FIRST INVENTORY OF VASCULAR FLORA OF MATOKIT MOUNTAIN (BIOKOVO MASSIF, CROATIA)

PRVA INVENTARIZACIJA VASKULARNE FLORE PLANINE MATOKIT (BIOKOVO MASIV, HRVATSKA)

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INTRODUCTION

UVOD

The Dinaric mountain range is the lower chained highland mountain of Southeastern Europe, representing the largest karst area that is known for its extremely high plant richness and biodiversity. The highest mountains in the Croatian Dinarides are Velebit, Dinara and Biokovo Massif. Within Biokovo Massif, Matokit Mt (lat. Monte Acutum, translated “the sharp Mountain”) is the mountain ridge located in the surrounding of the town of Vrgorac in Dalmatian hinterland, and represents a wider area of the Biokovo Massif (Fig. 1). Matokit Mt provides the dinaric northwest-southeast direction with the highest peak (Sv. Rok) at 1062 m a.s.l. and total length of approximately 8.5 km (Vukosav 2006; Vukojević 2011).

Matokit Mt is situated in southern Croatia, next to the Vrgorac Town (Fig. 1). The eastern side of the Matokit Mt has relatively steep slopes, while the western slopes are easily accessible. The climate is a sub-Mediterranean with a great influence of continental climate, with an average annual temperature of 14.3°C (lower than the average of typical Mediterranean climate) and 1720 mm of average annual rainfall measured by National Hydrometeorological Institute from 1981 to 2010 for the Town Vrgorac). The duration of snow cover is short at a lower altitude, but in higher altitudinal zo-

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nes the snow cover can last up to three months. In geological sense the northern slopes of Matokit Mt are composed of well-bedded (20-150 cm thick) Turonian limestone. Prevailing soils are shallow soils, with a significant share of stone fragments. In the areas between 500 and 1000 m a.s.l. there are brown soils (calcocambisol), and above 1000 m black soils on carbonate basis (calcomelanosol) (Martinović 2000).

In spite of the fact that botanical studies of broader area of Biokovo Massif started 60 years ago (Kušan 1956, 1969; Domac 1957; Radić 1974, 1976, 1977; Lovrić and Rac 1987; Rac and Lovrić 1987; Šilić and Šolić 1999, 2002; Pavletić 2002; Trinajstić 2002; Hršak and Alegro 2008; Alegro 2010), still botanical unexplored areas exist, and therefore we founded necessary to fill this gap. The study area of Matokit Mt as a part of Biokovo Massif was chosen because its vascular flora has never been studied systematically in the past. Sporadically floristic records of invasive and threatened plant species of Matokit Mt were published by Vukojević (2011), Vukojević and Vitasović Kosić (2012) and Vukojević et al. (2016). Here we present the original results of the first comprehensive botanical study and flora inventory of Matokit Mt, including its foothills, northern and southern slopes performed from 2010 to 2015.

The aim of this study was to fill the gap in botanical data of Matokit Mt as a part of Biokovo massif and to (a) perform inventory of the vascular flora, (b) to analyse plant diversity, as well as (c) to provide short overview on some interesting endemic and rare species of this mountain for species protection and conservation management of this area. The list of vascular flora includes an overview on some endemic, threatened, and invasive plant taxa of the Croatian flora.

**MATERIALS AND METHODS**

**MATERIJALI I METODE**

**Study area – Područje istraživanja**

Field research of vascular flora was carried out on Matokit Mt, as a part of Biokovo Massif, including its foothills (with nearby settlements), northern and southern slopes, the whole ridge of the mountain, covering different habitats,
mostly grasslands in succession, rocky crevices and forest fringes, altogether covering about an area of 15 km².

The researched area belongs to the Submediterranean zone (Fig. 2) with a high influence of the mountain climate and the vegetation is vertically divided according to altitude (from 250–1062 m a.s.l.). The dominant vegetation communities of Matokit Mt southern slopes, difficult to access, are dense maquis of alliance Fraxino orni-Quercion ilicis Biondoni, Casavecchia et Gigante in Biondi et al. (2013), and large stands of Juniperus oxycedrus L., rising up to 600 m a.s.l. On the northern side the Matokit Mt is covered with forest vegetation that belongs to the thermophilous coastal forest and scrub alliance Fraxino orni-Ostryion Tomažič 1940, with predominance of Querco-Carpinetum orientalis H-ić 1939 in lower parts (up to 400 m a.s.l.) (Vukosav 2006; Trinajstić 2008; Vukojević et al. 2016).

