudacorus</i> L.	Iridaceae	<i>Iris pseudacorus</i> L.	Reljevo			LC
299	Iridaceae	<i>Crocus biflorus</i> Mill.	Iridaceae	<i>Crocus biflorus</i> Mill.	Konjic, Mostar		CR	
300	Iridaceae	<i>Gladiolus imbricatus</i> L.	Iridaceae	<i>Gladiolus imbricatus</i> L.	Karaula (Travnik)		EN	
301	Juncaceae	<i>Juncus effusus</i> L.	Juncaceae	<i>Juncus effusus</i> L.	Blažuj, valley of the Željeznica			LC
302	Juncaceae	<i>Juncus trifidus</i> L.	Juncaceae	<i>Juncus trifidus</i> L.	Zec mt.		EN	
303	Juncaceae	<i>Juncus bufonius</i> L.	Juncaceae	<i>Juncus bufonius</i> L.	Valley of the Bosna			LC
304	Juncaceae	<i>Juncus lamprocarpus</i> Ehrh.	Juncaceae	<i>Juncus articulatus</i> L.	Ilidža, Dobrinjka, Željeznica, Pliva			LC
305	Gramineae	<i>Festuca rubra</i> L.	Poaceae	<i>Festuca rubra</i> L.	Sarajevo field			LC
306	Gramineae	<i>Festuca ovina</i> L.	Poaceae	<i>Festuca ovina</i> L.	Glog, Sarajevo field, Berkua, Trebević			LC
307	Gramineae	<i>Lolium perenne</i> L.	Poaceae	<i>Lolium perenne</i> L.	Sarajevo			LC
308	Gramineae	<i>Poa pratensis</i> L.	Poaceae	<i>Poa pratensis</i> L.	Sarajevo, Trebević, Reljevo, Kobilja glava			LC
309	Gramineae	<i>Poa alpina</i> L. var. <i>badensis</i> Haenke	Poaceae	<i>Poa alpina</i> L.	Berkua, Trebević			LC
310	Gramineae	<i>Catabrosa aquatica</i> (L.) P. B.	Poaceae	<i>Catabrosa aquatica</i> (L.) P. Beauv.	Vrelo Bosne (the spring of the Bosna river)			LC
311	Gramineae	<i>Bromus moellendorffianus</i> Aschers. & Graebner	Poaceae	<i>Bromus moellendorffianus</i> (Asch. & Graebn.) Hayek	Ablakovina (Trebević)	regional endemic	CR	
312	Gramineae	<i>Hordeum murinum</i> L.	Poaceae	<i>Hordeum murinum</i> L.	Sarajevo			LC
313	Gramineae	<i>Avena blavii</i> Janka	Poaceae	<i>Helictotrichon blavii</i> (Asch. & Janka) C.E.Hubb.	Trebević	regional endemic		
314	Gramineae	<i>Phleum pratense</i> L.	Poaceae	<i>Phleum pratense</i> L.	Lopata mt., Zec mt.			LC
315	Gramineae	<i>Alopecurus pratensis</i> L.	Poaceae	<i>Alopecurus pratensis</i> L.	Reljevo			LC
316	Gramineae	<i>Alopecurus geniculatus</i> L.	Poaceae	<i>Alopecurus geniculatus</i> L.	Sarajevo			LC
317	Gramineae	<i>Arundo phragmites</i> L.	Poaceae	<i>Phragmites australis</i> (Cav.) Steud.	Ilidža, Reljevo			LC
318	Araceae	<i>Lemna minor</i> L.	Lemnaceae	<i>Lemna minor</i> L.	Dobrinja (Sarajevo)			LC
319	Araceae	<i>Typha angustifolia</i> L.	Typhaceae	<i>Typha angustifolia</i> L.	Surroundings of Sarajevo, Blažuj			LC
320	Araceae	<i>Typha latifolia</i> L.	Typhaceae	<i>Typha latifolia</i> L.	Sarajevo field, valley of the Bosna			LC
321	Cyperaceae	<i>Scirpus palustris</i> L.	Cyperaceae	<i>Eleocharis palustris</i> (L.) Roem. & Schult.	Mošćanica, Reljevo			LC
322	Cyperaceae	<i>Scirpus sylvaticus</i> L.	Cyperaceae	<i>Scirpus sylvaticus</i> L.	Valley of the Miljacka			LC
323	Cyperaceae	<i>Cyperus fuscus</i> L.	Cyperaceae	<i>Cyperus fuscus</i> L.	Buna			LC
324	Cyperaceae	<i>Cyperus flavescens</i> L.	Cyperaceae	<i>Cyperus flavescens</i> L.	Busovača			LC
325	Cyperaceae	<i>Carex rostrata</i> W.	Cyperaceae	<i>Carex rostrata</i> Hoppe ex Schkuhr	Romanija			LC
326	Cyperaceae	<i>Carex vesicaria</i> L.	Cyperaceae	<i>Carex vesicaria</i> L.	Reljevo			LC
327	Orchidaceae	<i>Epipactis palustris</i> Cr.	Orchidaceae	<i>Epipactis palustris</i> (L.) Crantz	Plivsko lake near Jajce			LC

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328	Orchidaceae	<i>Cephalanthera rubra</i> (L.) Rchb.	Orchidaceae	<i>Cephalanthera rubra</i> (L.) Rich.	Stari grad, canyon of Miljacka, Treskavica		VU	LC
329	Orchidaceae	<i>Neottia nidus-avis</i> (L.) Rich.	Orchidaceae	<i>Neottia nidus-avis</i> (L.) Rich.	Ozren			LC
330	Orchidaceae	<i>Neottia ovata</i> (L.) Bl. & Fing.	Orchidaceae	<i>Neottia ovata</i> (L.) Bluff & Fingerh.	Stari grad, Trebević, Bjelašnica			LC
331	Orchidaceae	<i>Platanthera bifolia</i> (L.) Rchb. fil.	Orchidaceae	<i>Platanthera bifolia</i> (L.) Rich.	Stari grad, Trebević, Igman, near Blažuj		NT	LC
332	Orchidaceae	<i>Gymnadenia conopsea</i> (L.) R.Br.	Orchidaceae	<i>Gymnadenia conopsea</i> (L.) R.Br.	Stari grad, Trebević, Bradina			LC
333	Orchidaceae	<i>Nigritella nigra</i> Scop.	Orchidaceae	<i>Gymnadenia rhellicani</i> (Teppner & E.Klein) Teppner & E.Klein	Dobra voda on Trebević		NT	LC
334	Orchidaceae	<i>Orchis sambucina</i> L.	Orchidaceae	<i>Dactylorhiza sambucina</i> (L.) Soo	Ozren, Trebević, Lapišnica, Hranisava, Reljevo			LC
335	Orchidaceae	<i>Orchis incarnata</i> L.	Orchidaceae	<i>Dactylorhiza incarnata</i> (L.) Soo	Trebević, valley of the Željeznica - Hrasnica, Hreša - Han, Tarčin			LC
336	Orchidaceae	<i>Orchis maculata</i> L.	Orchidaceae	<i>Dactylorhiza maculata</i> (L.) Soó subsp. <i>maculata</i>	Stari grad, Dupovci, valley of the Mošćanica, Trebević		VU	LC
337	Orchidaceae	<i>Orchis globosa</i> L.	Orchidaceae	<i>Trautsteinera globosa</i> (L.) Rchb.	Han near Nahorevo		NT	LC
338	Orchidaceae	<i>Orchis morio</i> L.	Orchidaceae	<i>Orchis morio</i> L.	Surroundings of Sarajevo			NT
339	Orchidaceae	<i>Orchis ustulata</i> L.	Orchidaceae	<i>Neottia ustulata</i> (L.) R. M. Bateman, Pridgeon & M. W. Chase	Surroundings of Sarajevo			LC
340	Orchidaceae	<i>Orchis tridentata</i> Scop.	Orchidaceae	<i>Neottia tridentata</i> (Scop.) R. M. Bateman, Pridgeon & M. W. Chase	Valley of the Miljacka, Lapišnica			LC
341	Orchidaceae	<i>Orchis simia</i> Link	Orchidaceae	<i>Orchis simia</i> Lam.	Trebević, Pazarić		VU	LC
342	Orchidaceae	<i>Orchis purpurea</i> Huds.	Orchidaceae	<i>Orchis purpurea</i> Huds.	Reljevo		VU	LC
343	Orchidaceae	<i>Orchis mascula</i> L.	Orchidaceae	<i>Orchis mascula</i> (L.) L.	Trebević			LC
344	Orchidaceae	<i>Orchis pallens</i> L.	Orchidaceae	<i>Orchis pallens</i> L.	Igman			LC
345	Orchidaceae	<i>Aceras pyramidalis</i> (L.) Rchb. fil.	Orchidaceae	<i>Anacamptis pyramidalis</i> (L.) L.C.M. Richard	Stari grad (Sarajevo)		NT	LC
346	Orchidaceae	<i>Ophrys aranifera</i> Huds.	Orchidaceae	<i>Ophrys sphegodes</i> Mill. subsp.	Stari grad, Hum			LC
347	Orchidaceae	<i>Ophrys fuciflora</i> Scop.	Orchidaceae	<i>Ophrys fuciflora</i> (F.W.Schmidt) Moench	Canyon of the Miljacka			LC
348	Orchidaceae	<i>Ophrys apifera</i> Huds.	Orchidaceae	<i>Ophrys apifera</i> Huds.	Grdonj			LC