Data sources – Izvori podataka

Data on plant taxa from Matokit Mt and its surroundings were collected during field researches from 2010 to 2015, throughout each vegetation season, using the standard methods for flora mapping in Croatia according to Nikolić (2006). Plant taxa were collected on two different transects (east-west and north-south) along the Matokit Mt, as well as in different types of habitats during four vegetation seasons on the same transects e.g. mountain routes. Herbarium specimens were collected, digitalized and deposited in the Herbarium ZAGR and are accessible through the Virtual Herbarium ZAGR on http://herbarium.agr.hr (Bogдановић et al. 2016).

Taxa were determined according to Pignatti (1982, 1984), Tutin et al. (1964–1980, 1993), and Nikolić (2019a). The plant nomenclature follows Flora Croatica Database (Nikolić 2019b). The plant taxa listed in Tab. 3 are given in alphabetical order where the families and life forms were attributed to each taxon, IUCN category, endemic status, or invasiveness are also provided. The attributed life forms were denoted according to classification of Raunkiaer (1934) and Horvat (1949). In the floristic list (Tab. 3) they were marked with the following abbreviations Ch (Chamaephyta), G (Geophyta), H (Hemicryptophyta), Ph (Phanerophyta), and T (Therophyta). The status of endangered plant taxa was analysed according to IUCN criteria and categories that are implemented in the Flora Croatica Database (Nikolić 2019b), thereby the following abbreviations were used: CR (Critically endangered), EN (Endangered), VU (Vulnerable), LC (Least Concern), NT (Near Threatened), and DD (Data Deficient). Endemic status of plant taxa, endemic (E) and stenoendemic (sE) was denoted according to Nikolić et al. (2015) and the Flora Croatica Database (Nikolić 2019b). The status of invasive alien species (Inv) was denoted according to Boršić et al. (2008) and Nikolić et al. (2014).
RESULTS AND DISCUSSION
REZULTATI I RASPRAVA

During the floristic research of Matokit Mt, a total of 604 vascular plant taxa were found (Tab. 3). In taxonomic analysis 569 species and 35 subspecies of native and naturalised vascular plants were noted, altogether from 86 families and 337 genera. Eight taxa of Pteridophyta, five taxa of Gymnospermae, and 591 taxa of Angiospermae (Magnoliidae 479 and Liliidae 112 taxa) were recorded (Tab. 1). The most represented families were Fabaceae (9.9%), Poaceae (9.1%), Asteraceae (7.4%), Lamiales (6.8%), Brassicaceae (5.0%) and Rosaceae (4.8%). A total of 345 herbarium sheets were collected and deposited at the ZAGR herbarium (206 of them have been digitalized till now).

The analysis of life forms (Tab. 2) indicate that dominant them have been digitalized till now). A total of 345 herbarium sheets were collected and deposited at the ZAGR herbarium (206 of them have been digitalized till now).