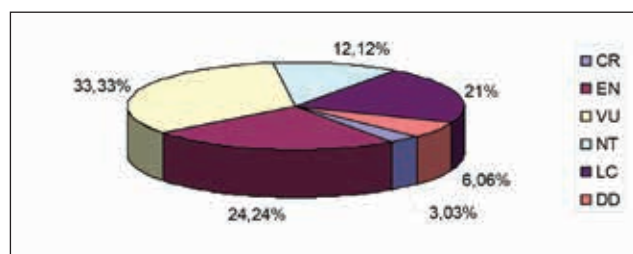


Figure 1. IUCN Threatened status of endemic species in Blau's herbarium according to the Red List of FB&H

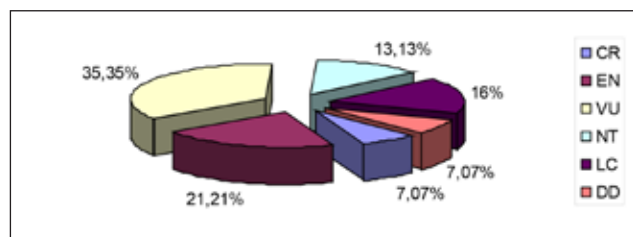


Figure 2. IUCN Threatened status of species from Blau's collection according to the Red List of FB&H

from Bosnia and Herzegovina (1404) confirmed that a total of 341 taxa have conservation status:

- 99 (30%) taxa are included in the Red List of FBiH (**CR** – 7 species, **EN** – 21 species, **VU** – 35 species, **NT** – 13 species, **LC** – 16 species, **DD** – 7 species) (Fig. 2);
- 274 (80%) taxa are included in the European Red List (**VU** – 1 species, **NT** – 7 species, **LC** – 259 species, **DD** – 7 species);
- 35 (10%) taxa were included in both lists (Fig. 2).

CONCLUSION

The review of literature sources and their comparison with the original collection material confirmed the floristic value of Blau's herbarium on the basis of the following:

- of the total number of species and subspecies (1404) of the *Herbarium Blavianum* collection originating from Bosnia and Herzegovina, 2.9% are endemics mostly of trans-regional (**TRE**), regional (**RE**), and local (**LE**) distributions;
- of the 41 registered endemic species, 33 have a defined conservation status in the Federation of Bosnia and Herzegovina, while 6 taxa are included in the European Red List: *Chouardia litardierei* (Breistr.) Speta - Near Threatened (**NT**), *Silene sendtneri* Boiss., *Petteria ramentacea* (Sieber) C. Presl, *Stachys anisochila* Vis. & Panč., *Tanacetum cinerariifolium* (Trevir.) Sch. Bip., *Lactuca pancicii* (Vis.) N. Kilian & Greuter – Last Concern (**LC**);
- of the total number of endemic species if the Blau's collection, 20 are at risk of extinction (**CR**, **EN**, **VU**);
- the endangered part of the collection is represented by 341 species, of which 30% are included in the Red List of the Federation of BiH, 80% in the European Red List and 10% in both lists;
- taxonomic revision indicated numerous changes in the status of species at the family and genus level.

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SAŽETAK

Najstariji primjerci SARA herbarija datiraju iz druge polovine 19. stoljeća i pripadaju kolekciji dr. Otto Blau-a pohranjenoj u Zemaljskom muzeju Bosne i Hercegovine. Cilj rada bio je da se omogući transparentnost podataka kolekcije koji pružaju mogućnost sagledavanja areala endemičnih i ugroženih vrsta do unazad 153 godine, odnosno da se ukaže na brojnost, brzinu i stepen smanjivanja i uništavanja prirodnih staništa i vrsta koje u ovom momentu imaju sve više kategorije ugroženosti (CR, EN, VU). Utvrđena je njihova brojnost prema originalnoj kolekciji i pratećem katalogu sa pregledom od nivoa porodice čiji su nazivi revidirani prema važećoj nomenklaturi. Također je dat pregled lokaliteta, opća rasprostranjenost endemskih vrsta kao i kategorije ugroženosti. Od ukupno 1404 kolekcijskih vrsta prikupljenih sa područja Bosne i Hercegovine, konstantirane su vrste koje se nalaze na bosanskohercegovačkoj (99) i evropskoj Crvenoj listi ugroženosti (274). Posebno obilježje istraživanoj kolekciji *Herbarium Blavianum* daju registrirane endemične vrste (41) različitih kategorija ugroženosti u FBiH (33) i Evropi (6). Rezultati ovoga rada ukazuju na izuzetnu vrijednost Blauovog herbarija koji sa muzeološkog aspekta ima status kolekcije od posebnog znanstvenog i historijskog značaja u sklopu herbarske zbirke Zemaljskog muzeja BiH (SARA).

Ključne riječi: herbarij, Bosna i Hercegovina, SARA, distribucija, IUCN

Analysis of some families from Carl Studniczka's herbarium

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Review article

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Abstract: We analysed herbarium maps which mostly contain the following families: Amaranthaceae (Ord. Amaranthaceen, Salsoleen and Chenopodeen), Plumbaginaceae (Ord. Plumbagineen), Aristolochiaceae, Thymelaeaceae, Lauraceae, Eleagnaceae, and Santalaceae (Ord. Aristolochieen and Thymeleen) in Carl Studniczka's herbarium (herbarium code: NHMS). Most of the analysed herbal material (174 herbarium sheets, with 414 samples) in this part of the C. Studniczka's herbarium was collected in Europe (162 herbarium sheets). According to the labels, the majority of herborized material was collected in the area of Austria (36 herbarium sheets). Most herbarium sheets (25) belong to the Flora Dalmatiens collection and most herbarium sheets were collected by Studniczka himself (79). The oldest herbarium sheets dates to 1865, whereas the newest one dates to 1904. The exact year of collection is missing from 13 herbarium labels. In reference to the part of Studniczka's herbarium, which has already been analysed, the following botanists or collectors of herbal material are mentioned for the first time: Boller, Hülsen, Kühlewein, Kuhn, Tholin, and Uloth. Also, there are some collections which are mentioned for the first time: Flora n. Pritzerbe and Flora der Wetterau.

Key words: Natural History Museum in Split, historical plant collection

INTRODUCTION

Since 2005, we have been working on Carl Studniczka's herbarium which can be found in the Natural History Museum in Split. According to the available literature, there are only few facts about the life and work of this Austro-Hungarian officer. As a botanist amateur, Carl Studniczka collected plants while travelling (1869-1904) and working as an officer (data is known from herbarium labels: the wider surrounding area of Vienna and Wiener Neustadt in Austria; Split, Hvar, and Dubrovnik in Croatia; Celje, Koper, and Izola in Slovenia; Kotor and Herceg Novi in Montenegro; Olomouc and Leitmeritz in the Czech Republic; Przemysl in Poland, and finally the wider surrounding area of Trieste in Italy). The analysis has shown that this herbarium contains samples of the plants which were collected and sent to Studniczka by many botanists or collectors of that time. The main goal of this paper is to make available data regarding the time, place, and collectors of the plants collected in Studniczka's herbarium.

MATERIAL AND METHODS

In this paper, we analysed the herbarium maps which mostly contain the following families: Amaranthaceae (Ord. Amaranthaceen, Salsoleen and Chenopodeen), Plumbaginaceae (Ord. Plumbagineen), Aristolochiaceae, Thymelaeaceae, Lauraceae, Eleagnaceae, and Santalaceae (Ord. Aristolochieen and Thymeleen) in Carl Studniczka's herbarium. Each herbarium sheet has its own museum inventory number, so each is numbered separately in the list. From the labels of the herbarium sheets, we copied the Latin name of the genus and the species; then the date, month, and year of collection; followed by the collector (**A**-Alioth, **An**-Anthouard, **Ay**-Ayasse, **B**-Baenitz, **Bo**-Boller, **C**-Canby, **Ca**-Canut, **D**-Debeaux, **De**-Déséglise, **Di**-Dichtl, **E**-Eggert, **En**-Engelmann, **F**-Freyn, **G**-Gandoger, **Gl**-Glastier, **Gr**-Graf, **Gro**-Groves, **Gru**-Grundl, **H**-Halácsy, **Ha**-Hansen, **Har**-Harbord, **He**-Heiland, **Hu**-Huet, **Hü**-Hülse, **J**-Jabornegg, **Ja**-Janka, **K**-Körnicke, **Kr**-Krenberger, **Ku**-Kühlewein, **Kuh**-Kuhn, **M**-Matz, **Mo**-Mohr, **My**-Moyer, **O**-Oertel, **P**-Paillot, **R**-Rauscher, **Ri**-Richter, **Ru**-Ruhmer, **S**-Studniczka, **Si**-Siegfried, **So**-Sommier, **T**-Tauscher, **Th**-Tholin, **Tr**-Trémols, **U**-Uloth, **V**-Vandrelly, **W**-Wolf) and the affiliation to the particular herbarium collection (F-Flora Austriae inf., FA-Flora Algeriensis exsiccata, FB-Flora Böhmens, FBr-Flora Brandenburgia, FD-Flora Dalmatiens, FG-Flora Gallica exsiccata, FH-Flora hungarica, FI-Flora von Istrien, FN-Flora aus Nieder Österreich, FP-Flora Prussiae orientalis, FPo-Flora von oesterr. Polen, FPr-Flora n. Pritzerbe, FR-Flora rhenana, FS-Flora von Schleswig, FSü-Flora Süddalmatiens, FT-Flora Thuringiana, FvB-Flora von Böhmen, FvN-Flora von N. Oesterreich, FvT-Flora von Triest, FW-Flora von Wr Neustadt, FWe-Flora der Wetterau, FWi-Flora von Wien, HA-Eggert, Herbarium Americanum, HD-Herbier De O. Debeaux, HE-C. Baenitz, Herbari-

um Europaeum, HH-Herbarium Dr. E. Halácsy, HK-Herb. Dr de Kühlewein, HP-Herbier du pensionnat des Frères Avignon, HT-Herb. F. Tremols, HV-Herbier X. Vendrelly, HW-Herbarium E. O. Wolf, PO-J. Freyn Pflanzen aus Oesterreich-Ungarn, S-Société helvétique, SH-Soc. Helvetica, SV-Soc. Vog. Rhénane). According to The Plant list and USDA plants Database, we listed the name of the species in brackets; from the label, we copied the numeric sign, name of the place where the plant was found with altitude data if available, and listed the number of herbarium samples in brackets.

RESULTS

LIST OF SPECIES

(Ord.: Amaranthaceen, Salsoleen and Chenopodeen) In this map, besides herbarium samples for the family Amaranthaceae, we found samples from the families Compositae, Plantaginaceae, and Rubiaceae (marked at the end in the brackets).

1. *Albersia blitum* Kuth. 3.9.1880. **F** /*Amaranthus blitum* L./ Bohemia. Opočno. In hortis frequens (3)
2. *Amaranthus albus* L. 19.7.1874. **E** HA /*A. albus* L./ Wüste Plätze (3)
3. *A. deflexus* L. 15.9.1872. **Ay** /*A. deflexus* L./ A Carouge près Genève (1)
4. *A. prostratus* Balb. 31.7.1875. **S** FD /*A. deflexus* L./ auf Wegen um Spalato (3)
5. *A. retroflexus* L. 11.10.1872. **S** FD /*A. retroflexus* L./ wüsten Plätzen bei Punta d'Ostro (1)
6. *A. retroflexus* L. 13.9.1902. **S** FvT /*A. retroflexus* L./ Schutthaufen bei Barcola (2)
7. *A. silvestris* Desf. 11.8.1902. **S** FvT /*A. graecizans* L. subsp. *silvestris* (Vill.) Brenan/ wüste platze um Barcola Miramarstrasse (Schutt) (1)
8. *A. strictus* Ten. 18.8.1876. **G** FG /*A. retroflexus* L./ No 1056 Hab. in cultis prope Arnas (Rhône) (1)
9. *Atriplex angustifolia* Sm. β *inappendiculata* 1897. **S** FW /*A. patula* L./ um Wr Neustadt (1)
10. *A. angustifolia* Sm. γ *tatarica* 14.9.1893. **S** FW /*A. patula* L./ um die Stadt (1)
11. *A. babingtonii* Woods. 16.9.1876. **Har** /*A. glabriuscula* Edmondston/ River shore S. of Lpool (8)
12. *A. campestris* Koch & Z. 9.1878. **R** S /*A. tatarica* L./ Budapest, Hungaria. In locis incultis ad fontem Hunyadi Janos (2)
13. *A. campestris* W & Z. = *tatarica* L. 23.8.1882. **S** FvB /*A. tatarica* L./ auf der Wöllen von Theresienstadt (2)
14. *A. hastatum* L. (p.p.) 16.9.1877. **F** PO /*A. prostrata* Boucher ex DC. subsp. *calotheca* (Rafn) M.A.Gust./ Süd-Istrien. Gegend von Pola. Klippen von Levano piccolo 3 m (3)