Table 3. Alphabetical list of vascular flora of Matokit Mt (Biokovo Massif).
Tablica 3. Abeckedri popis vaskularne flore planine Matokit (Biokovo masiv)
1. Acantus balsamicus Heywood et I. Richardson, Acanthaceae, H
2. Acer monocephalum Lam., Aceraceae, Ph
3. Achillea millefolium L., Asteraceae, H
4. Aconitum arvense (Lam.) Dandy, Lamiaceae, Ch
5. Aegopodium podagraria Roth, Poaceae, T
6. Aegopodium neglecta Req. ex Bertol., Poaceae, T, NT
7. Aethionema saxatile (L.) R. Br., Brassicaceae, Ch
8. Agimorina euripatoria L., Rosaceae, H
9. Agrostemma githago L., Caryophyllaceae, T
10. Allantus altissimus (Mill.) Swingle, Simaroubaceae, Ph, Inv
11. Ajuga elegantissima Schur, Poaceae, T
12. Ajuga chamaepitys (L. Schreb.), Lamiaceae, T
13. Ajuga genevensis (L.) Less., Lamiaceae, H
14. Ajuga reptans L., Lamiaceae, H
15. Allaria petiolata (M. Bieb.) Cavara et Grande, Brassicaceae, H
16. Allium ampeloprasum L., Amaryllidaceae, G
17. Allium curnaturn L., Amaryllidaceae, G
18. Allium deuterium Webb et Berthel., Amaryllidaceae, G
19. Allium flavum L., Amaryllidaceae, G
20. Allium lusitanicum Lam., Amaryllidaceae, G
21. Allium moschatum L., Amaryllidaceae, G
22. Allium pallens L. ssp. tenellum (Ten.) Stemam, Amaryllidaceae, G
23. Allium roseum L., Amaryllidaceae, G
24. Allium sphaerocephalon L., Amaryllidaceae, G
25. Alyssoides utriculata (L.) Medik., Brassicaceae, Ch
26. Alyssum murale Waldst. et Kit., Brassicaceae, H
27. Alyssum petiolatum L., Lamiaceae, H
28. Ambrosia artemisiafolia L., Asteraceae, T, Inv
29. Amelanchier ovalis Medik., Rosaceae, N
30. Anacamptis pyramidalis (L.) Rich., Orchidaceae, G, NT
31. Anagalis arvensis L., Primulaceae, T
32. Anagalis coerulea Schreb., Primulaceae, T
33. Anchusa cretica (Mill.) Bigazzi, E.Nardi et Salvi, Boraginaceae, T
34. Anthericum lilio L., Asparagaceae, G
35. Anthoxanthum odoratum L., Poaceae, H
36. Anthriscus sylvestris (L.) Hoffm., Apiaceae, H
37. Anthyllis vulneraria L., Fabaceae, H
38. Anthyllis vulneraria L. subsp. pulchella (Vis.) Borr., Fabaceae, H
39. Aposeris foetida (L.) Less., Asteraceae, H
40. Arabis collina Ten., Brassicaceae, H
41. Arabis glabra (L.) Bernhardt, Brassicaceae, H
42. Arabis hirsuta (L.) Scop., Brassicaceae, H
43. Arabis turrita L., Brassicaceae, H
44. Arabis verae (L.) R. Br., Brassicaceae, T
45. Argyrolobium zanonii (Turn) P.W. Ball, Fabaceae, Ch
46. Aristolochia rotunda L., Aristolochiaceae, G
47. Artemisia vulgaris L., Asteraceae, Ch
48. Arum italicum Mill., Araceae, G
49. Asparagus acutifolius L., Asparagaceae, N
50. Asperula arista L., Rubiaceae, H
51. Asperula scutellaris Vis., Rubiaceae, Ch, E
52. Asphodeline lutea (L.) Reichenb., Xanthorrhoeaceae, G
53. Asplenium ceterach L., Aspleniaceae, H
54. Asplenium onopteris L., Aspleniaceae, H
55. Asplenium ruta-muraria L., Aspleniaceae, H
56. Asplenium trichomanes L., Aspleniaceae, H
57. Astragalus muelleni Steud. et Hochst., Fabaceae, H, NT, E
58. Astragalus vesicarius L., Fabaceae, Ch
59. Asyneuma limonifolium (L.) Janch., Campanulaceae, H
60. Athyrium filix-femina (L.) Roth, Woodsiaieae, H
61. Avena barbata Pott ex Link, Poaceae, T
62. Bellis annua L., Astersacea, T
63. Bellis perennis L., Astersacea, H
64. Bellis sylvestris Crillo, Astersacea, H
65. Berberis vulgaris (Vent.) DC., Berberidaceae, H
66. Betonica officinalis L., Lamiaceae, H
67. Bituminaria bituminosa (L.) Stirton, Fabaceae, H
68. Blackstonia perfoliata (L.) Huds., Gentianaceae, T
69. Bombycilaena erecta (L.) Smoljan., Fabaceae, H
70. Bombycilla cretica (Lam.) Dandy, Lamiaceae, Ch
71. Bombycilla nuttalliana (L.) Huds., Gentianaceae, T
72. Bombycilla racemosa (L.) Schreb., Gentianaceae, T
73. Brassica oleracea L. ssp. acephala (DC.) O. Schwarz, Brassicaceae, Ch
74. Briza maxima L., Poaceae, T
75. Briza minor L., Poaceae, T
76. Bromus commutatus Schrad., Poaceae, T
77. Bromus erectus Huds., Poaceae, H
78. Bromus hordeaceus L., Poaceae, T
79. Bromus squarrosum L., Poaceae, T
80. Bromus sterilis L., Poaceae, T
81. Broussonetia papyrifera (L.) Rehd., Moraceae, Ph, Inv
82. Bryonia dioica Jacq., Cucurbitaceae, H
83. Bunium alpinum Waldst. et Kit. ssp. montanum (W. D. J. Koch) P.W. Ball, Apiaceae, Ch
84. Bupleurum praecatum L., Apiaceae, T
85. Bupleurum veroneense Turra, Apiaceae, T
86. Calamagrostis epigejos (L.) P. Beauv., Poaceae, T
87. Calamagrostis grandiflora (L.) Moench, Gentianaceae, T
88. Calamagrostis epigejos (L.) Bernhardt, Brassicaceae, Ch
89. Calamintha nepetoides (L.) Moench, Lamiaceae, H
90. Campanula bononiensis L., Campanulaceae, H
91. Campanula lingulata Waldst. et Kit., Campanulaceae, H
92. Campanula persicifolia L., Campanulaceae, H
93. Campanula pyramidalis L., Campanulaceae, H
94. Campanula rapunculoides L., Campanulaceae, H
95. Campanula rapunculus L., Campanulaceae, H
96. Campanula sibirica L., Campanulaceae, H
97. Capsella bursa-pastoris (L.) Medik., Brassicaceae, H
98. Capsella rubella Reut., Brassicaceae, T
99. Capsicum annuum L., Solanaceae, T
100. Cardamine fialae Fritsch, Brassicaceae, T, sE
Vahl., Lamiaceae, Ch