15. *A. hortensis* L. 9.1875. **S** FD /*A. prostrata* Boucher ex DC. subsp. *latifolia* (Wahlenb.) Rauschert/ wüste Orte um Clissa (1)
16. *A. laciniata* L. 9.1878. **H** F /*A. laciniata* L./ in ruderatis ad Döbling prope Viennam (2)
17. *A. laciniata* L. 9.1897. **S** FW /*A. laciniata* L./ wüste Plätze um Wr N. (2)
18. *A. latifolia* Wahlbg. 2.9.1881. **S** FB /*A. prostrata* Boucher ex DC. subsp. *latifolia* (Wahlenb.) Rauschert/ Gemüse gärten um Theresienstadt (1)
19. *A. latifolia* Wahlbg. 1897. **S** FW /*A. prostrata* Boucher ex DC. subsp. *latifolia* (Wahlenb.) Rauschert/ um die Stadt (3)
20. *A. latifolia* Wahlbg. & *salinas* 11.8.1902. **S** FvT /*A. prostrata* Boucher ex DC. subsp. *latifolia* (Wahlenb.) Rauschert/ an der Miramarstrasse bei Barcola (1)
21. *A. latifolium* Wahlbg. = *A. hastatum* L. 1902. **S** FvT /*A. prostrata* Boucher ex DC. subsp. *latifolia* (Wahlenb.) Rauschert/ längst der Miramarstrasse (1)
22. *A. nitens* Rebert. 3.8.1882. **S** FB /*A. sagittata* Borkh./ sandige Egerufer b. Theresienstadt (1)
23. *A. nitens* Rebert. 9.1897. **S** FW /*A. sagittata* Borkh./ wüste Plätze um Wr N. (1)
24. *A. patula* L. 11.10.1872. **S** FD /*A. patula* L./ Gärten der Halbinsel Punta d'Ostro (1)
25. *A. rosea* L. 21.8.1869. **Hu** S /*A. rosea* L./ décombres à Toulon (Var) (1)
26. *A. rosea* L. 8.1901. **S** FvT /*A. rosea* L./ bei Miramare (1)
27. *Beta maritima* L. 13.6.1875. **F** /*B. vulgaris* L./ Istrien. Meeresstrand bei Pola /:Brioni:/ Kalk 2 m (1)
28. *B. vulgaris* L. 21.7.1871. **S** FWi /*B. vulgaris* L./ bei Gutenhof (1)
29. *Blitum glaucum* Koch. 9.1871. **H** /*Chenopodium glaucum* L./ an Häusern in Tribuswinkel nächst Baden in N. Östr. (4)
30. *B. glaucum* Koch. 13.9.1882. **S** FB /*C. glaucum* L./ sandufer der Elbe bei Leitmeritz (4)
31. *B. virgatum* L. 1903. **S** FvT /*Beta vulgaris* L./ wüste Plätze bei Cedras (Miramarstrasse) (2)
32. *Camphorosma monspeliaca* L. 4.8.1875. **S** FD /*C. monspeliaca* L./ Meeresufer bei St. Stefano nächst Spalato auf Felsen (1)
33. *C. monspeliacum* L. 30.8.1904. **S** FI /*Suaeda maritima* (L.) Dumort./ an den Salinen von Capo d'Istria (2)
34. *Chenopodium acutifolium* Kit. 7.9.1876. **G** FG /*C. polyspermum* L./ No 356. Hab. In pratis udis ad Arnas (Rhône) (1)
35. *C. album* L. 9.1873. **Ay** /*C. album* L./ Auteur des fumiers à Genève (3)
36. *C. album* L. var. 20.8.1875. **Kr** /*C. album* L./ An mauern bei Raabs, NOestr. (1)
37. *C. album* L. var. 13.9.1902. **S** FvT /*C. album* L./ an der Miramarstrasse bei Barcola (1)
38. *C. ambrosioides* L. 20.10.1872. **S** FD /*Dysphania ambrosioides* (L.) Mosyakin & Clemants/ an Mauern, auf Wegen nächst dem Fort auf Punta d'Ostro (Castelnuovo) (1)
39. *C. bonus henricus* L. 28.5.1882. **S** FB /*C. bonus-henricus* L./ wüste Plätze im Dorfe Kamaik b. Leitmeritz (2)
40. *C. botrys* L. 19.7.1872. **S** FWi /*Dysphania botrys* (L.) Mosyakin & Clemants/ auf wüsten Plätzen auf der Turken-schanze (1)
41. *C. botrys* L. 7.1878. **H** HH /*Dysphania botrys* (L.) Mosyakin & Clemants/ In collibus arenosis Türkenschanze, ad Viennam Austriae inf. (2)
42. *C. ficifolium* Sm. 30.8.1872. **O** FT /*C. ficifolium* Sm./ Kartoffelacker bis Artern Heuboden (6)
43. *C. gracilicaule* Gdgr! 20.8.1870. **G** FG /*C. ficifolium* Sm./ No 323 Hab. In campis ad St Julien Rhône (5)
44. *C. hybridum* L. 7.6.1872. **S** FWi /*C. hybridum* L./ Brachäcker am Laerberg (1)
45. *C. hybridum* L. 29.9.1880. **F** /*C. hybridum* L./ Böhmen Opočno Gärten (1)
46. *C. murale* L. var. 2.11.1870. **G** FG /*C. murale* L./ No 348. Hab. Circa Frang (Ain) in ruderatis (1)
47. *C. murale* L. 18.7.1877. **V** HV /*C. murale* L./ Localité Champagne Station Bords des rues Altitude 380 m (2)
48. *C. opulifolium* Schrad. 8.1873. **A** /*C. opulifolium* Schrad. ex W.D.J.Koch & Ziz/ Stalden bei Visp, Vallis (1)
49. *C. opulifolium* Schr. 4.8.1878. **Gl** /*C. opulifolium* Schrad. ex W.D.J.Koch & Ziz/ Bords des chemins Limagne (1)
50. *C. polyspermum* L. 8.1882. **S** FB /*C. polyspermum* L./ Elbeufer b. Theresienstadt (2)
51. *C. polyspermum* L. 14.7.1885. **S** FPo /*C. polyspermum* L./ wüste Plätze Zeughaus in Przemyśl (3)
52. *C. rubrum* L. 6.8.1867. **P** HV /*C. rubrum* L./ Localité Chauvort (Saône et Loire) Station Bords desséchés des marais (2)
53. *C. rubrum* L. 9.1874. **He** FBr /*C. rubrum* L./ 31. Lychen aus getrocknet des Blasswg in Rutenberg (2)
54. *C. urticum* L. 29.7.1872. **S** FN /*C. urticum* L./ 591. Laerbg, Weingarten & heide (1)
55. *C. vulvaria* L. 9.1885. **S** FPo /*C. vulvaria* L./ wüste Orte, lgst Wegen in Przemyśl (1)
56. *C. vulvaria* L. 1897. **S** FW /*C. vulvaria* L./ wüste Plätze um die Stadt (2)
57. *Corispermum hyssopifolium* L. 7.9.1873. **F** /*C. hyssopifolium* L./ Ungarn. Raine bei Neu-Pest. Sand 120 m (2)
58. *C. hyssopifol* L. 9.10.1878. **Ru** /*C. hyssopifolium* L./ Berlin: qu. sp. (2)
59. *C. intermedium* Schweigg. 4.9.1865. **K** FP /*C. intermedium* Schweigg./ Pillau in Dünensande (3)
60. *C. intermedium* Schwgg. 31.8.1873. **B** /*C. intermedium* Schweigg./ Königsberg: Aecker bei Alt-Pillau (3)
61. *C. nitidum* Kit. 18.9.1875. **R** FH /*C. nitidum* Kit./ Ort Pest Rákos Unterlage Sand (2)

62. *Diotis candidissima* Desf. 20.7.1878. **So** SH /*Achillea maritima* (L.) Ehrend. & Y.P.Guo/ Migliarino - Prope Pisas in arenosis maritimis (2) (**fam. Compositae**)
63. *Halimocnemis volvox* C.A.M. **Ku** HK /*Petrosimonia triandra* (Pall.) Rech./ Rossia merid. (2)
64. *Halimus portulacoides* Wallr. 23.8.1874. **F** /*Atriplex portulacoides* L./ Istrien. Umgebung von Pola Meeresstrand Bodenunterlage Kalk Seehöhe 1 m (1)
65. *H. portulacoides* Wallr. 13.6.1901. **S** FvT /*A. portulacoides* L./ Sümpfe am Ufer bei St. Sabo (3)
66. *Haloepelis amplexicaulis* Vahl 7.1875. **Gro** HE /*H. amplexicaulis* (Vahl) Ung.-Sternb. ex Ces., Pass. & Gibelli/ In locis salsis prope Tarentum Saline di San Bruno (5)
67. *Kochia arenaria* Rth. 22.8.1877. **KFR**/K. *arenaria* (Maerkl.) Roth/ Rheingau: Sandige Wegränder bei Heidesheim (1)
68. *K. prostrata* Schrad. 7.1874. **S** FD /*Suaeda maritima* (L.) Dumort./ am Meeresufer bei Bodicelli nächst Spalato (2)
69. *K. prostrata* Schrad. 25.6.1879. **D** /*Bassia prostrata* (L.) Beck/ Italie. Vignes d'Torte (2)
70. *K. scoparia* Schrad 9.1871. **H** F /*B. scoparia* (L.) A.J.Scott/ Pottaschenfiederei von Grossenzersdorf (1)
71. *K. sedoides* Schrad. 15.9.1872. **F** /*Sedobassia sedoides* (Schrad.) Freitag & G.Kadereit/ Ungarn. Umgebung von Ofen-Pest Lehmige Stellen am Blocksberg Kalk 150 m (3)
72. *Litorea lacustris* L. f. *sterilis* 17.7.1874. **B** HE /*L. uniflora* (L.) Asch./ Danzig: Im espenkruger See (5) (**fam. Plantaginaceae**)
73. *Obione pedunculata* Moq. Tand. 16.8.1868. **K** /*Atriplex pedunculata* L./ Nordseeinsel Borkun: Westland an der Aufserweide (8)
74. *O. pedunculata* Moq. Tand. var. *minor* **Ha** FS /*A. pedunculata* L./ Husum, im Dock Koeg aus acker (4)
75. *Polycnemum arvense* L. 7.9.1871. **S** FWi /*P. arvense* L./ bei Fischau (1)
76. *P. heuffelii* Láng. 9.1872. **Gru** /*P. heuffelii* Láng/ In den sandigen Wäldern zü Dorogh nächst Gran in Ungarn (3)
77. *P. heuffelii* Láng. 9.1876. **Gru** HE /*P. heuffelii* Láng/ Nr 3073. Hungaria: Dorogh ad Strigonium /:Gran:/, In sylvis arenosis (4)
78. *P. heuffelii* Láng **Gr** /*P. heuffelii* Láng/ ung. Ins. Cepel (1)
79. *P. majus* A. Br. 14.9.1874. **Di** /*P. majus* A.Braun/ München-dorf bei Wien (1)
80. *P. verrucosum* Láng. 9.1872. **Gru** /*P. verrucosum* Láng/ Auf sandigen Hütweide zü Dorogh nächst Gran in Ungarn (4)
81. *P. verrucosum* Láng 9.1876. **Gru** HE /*P. verrucosum* Láng/ Nr 3075. Hungaria: Dorogh ad Strigonium /:Gran:/, In pascuis arenosis (5)
82. *Salicornia fruticosa* L. β *pachystachya* = *macrostachya* Moricaud 9.1875. **S** FD /*Arthrocnemum macrostachyum* (Moric.) K.Koch/ salzhalt. Stellen am Meeresufer bei Spalato (4)
83. *S. herbacea* L. 8.1878. **S** FD /*S. europaea* L./ auf salzigen Orten am Meeresufer der Insel St. Giorgio bei Perasto (2)
84. *S. herbacea* L. var. 5.9.1904. **S** FvT /*Arthrocnemum macrostachyum* (Moric.) K.Koch/ an Salinen bei Semedella Capo d'Istria (3)
85. *S. macrostachya* Moric. 16.6.1874. **F** /*A. macrostachyum* (Moric.) K.Koch/ Istrien. Umgebung von Pola felsiger Meeresstrand Bodenunterlage Kalk Seehöhe 2 m (2)
86. *S. patula* Duval Jouve **U** FWe /*S. patula* Duval-Jouve/ Wisselsheim (4)
87. *S. patula* Duv.-Jouve 9.1876. **Kuh** HE /*S. patula* Duval-Jouve/ Am salziger See b. Erdeborn (3)
88. *Salsola arenaria* W.K. 9.1872. **Gru** /*Bassia laniflora* (S.G.Gmel.) A.J.Scott/ Auf sandigen Hügeln zü Dorogh nächst Gran in Ungarn (5)
89. *S. kali* L. f. *simplex* 2.8.1872. **B** /*S. kali* L./ Danzig: Am Loch an der Westerplatte (14)
90. *S. kali* L. 1872. **S** FD /*S. kali* L./ Meeresufer bei Punta d'Ostro (1)
91. *S. kali* L. 1893. **S** FvN /*S. kali* L./ Brachen um Wr Neustadt (1)
92. *S. soda* L. 26.7.1870. **S** FvN /*S. soda* L./ am Laaerberg b. Wien (1)
93. *S. soda* L. 4.8.1875. **S** FD /*S. soda* L./ am Meeres ufer bei Toretta nächst Spalato (1)
94. *S. soda* L. 25.8.1893. **S** FW /*S. soda* L./ Aecker um Neustadt (3)
95. *S. soda* L. 10.10.1902. **S** FvT /*S. soda* L./ in Gräben an der Miramarstrasse bei Barcola (2)
96. *Schoberia maritima* Myr **T** /*Suaeda maritima* (L.) Dumort./ Csepel Ins. in Ungarn (1)
97. *Spinacia spinosa* L. 8.1872. **S** FWi /*S. oleracea* L./ cult. um Wien (1)
98. *S. spinosa* Mnch. 9.7.1878. **F** /*S. oleracea* L./ 242. Bohe-mia. Opočno In hortis frequens culta 265 m (1)
99. *Thelygonum cynocrambe* L. 20.3.1874. **S** FD /*Theligonum cynocrambe* L./ zwischen mäuern ü. auf sonnigen Rainen um Spalato (11) (**fam. Rubiaceae**)
100. *Theligonum cynocrambe* L. 4.1874. **So** SV /*T. cynocrambe* L./ Villa Herzen prope Florentiam (Italia) In muris vetustis (5) (**fam. Rubiaceae**)
101. *Thelygonum cynocrambe* 17.3.1876. **S** FD /*T. cynocrambe* L./ Rainen und steinig sonnigen Grasplätzen am Giovanni (6) (**fam. Rubiaceae**)
- (Ord. Plumbagineen)
102. *Armeria ararica* Gdgr. 7.9.1876. **G** FG /*A. canescens* /Host/ Boiss. subsp. *nebrodensis* /Guss./ P.Silva No 110 Hab. in arenosis ad Arnas (Rhône) (3)
103. *A. juncea* Gir. 3.6.1878. **An** S /*A. girardii* /Bernis/ Litard.) Localité: Fontaret près de Blandas (Gard) Station: Rochers dolomitiques calcaires Altitude: 250 m (2)

104. *A. plantaginea* Willd. 8.1874. **W** HW (*A. arenaria* /Pers./ Schult. St. Rémy (3))
105. *A. rumelica* Boiss. **Ja** (*A. cariensis* Boiss. var. *rumelica* / Boiss./ Boiss.) Balkan (1)
106. *A. vulgaris* W. syn. *elongata* Hoffm. 30.5.1875. **S** FD (*A. maritima* /Mill./ Willd.) auf den grasigen Abhängen des Forts Clissa (1)
107. *A. vulgaris* W. = *Statice elongata* Hoffm. 29.5.1881. **S** FB (*A. maritima* /Mill./ Willd.) sandige Waldblößen um Theresienstadt (2)
108. *Plumbago europaea* L. 9.1875. **S** FD (*P. europaea* L.) Feldrainen u. wüsten Plätzen um Spalato (1)
109. *P. europaea* L. 7.9.1877. **Ca** (*P. europaea* L.) Lieux incultes et pierreux à Nice (Alp. Maritimes) (3)
110. *P. larpentae* Lindl. 4.10.1870. **G** FG (*Cerastostigma plumbaginoides* Bunge) No 336 Hab. ad muros subspont. prope Arnas (Rhône) (1)
111. *Statice alpina* Willd. 13.7.1897. **S** FW (*Armeria alpina* / DC./ Willd.) am Waxriegel das Schneeberges (2)
112. *S. alpina* Willd. 8.8.1899. **S** FW (*A. alpina* /DC./ Willd.) am-Schneeberg 1800 met. (3)
113. *S. cancellata* Bernh. 9.1872. **S** FD (*Limonium cancellatum* /Bernh. ex Bertol./ Kuntze) Auf Felsen der Halbinsel Punta d'Ostro bei Castelnuovo (3)
114. *S. confusa* G G 8.1874. **Tr** (*L. ramosissimum* /Poir./ Maire subsp. *confusum* /Gren. & Godr./ Pignatti) Ile Ste Lucie france Prairies salées (2)
115. *S. diffusa* Pourr. 7.1873. **F** (*L. diffusum* /Pourr./ Kuntze) France. Ile Ste Lucie près Narbonne Aude (2)
116. *S. gmelini* Willd. 9.1873. **F** (*L. gmelinii* /Willd./ Kuntze) Ungarn. Salzwiesen bei Ofen. Alluv. 120 m (1)
117. *S. incana* L. 7.1875. **S** FD (*Goniolimon dalmaticum* /C.Presl/ Rchb.) längst dem Meeresufer auf der Nordseite des Marian bei Spalato (2)
118. *S. limonium* L. 8.1875. **S** FD (*Limonium vulgare* Mill.) am salzigen Meeres ufer bei Spalato (2)
119. *S. limonium* L. 13.8.1901. **S** FI (*L. vulgare* Mill. subsp. *serotinum* /Rchb./ Gams) in Meeressümpfen bei St. Sabo (2)
120. *S. limonium* L. 30.8.1904. **S** FI (*L. vulgare* Mill. subsp. *serotinum* /Rchb./ Gams) an den Salinen von Capo d'Istria (1)
121. *S. lychnidifolia* Gir. 7.1874. **Tr** HT (*L. auriculae-ursifolium* /Pourr./ Druce) Hab. Prairies salés de l'Île de Ste Lucie près Narbone (france) (2)
122. *S. monopetala* L. *Limoniasrum* Boiss. 7.1873. **F** (*Limoniasrum monopetalum* /L./ Boiss.) France. Ile Ste Lucie près Narbonne Aude (2)
123. *S. sinuata* L. 4.1874. **Gr** (*Limonium sinuatum* /L./ Mill.) Algerie. Cap. Matifou (1)
124. *S. virgata* Willd. 7.1874. **Tr** HT (*L. oleifolium* Mill.) Hab. Prairies salés de l'Île de Ste Lucie près Narbone (france) (2)

(Ord. Aristolochieen) In this map, besides herbarium samples for the family Aristolochiaceae and Lauraceae, we found samples from the families Araceae and Myricaceae (marked at the end in the brackets).

125. *Arisaema dracontium* Schott. 3.6.1875. **E** HA /*A. dracontium* (L.) Schott/ Wald an Olive straße (1) (**fam. Araceae**)
126. *Aristolochia clematitis* L. 2.5.1873. **S** FD /*A. clematitis* L./ an Ackerrändern in der Suttolina bei Topla (1)
127. *A. clematitis* L. 13.6.1900. **S** FvT /*A. clematitis* L./ Gebüsche Greta & Barcola (1)
128. *A. fontanesii* B.R. 3.1879. **G** FA /*A. fontanesii* Boiss. & Reut./ No 230 Hab. in ditone urbis Alger, loco dicto Birmandreis (2)
129. *A. longa* L. 13.4.1877. **D** HD /*A. fontanesii* Boiss. & Reut./ Perpignan (Pyr. Orient) River de la Tét, parmi les rochers (3)
130. *A. pallida* Willd. 5.1880. **S** FD /*A. pallida* Willd./ zwischen Felsen am Monte Sella bei Trinita nächst Cattaro (1)
131. *A. pallida* Willd. 5.6.1902. **S** FvT /*A. pallida* Willd./ Gebüschrand nächst der Wiese am Trstenik (6)
132. *A. rotunda* L. 15.6.1875. **S** FD /*A. rotunda* L./ zwischen Gesträuch um Clissa /:Fort:/ (3)
133. *A. rotunda* L. 5.1878. **S** FD /*A. rotunda* L./ an Feldmauern bei Stolivo (2)
134. *A. siphon* L. **My** /*A. macrophylla* Lam./ Quakertown Pa. (1)
135. *A. tomentosa* Sims. 28.5.1875. **E** HA /*A. tomentosa* Sims/ Forest Park (2)
136. *A. tomentosa* Mx. **Mo** /*A. tomentosa* Sims/ Mobile, Alabama (1)
137. *Asarum canadense* L. 14.5.1875. **E** HA /*A. canadense* L./ Forest Park (2)
138. *A. canadense* L. **C** /*A. canadense* L./ Delaware (1)
139. *A. europaeum* L. **B** /*A. europaeum* L./ Förthofers flucht bei Krems (3)
140. *Laurus nobilis* L. 24.4.1901. **S** FvT /*L. nobilis* L./ Barcola (5)
141. *Myrica cerifera* L. **C** /*Morella cerifera* (L.) Small / Delaware (1) (**fam. Myricaceae**)
142. *Sassafras officinalis* Nees. 5.8.1875. **E** HA /*S. albidum* (Nutt.) Nees/ Old Bonhomme Wegg (3)

(Ord. Thymeleen) In this map, besides herbarium samples for the family Thymelaeaceae, we found samples from the families Eleagnaceae, Santalaceae, and Rutaceae (marked at the end in the brackets).