548. Thymus longicaulis Vis. ex Benth., Lamiaceae, Ch, E

547. Thymus capitatum L. ssp. L., Lamiaceae, Ch

540. Teucrium polium L., Lamiaceae, Ch

539. Teucrium chamaedrys L., Lamiaceae, H

538. Taraxacum officinale (L.) Sch.Bip., Asteraceae, H

537. Tanacetum corymbosum Tanacetum cinerariifolium

536. Solidago gigantea

535. Solidago viridis

534. Sesleria autumnalis

533. Sesleria robusta (Scop.) F. W. Schutz, Poaceae, H

532. Sesleria tenuifolia

531. Sesleria maritima

530. Stipa bromoides

529. Stipa capillata

528. Stachys maritima

527. Serratula radiata

526. Spiraea cana

525. Spiraea alba

524. Sorbus domestica

523. Sorbus halepense

522. Sorbus domestica

521. Silene latifolia

520. Silene pendula

519. Silene italica

518. Silene sylvestris

517. Seseli montanum

516. Seseli pallasii

515. Seseli montanum

514. Sisymbrium officinale

513. Solidago gigantea

512. Solidago canadensis

511. Scilla autumnalis

510. Scilla bifolia

509. Scilla ignacea

508. Sedum latifolium

507. Sedum album

506. Sedum stellatum

505. Sedum spathulifolium

504. Sesleria robusta

503. Sesleria autumnalis

502. Seseli montanum

501. Seseli pallasii

500. Stachys maritima

499. Serratula radiata

498. Senecio vulgaris

497. Senecio jacobaea

496. Saxifraga stolonifera

495. Saxifraga oppositifolia

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The occurrence of families Fabaceae (9.9%), Poaceae (9.1%), Asteraceae (7.4%) and Lamiaceae (6.8%) in the flora of Matokit Mt is quite normally distributed according to Nikolić (2001). The domination of hemicycrophytes (39.9%) and therophytes (26.2%) in the flora of Matokit Mt, as well as moderate present of geophytes (12.4%), phanerophytes and chamaephytes (10.8%) indicates high influence of the Mediterranean climate according to Horvat (1949).

In the flora of Matokit Mt a total of 32 endemic taxa were found (Tab. 3). Majority of endemic taxa were found within the vegetation of Natura 2000 grasslands and pastures in different successions stages e.g. a combination of rocky pastures of Chrysopogono grylli-Saturejion subspicatae Horvat & Horvatić ex Černjavski, Grebenščikov & Pavlović 1949 and grasslands of Saturejon subspicatae Tomić-Stanković 1970, as well as within chasmophytic vegetation of the Centaureo cuspidatae-Portenschlagiellion ramosissimae Trinajstić ex Terzić et Di Pietro 2016. Especially interesting for the Croatian flora are the findings of recently recorded Cardamine fialae in the flora of Matokit Mt (Vukojević et al. 2016). The species grows on lower altitudes in rocky ground within the vegetation of forest fringes and secondary also in ruderal places, in arable fields, on shady screes and very rarely in rock crevices (Vukojević et al. 2016). All new localities in Croatia are close to Klobuk (locus classicus) in Bosnia and Herzegovina. Another Balkan endemic taxon, Erysimum croaticum, recently described by Polatschk (2013) from Zadvarje in Croatia was found in the flora of Matokit Mt there were a few individuals on screes of southern slopes. According to Polatschek (2013) this species is distributed in West Kosovo and Dalmatia (Mosor, Omiš, Brela region, Zadvarje and Makarska) and the new locality on Matokit Mt within Biokovo massif contributes to a better understanding of species distribution.

A spontaneous hybridogenic Iris population, evidently hybrid between I. illyrica and I. pseudopallida was recorded. Several populations with a few individuals growing within rocky grassland at higher altitudes (approximately 900-1000 m a.s.l.) were found. In the Flora Croatica Database (Nikolić 2019a) this taxon is not listed, and the occurrence of this Iris hybrid is not surprising because Matokit Mt represents the overlapping distribution area of I. illyrica and I. pseudopallida, and it could be found anywhere along the Adriatic littoral where parental species occur. Although those hybrids are known from literature in Croatian flora (Mitić et al. 2000, 2001, 2013; Biljaković 2002) taxonomical status of this hybrid is questionable and was not a subject of this research.

Some narrowly distributed species of the Croatian flora were also found in the flora of Matokit Mt e.g. Thymus bracteosus and Linaria microsepala. For endemic taxon Vicia ochroleuca ssp. dinara, the Matokit Mt represents the...
The main problem in studied area is a high degree of vegetation degradation which is mostly present in lower zones (up to 400 meters). Because of strong human emigration from mountainous areas cattle-raising in northern settlements is almost completely abandoned (Vukosav 2006) and that endangered grassland habitats. Invasive species and grasslands in different stages of succession (mostly in a form of maquis and garrigue communities) occupy increasingly large areas mostly on abandoned arable land (Vukojević and Vitasović Kosić 2012). Grassland habitats succession and consequently the loss of endangered and endemic taxa contributes to the long-lasting succession of Juniperus oxycedrus L., which is a consequence of reduced grazing (sheep and goat) in this area.

During the year 2014 the reforestation of Aleppo pine (Pinus halepensis) was noticed. This management of reforestation resulted in an additional reduction of the grassland surface and significant loss of natural flora and vegetation, additionally threatening endemic and endangered taxa. Similarly, it has already happened in the nearby area of Orah Hill (on its southern slopes), that was afforested approximately 25 years ago, and already has today lost its natural grassland vegetation and flora diversity.

The flora diversity depends on human (non)activity (agriculture, urbanization). Therefore, proper management (regular mowing of meadows, pasture grazing, and maintenance of arable land) will help to create better conditions for the development of agriculture and sheep farming, while it can also reduce the spread of invasive plant taxa and contribute to conservation of plant diversity. In order to preserve the grassland habitats for endangered and endemic taxa we suggest the introduction of educational workshops for local residents and hunting associations.