143. *Daphne alpina* L. 5.1872. **Gr** /*D. alpina* L./ Istria. M. santo pr. Görz (4)
144. *D. blagayana* Freyer **F** /*D. blagayana* Freyer/ Lorenzberg bei Billichgrätz in Krain (2)
145. *D. cneorum* L. 21.5.1875. **A** /*D. cneorum* L./ Monte Salvatore bei Lugano, Tessin (5)

146. *D. cneorum* L. 5.1893. **S** FvN /*D. cneorum* L./ Malleiten bei Wollersdorf (9)
147. *D. gnidium* Lin. 8.1874. **Th** HP /*D. gnidium* L./ Bois Avignon (2)
148. *D. laureola* L. 1870. **S** FWi /*D. laureola* L./ Berge um Döbling (3)
149. *D. laureola* L. 5.1878. **H** F /*D. laureola* L./ in silvis mont. ad Gissühel (2)
150. *D. mezereum* L. 11.4.1872. **S** FWi /*D. mezereum* L./ Wälder bei Maüerbach, Gablitz & Pürkersdorf (4)
151. *D. mezereum* L. 3.1885. **S** FPo /*D. mezereum* L./ in Waldern bei Buda nächst Przemysl (5)
152. *D. striata* Tratt. 1869. **J** /*D. striata* Tratt./ Alpe Ortazha nächst dem Loibl, Kärnthen (3)
153. *Dirca palustris* L. **En** /*D. palustris* L./ Louisiana (3)
154. *Passerina annua* Wick. 7.1873. **S** FD /*Thymelaea passerina* (L.) Coss. & Germ./ Brachäcker & Rainen bei Punta d'Ostro & bei Paludi nächst Spalato (2)
155. *P. annua* L. 18.9.1876. **G** FG /*T. passerina* (L.) Coss. & Germ./ No 1067 Hab. in arvis circa Arnas (Rhône) (3)
156. *P. annua* Wigstr. 8.8.1902. **S** FvT /*T. passerina* (L.) Coss. & Germ./ am Trstenik ober Barcola (1)
157. *P. hirsuta* L. 6.9.1876. **Hu** S /*T. hirsuta* (L.) Endl./ coteaux schisteux du bord delamer à la Grotte Tour près de Toulon (Var) (2)
158. *Cneorum tricoccon* L. 6.1874. **F** /*C. tricoccon* L./ La Clappe près Narbonne (1) (**fam. Rutaceae**)
159. *Osyris alba* L. 29.4.1879. **S** FD /*O. alba* L./ überall auf felsen um Cattaro (Giovanni) (2)
160. *O. alba* L. 7.1902. **S** FvT /*O. alba* L./ Gebüsche am Trstenik u. gegen Contovello ober Barcola (2)
161. *Thesium alpinum* L. 6.1867. **Hü** FPr /*T. alpinum* L./ Kützkow: an der Linkerner Spitze (2)
162. *T. alpinum* L. 13.6.1897. **S** FW /*T. alpinum* L./ am Grässenberg bei Muthmannsdorf (2)
163. *T. divaricatum* Jan. 14.5.1874. **S** FSü /*T. divaricatum* Jan ex Mert. & W.D.J.Koch/ auf steinig Triften am Marian (1)
164. *T. divaricatum* Jan. 7.1900. **S** FvT /*T. divaricatum* Jan ex Mert. & D.J.Koch/ Greta (2)
165. *T. humile* Vahl 5.1871. **M** /*T. humile* Vahl/ Auf Brachen im Marchfeld (2)
166. *T. intermedium* Schrd. 5.1878. **H** F /*T. linophyllon* L./ In pratis montanis ad neuskift am Walde (2)
167. *T. intermedium* Schrad 4.6.1901. **S** FvT /*T. linophyllon* L./ am Trstenik (1)
168. *T. montanum* Ehrh. 25.6.1895. **S** FW /*T. bavarum* Schrank/ hügel bei Wöllersdorf (6)
169. *T. ramosum* Hayne. 6.1874. **H** F /*T. arvense* Horv./ In arvis montis Laaerberg ad Viennam (2)
170. *T. ramosum* Hayne 15.6.1897. **S** FW /*T. arvense* Horv./ am Eisenbachndamm b. Wr N. (2)

171. *T. rostratum* M. & K. 8.6.1876. **Si** HE /*T. rostratum* Mert. & W.D.J.Koch/ No 3667 Helvetia: Uto bis Zürich (2)
172. *Eleagnus angustifolius* L. 12.6.1874. **A** /*Elaeagnus angustifolia* L./ Dans et bosquets à Genève (2)
173. *Elaeagnus angustifolia* L. 1897. **S** FW /*E. angustifolia* L./ cult. in Gärten (1)
174. *Hippophae rhamnoides* L. 8.1870. **R** /*E. rhamnoides* (L.) A.Nelson/ Wegen bei Urfahr nächst Linz (2)

DISCUSSION

The total number of the herbarium sheets (maps Ord. Amaranthaceen, Salsoleen and Chenopodeen) in the analysed family Amaranthaceae is 96 (with 218 samples excluding herbarium sheets under the ordinal number: 62 *Diotis candidissima* Desf. – which belongs to the family Compositae, 72. *Litorella lacustris* L. f. *sterilis* – Plantaginaceae, 99., 100. and 101. *Theligonum* /*Thelygonum*/ *cynocrambe* L. – Rubiaceae). The majority of the plants was collected in Europe (95 herbarium sheets), and one sheet originates from North America. Most of the herbarium samples were collected in the area of Austria (21 herbarium sheets) and Croatia (14), Italy (11), Hungary (11), Czech Republic (9), France (8), Germany (8), Poland (3), Russia (3), Switzerland (3), Slovenia (2). One herbarium sheet was collected in Montenegro, UK, and USA, respectively. According to the affiliation to a particular herbarium collection in the analysed family, the most represented is Flora Dalmatiens with 11 herbarium sheets. This is followed by other collections, such as: Flora von Triest (10), Flora von Wr Neustadt (7), Flora Böhmens (including Flora von Böhmen collection) (6), Flora von Wien (5), C. Baenitz Herbarium Europaeum (4), Flora Gallica exsiccata (4) and others. There are 26 herbarium sheets that are unmarked and therefore we do not know which herbarium collection they belong to. Most of the samples of herbarium plants were collected by Studniczka himself (45 herbarium sheets), while others were sent to him by Freyn (9), Grundl (5), Gandoger (4), Halácsy (4), Körnicke (3), Ayasse (2), Baenitz (2), Richter (2) and others. In the part of the herbarium which has already been analysed (compare with: Vladović et al, 2007, 2009, 2010, 2012, 2013a, 2013b, 2014a, 2014b, 2015; Mitić et al., 2008, 2010–2011, 2011, 2012, 2013; Vladović & Mitić 2016, 2017a, 2017b, Ževrnja et al, 2008, 2009a, 2009b, 2010a, 2010b, 2011, 2013a, 2013b, 2013c, 2014a, 2014b, 2015), there are botanists or collectors of the herbal material who are mentioned for the first time: Kuhn, Kühlewein, and Uloth. The oldest herbarium sheet dates to 1865, whereas the newest ones date to 1904. The vast majority of herbarium sheets (65), was collected during the period from 1870 to 1880. The exact year of collection from 5 herbarium labels is missing. According to Studniczka, within 96 herbarium sheets in the analysed family Amaranthaceae (orders: Amaranthaceen, Salsoleen, and Chenopodeen), there are 18

genera with 61 species, in terms of which 6 varieties were recorded.

The total number of the herbarium sheets (map Ord. Plumbagineen) in the analysed family Plumbaginaceae is 23 (with 44 samples). The majority of the plants was collected in Europe (22 herbarium sheets), and one sheet originates from Africa. Most of the herbarium samples were collected in the area of France (9 herbarium sheets) and Croatia (5) and Austria (2). One herbarium sheet was collected in Algeria, Bulgaria, the Czech Republic, Hungary, Italy, Slovenia, and Switzerland, respectively. According to the affiliation to a particular herbarium collection in the analysed family, the most represented is Flora Dalmatiens with 5 herbarium sheets. This is followed by other collections, such as: Flora von Wr. Neustadt (2 herbarium sheets), Flora Gallica exsiccata (2), Herb F. Trémols (2), and others. There are 7 herbarium sheets that are unmarked and therefore we do not know which herbarium collection they belong to. Most of the samples of herbarium plants were collected by Studniczka himself (10 herbarium sheets), while others were sent to him by Trémols (3), Freyn (3), Gandoger (2), Halácsy (4) and others. The oldest herbarium sheet dates to 1870, whereas the newest ones date to 1904. The vast majority of herbarium sheets (17) was collected during the period from 1870 to 1880. The exact year of collection is missing from one herbarium label. According to Studniczka, within 23 herbarium sheets there are 3 genera with 18 species. The most interesting herbarium samples are under number 117. *Statice incana* L. collected by Studniczka 7.1875. on the northern slopes of Marjan Hill near the town of Split. By new determination, it has been established that it is the species *Goniolimon dalmaticum* /C.Presl/ Rchb, which is endangered and endemic taxa.

The total number of the herbarium sheets (maps: Ord Aristolochieen and Thymeleen) in analysed families Aristolochiaceae, Thymelaeaceae, Lauraceae, Eleagnaceae, and Santalaceae is 50 (with 123 samples), excluding herbarium sheets under the ordinal number: 125. *Arisaema dracontium* Schott. which belongs to the family Araceae, 141. *Myrica cerifera* L. – Myricaceae, and 158. *Cneorum tricocum* L. – Rutaceae). For the Aristolochiaceae family, it was recorded on 14 herbarium sheets, for the Thymelaeaceae 15, Santalaceae 13, Eleagnaceae 3, and Lauraceae 2 herbarium sheets. The majority of the plants was collected in Europe (39 herbarium sheets), North America (7), and one sheet originates from Africa. Most of the herbarium samples were collected in the area of Austria (13 herbarium sheets) and USA (7), Italy (7), France (4), Montenegro (4), Croatia (3), Slovenia (3), Switzerland (3). One herbarium sheet was collected in Algeria, Germany, and Poland, respectively.

According to the affiliation to a particular herbarium collection in the analysed families, the most represented is Flora Dalmatiens (including Flora Suddalmatiens collection)

and Flora von Triest with 7 herbarium sheets. This is followed by other collections, such as: Flora von Wr. Neustadt (4 sheets), Eggert Herbarium Americanum (3), Flora Austriae inf. (3), Flora von Wien (2), and others. In the part of the herbarium which has already been analysed, some new collections are mentioned for the first time and these are: Flora n. Pritzerbe and Herbar du pensionnat des Frères, Avignon. Most of the samples of herbarium plants were collected by Studniczka himself (22 herbarium sheets), while others were sent to him by Halácsy (3), Eggert (3), Freyn (2), Gandoger (2), and others. In the part of the herbarium which has already been analysed, there are botanists or collectors of the herbal material who are mentioned for the first time: Boller, Hülsen, and Tholin. The oldest herbarium sheet dates to 1867, whereas the newest ones date to 1902. The vast majority of herbarium sheets (26) was collected during the period from 1870 to 1880. The exact year of collection is missing from 7 herbarium labels. According to Studniczka, within 50 herbarium sheets in the analysed families Aristolochiaceae, Thymelaeaceae, Lauraceae, Eleagnaceae, and Santalaceae (maps: Ord Aristolochieen and Thymeleen), there are 11 genera with 31 species.

CONCLUSION

The total number of the analyzed herbarium sheets in this paper is 174 (with 414 samples). The majority of the plants was collected in Europe (162 herbarium sheets), North America (10), and two sheets originate from Africa. Most of the herbarium samples were collected in the area of Austria (36 herbarium sheets) and Croatia (23), France (22), Italy (21), Hungary (12), Czech Republic (10), USA (10), Germany (9), Switzerland (7), Montenegro (6), Slovenia (6), Poland (5), Russia (3), Algeria (2). One herbarium sheet was collected in UK and Bulgaria, respectively. Most of the samples of herbarium plants were collected by Studniczka himself (79 herbarium sheets), while others were sent to him by Freyn (14), Gandoger (8), Halácsy (7), Eggert (5), Grundl (5), Ayasse (3), Baenitz (3), Graf (3), Körnicke (3), Trémols (3), Alioth (2), Canby (2), Huet (2), Richter (2), Sommer (2). One herbarium sheet was collected by Anthouard, Boller, Canut, Debeaux, Déséglise, Dichtl, Engelmann, Glastier, Groves, Hansen, Heiland, Hülsen, Jabornegg, Janka, Krenberger, Kühlewein, Kuhn, Lewis Harbord, Matz, Mohr, Moyer, Oertel, Paillot, Rauscher, Ruhmer, Siegfried, Tauscher, Tholin, Uloth, Vandrely, and Wolf. The oldest herbarium sheet dates to 1865, whereas the newest ones date to 1904. The vast majority of herbarium sheets (110) was collected during the period from 1870 to 1880. The exact year of collection is missing from 13 herbarium labels.

So far 7346 herbarium sheets with 20121 samples have been registered for the Studniczka's herbarium.

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SAŽETAK

U radu je analiziran herbarijski biljni materijal iz porodica Amaranthaceae (Ord. Amaranthaceen, Salsoleen i Chenopodeen), Plumbaginaceae (Ord. Plumbagineen), Aristolochiaceae, Thymelaeaceae, Lauraceae, Eleagnaceae i Santalaceae (Ord. Aristolochieen i Thymeleen). Najveći dio od 174 herbarijska lista s 414 herbarijskih primjeraka sakupljen je u Europi (162 herbarijska lista). Prema herbarijskim etiketama najviše herbarijskog materijala sabrano je s područja današnje Austrije (36 herbarijskih listova). Prema pripadnosti pojedinim herbarijskim zbirkama najzastupljeniji su herbarijski listovi iz zbirke Flora Dalmatiens (25), a najviše herbarijskih listova sakupio je Studniczka (79). Najstariji herbarijski list je iz 1865. god., a najmlađi su iz 1904. god. Na 13 herbarijskih etiketa nije upisana godina sakupljanja.

Uvidom u dosada analizirani dio herbarija po prvi puta se spominju slijedeći sakupljači biljaka: Boller, Hülsen, Kühlewein, Kuhn, Tholin i Uloth kao i herbarijske zbirke: Flora n. Pritzerbe i Flora der Wetterau.

Ključne riječi: Prirodnački muzej u Splitu, istorijska zbirka biljaka

The life and work of Lijerka Kutleša, MSc (1929-2019)

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UDK: 929+012 Kutleša L. (497.6) " 1929/2019 "

Lijerka Kutleša was born in Livno (Bosnia and Herzegovina) on 6th November 1929 in a large family. She completed her primary education in her hometown and her secondary education at the State Mixed Teacher Training School in Sarajevo in 1950 with an excellent academic record. As expected, she dedicated the following two academic years to teaching in schools in Vareš. Eager to learn more and advance in her career, in the fall of 1952, Lijerka Kutleša enrolled at the Higher School of Pedagogy, the Department for Biology and Chemistry and successfully completed her studies in 1955. Dedicated to her profession, for the following two academic years, starting from the year 1954/55, she worked as a biology teacher in the Primary School in Turbe near Travnik. In August 1956, she started working as a plant preparation specialist at the Biology Department at the Faculty of Science in Sarajevo. In line with her desire to learn and her ambitions, she used the new work position to continue her education and, this time as a part-time student, she enrolled in biology and chemistry studies at the Faculty of Science. After successfully completing these studies as well at the beginning of 1960 and achieving the top grade (10) for her graduate thesis, in March of 1961, Lijerka Kutleša was elected as an Assistant at the Biology Department at the Faculty of Science at the University of Sarajevo, teaching the course *Systematics of flowering plants*.



MSc Lijerka Kutleša

Determined to accomplish her goals of advancement in career and scholarship, Lijerka Kutleša continued to work on her training and education. She enrolled in the master programme at the Biology Department, systematics and ecology line of study, at the Faculty of Science, University of Zagreb (Croatia), and she resided in Zagreb during the academic years of 1963/64 and 1964/65. She earned her master's degree in biology in 1969 and defended her master's thesis titled *Phytocenological Culture of Island Dolin in the Kvarner Gulf* which represents a continuation of her previous scientific interests. Namely, already in her graduate thesis in 1960, she focused on the dendroflora of the Krk peninsula, meaning the consistency in researching a very significant component of flora and vegetation of the Adriatic coast.