To keep plant richness in this area, special attention in the future should be paid to its protection and conservation through management measures, such as maintaining a general low pressure of grazing by means of grazing rotation, to prevent the process of secondary succession and the spread of unpalatable competitive tall grasses at a landscape level (Vitasović Kosić et al. 2014). Here presented results are very important, because this is the first inventory of flora here, even though the area is a part of the Biokovo sensu lato and Dinaric mountains, which are known for extremely high plant diversity. Species inventories presented here are the basic information needed for conservation of flora and habitats. It also represents a background for future monitoring especially the decline of grasslands area, and harbouring habitats for rare species found on Matokit Mt. Therefore, we hope this information should become accessible for broader audience and future conservation planning.

CONCLUSIONS

The first detailed floristic study for Matokit Mt recorded a total of 604 vascular plant taxa on grasslands in different succession stages, rocky crevices and forest fringes habitats. Herbarium specimens (345 sheets) were collected, digitalized (206), deposited and are accessible in on-line ZAGR Herbarium. The results of this study point to the high plant richness in the study area as a result of various biotic and abiotic factors, conditioned further by geological variety, soil, topography and microclimatic factors. The Matokit Mt represents a new site for the Flora of Croatia, especially for endemic (32), and endangered (36) taxa. The occurrence of some very rare endemics (Erysimum croaticum and Cardamine fialae (until now the only known site in Croatia)) in the flora of Matokit Mt is of special interest for the national flora. In addition, the north slopes of the Matokit Mt are the southernmost findings for some taxa: Myrrhoides nodosa, Centaurea pannonica, and Saxifraga rotundifolia. The reduction of the area of rocky grasslands in the studied area as a result of the strong human emigration, rapid abandonment of agriculture and livestock breeding, reforestation of Pinus halepensis, and a long-lasting succession of Juniperus oxycedrus has been evident. Such loss of grassland habitats leads to endangerment of some protected (CR, EN, and VU) and endemic plant species, at the same time abandoning of agricultural habitats around Town Vrgorac.
ACKNOWLEDGEMENT
ZAHVALA

Special thank to Mr. Aleksa Vukojević for the assistance on the field trip and for the hospitality during our stay in Vrgorac, Mrs Dragica Miletic for technical help in preparation of plant materials from Matokit Mt for ZAGR herbarium, sincere thank to Dr. Marija Jug-Dujaković for proofreading of English. We thank the reviewers for their careful reading of the manuscript and their constructive remarks.

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Istraživana je vaskularna flora planine Matokit (Biokovo masiv) u južnoj Hrvatskoj u različitim vegetacijskim razdobljima od 2010.-2015., a pronađene su ukupno 604 vaskularne biljne svojte, iz 86 rodica i 337 rodoa. Proučavano područje nikada nije istraženo u prošlosti i ovo su prvi detaljni floristički podaci za travnjake u različitim stadijima zarastanja. Sakupljeni herbarijski uzorci (345 listova) digitalizirani su i dostupni su na ZAGR herbariju on-line (http://herbarium.agr.hr). Dominantne porodice su mahunarke (Fabaceae 9,9%), trave (Poaceae 9,1%), glavočike cjevnjače (Asteraceae 7,4%) i usnjače (Lamiaceae 6,8%). Analiza životnih oblika pokazuje da su na planini Matokit dominantni hemikriptofiti (39,9%) i terofiti (26,2%) što ukazuje na veliki utjecaj mediteranske klime. Na istraživanom području zabilježeno je 36 ugroženih i 17 invazivnih biljnih svojci. Ukupno 32 biljne svojci su endemične (26 endema u širem smislu i 6 stenoendema) i predstavljaju nova nalazišta u flori Hrvatske. Pojava nekih vrlo rijetkih endema (Cardamine fialae Fritsch i Erysimum croaticum Polatschek) u flori Matokita od posebnog su interesa za nacionalnu floru.

SAŽETAK

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KLJUČNE RIJEČI: biljna raznolikost, endemične vrste, sukcesija travnjaka, Vrgorac