She began working on her doctoral thesis in 1980 at the Faculty of Science at the University of Sarajevo titled *Divergence and Differentiation of Viola elegantula Schott Species*. Due to the death of her mentor prof. Živko Slavnić, PhD in 1975, she chose a different thesis topic *Viola ser. cornutae s. lat. in the Southeastern Dinaric Alps* at the Department of Biology, Biotechnical Faculty, University of Ljubljana (Slovenia). Her mentor was a prominent botanist and academician Ernest Mayer. Due to a series of unfortunate events, this was the only task that she did not complete in a timely manner.

Admiring the professional and academic qualities of Lijerka Kutleša, MSc, and because of the need for regular and high-quality teaching, at the beginning of 1979, the Biology Department at the Faculty of Science selected her as the Assistant Professor for the course *Systematics of Cormophytes*, which remained her title until retirement in 1988.

During her many years of dedicated work at the Biology Department at the Faculty of Science, Lijerka Kutleša stood out for her teaching skills, as well as her scientific work. Namely, along with numerous teaching obligations, first as an assistant, then as a teacher at the Biology Department at the Faculty of Science and the Faculty of Pharmacy at the University of Sarajevo, she did research work in plant systematics and ecology. She participated in numerous scientific and scholarly projects, consisting of fieldwork in the entire territory of Bosnia and Herzegovina and beyond, as well as laboratory work following field explorations. Although her initial papers referred to the study results of Mediterranean flora and vegetation, Klek peninsula followed by island Dolin in the Kvarner gulf, during the subsequent phase, she participated in a series of ecosystem research projects involving the most important mountain ranges in the central Dinaric Alps – Maglić, Volujak, and Zelengora, with a special focus on Perućica forest, projects that analysed this issue through several cycles. Afterwards, she focused on the flora and vegetation of Vranica, the Una basin, boglands of mountains in Bosnia, and ecosystems of habitats with naturally occurring heavy metals; projects that represented a real research treat.

A specific contribution to her overall work is the participation in projects regarding the natural potentials of some medicinal, high-vitamin, and edible plant species, as well as the issue of natural progradations of vegetation in, increasingly prevailing and spacious, waste rock dumps near old mines.

Apart from ecosystem projects, Lijerka Kutleša had never neglected another important field of her scientific interests – systematic research. Within this sphere, she gave a significant contribution with her papers on Violaceae and Liliaceae families (*Viola* and *Lilium* type genus), as well as on some other families – she studied genera *Edraianthus*, *Leontopodium*, *Valeriana* and others.

Moreover, the participation of Lijerka Kutleša in a large-scale and significant project *Vegetation Map of Yugoslavia – the Territory of Bosnia and Herzegovina* is very important. This project lasted for many decades, it was complex and expensive, and gathered the most qualified botanists from Bosnia and Herzegovina of the 1970s and 1980s, but by a combination of circumstances, only fieldwork was completed for this project, with complete documentation and commentary. Working on this project, as a technical secretary for one period, Lijerka Kutleša gave by far greater contribution to field analysis and commentary preparation in a large number of sections as part of work groups during the years it took to do this task. Within this project, she analysed the vegetation of central, northwestern, and northern Bosnia, and a part of eastern Herzegovina.

Students remember her as an excellent teacher who possessed an enormous knowledge of botany, as well as the natural gift of passing her knowledge on to younger generations. It was no easy task of teaching botany when modern capabilities of illustrating objects were not available. However, only a few teachers in the 1970s and 1980s could make illustrations on a large piece of paper, in the form of posters, and thereby help students in the learning process. The way she organized theory and practical classes for the course *Systematics of Cormophytes* is a special story. Her students and close associates had unforgettable days of fieldwork on Treskavica Mountain which she called “Miss Mountain of Bosnia and Herzegovina”. She led a long line of students along the mountain to the village Turovi (820 m) until the mountain lodge “Josip Sigmund” (where the students were accommodated) in Kozija luka (1510 m) and further until the very top of the mountain (Pakliješ, 2086 m). Due to her fast and small strides, even the toughest had problems catching her up. Students also remember her being at the back of the line, helping the weaker to catch up the stronger in front of them, respecting the ethical rules of mountaineering, and often wearing the backpack of some students unable to carry heavy equipment, along with her own backpack. She was a reliable guide during the fieldwork. She worked with ease, confidence, zest, commitment, and sacrifice. Climbing the Treskavica Mountain, and visiting the wider territory of

this mountain until its peak, her students managed to learn a lot about mountain flora and collect rich plant specimens gathered in their own herbaria. These collections remained as a trace of fieldwork and good material for learning the systematics of cormophytes.

Lijerka Kutleša was not only a plant world enthusiast, but an avid mountaineer. She climbed the majority of mountains in former Yugoslavia and beyond. Mountaineers remember her as a persevering and brave person, full of other virtues valuable in nature. On these quests, she did not forget her profession so she collected botanic materials for her research and research of her colleagues who were unable to endure the exertion required for mountaineering. Even during the winter, Lijerka Kutleša did not forget the mountains – that is when she dedicated her time to skiing, which was her favourite sport. She passed her love for skiing and skills to younger generations. She was a talented skiing instructor. She taught the children of her colleagues and her relatives with great ease, almost like a professional instructor. She was renowned for this, especially at the Olympic ski resort Jahorina.

In addition, Lijerka Kutleša was a great admirer of all forms of art, especially literature. She was an avid reader and read a large number of international and local authors. She read works from the distant and close past, as well as the most recent works of local and international literary authors. She quenched her thirst for books by borrowing them from libraries and friends, and buying and archiving them in her own library. She also loved fine art and never missed an opportunity to visit an art exhibition in Sarajevo or elsewhere. Film art was her favourite art form, especially on the big screen in movie theatres. She was also a classical music aficionado and, as long as her health allowed her, she regularly visited classical music concerts and operas at the National Theatre in Sarajevo or elsewhere in the world during her travels. In addition, she immensely loved travelling. She visited many countries in Europe, Asia, and even visited Argentina. One of the last places to visit was Spain, the country that left a special impression on her, and often told stories about it.

Up until her late years, Lijerka Kutleša did not abandon her desire to gain knowledge and skills. She very quickly acquired the skill of using computers in order to obtain many pieces of information from different spheres of interest. Using email and Skype, she was able to communicate with former colleagues, numerous friends, and relatives all over the world.

During her many years of dedicated work at the Biology Department at the Faculty of Science, apart from being a

teacher and a scholar, she performed many other duties. She was a member of different commissions established for the purpose of the Department and Faculty. She was an active member of the Biological and Ecological Society of Bosnia and Herzegovina. She was also a successful president of an Assembly of Working People gathering all working people at the Department, from teachers, assistants, to laboratory assistants. With her patience and wisdom, she successfully solved the problems of working people as their President for two years.

While working as the Chair, despite also being a part-time student, she received the best, exemplary, appraisals for her work. She received many collective recognitions, numerous monetary rewards at the Biology Department, as well as praises from the Faculty of Pharmacy. On the occasion of celebrating 30th anniversary of the Biology Institute at the University of Sarajevo, she received a Charter. She received Recognition from the Faculty of Science for 20 years of her work.

The list of biographical facts does not give us a complete picture of a person, only their professional and academic interests, omitting their human side, especially when it comes to such a persona as Lijerka Kutleša, whose personality traits were difficult to separate as far as their quality is concerned. Therefore, we come to the missing fragment of a scholar and expert – their personality, the human within. We do not speak of a person with many faces and profiles, one for every occasion. Lijerka Kutleša was and remained a strong and stable person, with exceptional qualities, for every occasion, at every place. She selflessly encouraged younger colleagues in their professional advancements and was sincerely rejoiced for their accomplishments, whether they were promoted, published a paper, or issued a book. She was known for never forgetting to congratulate with a bouquet and a smile.

Students and colleagues, as well as numerous friends, loved and respected her. She earned this respect through correct relationship towards work, persons she worked and socialized with, and her willingness to help professionally and privately, as well as through her moral virtues.

Ms Lijerka Kutleša is remembered by everyone as a kind soul, altruist, and, above all, an honourable person. Although petite, she had a big heart, an open mind, intellectual, and full of truly human values.

The heart of Lijerka Kutleša stopped beating on 26 March 2019 in Sarajevo. Her remains were buried in her home loved town Livno.

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Kotrošan, D., Ružić, M., Radišić, D., Šimić, E., Sjeničić, J. & Derović, I. 2011. First results of the census of winter roost sites of the Long-eared Owl in Bosnia and Herzegovina. In: *Abstract Book of International Conference on the Survey, Monitoring and Conservation of the Long-eared Owl Asio otus*, 1–5 November 2011, Kikinda, p. 31.

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