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ENDEMIC FLORA WITHIN COMMUNITIES OF MOUNTAIN PINE (*Pinus mugo* Turra) AT METOHIAN PROKLETIJE MOUNTAIN

ABSTRACT: Metohian Prokletije is marked as one of the main European centers of the Balkan floristic endemism due to their geographical position on the fringe of the Mediterranean Sea and complex and diverse geomorphological, geological, orographic and climatic factors. This paper presents the results of long-standing comprehensive floristic researches of endemic flora in the Metohian Prokletije Mt., with particular reference to their high mountainous areas over the tree limit where *Pinus mugo* communities are concentrated. These types of ecosystems represent a transitional zone between the coniferous forests and high mountain bushy and herbaceous vegetation, at an altitude of 1,700 m do 2,400 m. Based on detailed field surveys, 118 Balkan endemic plant taxa within these communities were recorded so far. The phytogeographical analysis showed that the Balkan endemic taxa predominantly belong to the South-European mountainous (SEM) and Central-European mountainous (CEM) chorological groups with the following participation of floristic elements: 1) Dinaric-Scardo-Pindhian-Moesian (44 taxa or 37%), 2) Dinaric-Scardo-Pindhian (40 taxa or 34%), 3) Dinaric (24 taxa or 20%), and 4) Dinaric-Moesian elements (10 taxa or 9%). The biological spectrum was characterized by the prevalence of hemicryptophytes and chamaephytes. The obtained results on the presence of numerous endemic plants in the studied area can increase the interest in further floristic research, while the provided information of the ecological importance as well conservation status of threatened plant communities with *Pinus mugo* aimed at encouraging more effective biodiversity protection and sustainable management of natural resources.

KEYWORDS: Endemic flora, communities of mountain pine (*Pinus mugo*), Metohian Prokletije

INTRODUCTION

The Prokletije Mountains are located in the extreme southeast of the Dinaric region within the wider Mediterranean mountain chain zone. They are one of the highest and most rugged mountain ranges on the Balkan Peninsula situated in the border zone of southern Serbia (Kosovo and Metohija), eastern

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Montenegro and northern Albania. The northeastern part of the Prokletije Mountains belongs to the Metohian Prokletije.

The geographical position on the fringe of the Mediterranean Sea (Adriatic Sea), complex and heterogenous geomorphological properties of terrain and geological composition, and various climatic conditions from sub-Mediterranean to Arcto-Alpine climate contributed to a high floristic and vegetation diversity of Metohian Prokletije Mt. (Lakušić, 1968; Stevanović, 1992a; 1992b; Stevanović et al., 1995; Janković, 1998a; Amidžić & Panjković, 2003; Tomović, 2007).

Intensive research on high-mountain flora and vegetation of Prokletije, including Metohian Prokletije, has started in 1960s (Janković, 1958; Lakušić, 1968; Janković, 1972; Amidžić & Stevanović, 1997; Janković, 1998b; Amidžić & Krivošej, 1998; Amidžić & Belij, 1998; Amidžić, 2003; Pavlović-Muratspahić, 2003; etc). High-mountain zone above the upper forest border is particularly distinguished by the richness and diversity of flora and the presence of endemic plant taxa. Regarding the high floristic richness and endemism, forest ecosystems and vegetation of subalpine and alpine zone are particularly outstanding due to their refugial character in Pleistocene (Stevanović, 1996).

A special place in the high-mountain flora of Metohian Prokletije Mt. is occupied by a significant number of Balkan endemic taxa, making them one of the most important Balkan and European floristic diversity centers, along with the Šar Mt. (Amidžić et al., 2013; Tomović et al., 2014). The majority of endemic taxa are largely related to the communities of mountain pine (*Pinus mugo* Turra) which are located in a specific transition zone (so-called combat zone) between the upper forest limit and high mountain bushy and herbaceous vegetation (Janković & Amidžić, 2003).

Although a comprehensive floristic analysis of the endemic plant taxa in Metohian Prokletije has been provided by Amidžić et al. (2003; 2013), so far, no single research has been conducted and published concerning Balkan endemics within this transitional dwarf mountain pine scrub vegetation. Therefore, primary aim of this study is to provide a list of 118 Balkan endemics that were recorded within given investigated area and to present their phytogeographical (classification into major chorological groups and floristic elements) and ecological characteristics as well as syntaxonomy overview of the mountain pine communities at the upper limit of the tree line.

MATERIAL AND METHODS

Study area

The Metohian Prokletije is a continuous mountain range, over 90 km long, situated in the outermost southwestern part of Serbia and bordered by the Prokletije Mountains on the northwest (Figure 1). This mountain range is composed of 24 mountain groups covering an area of over 2.000 km² and is divided into three relief units located in the northern, central and southern part (Knežević, 1998; Belij, 2003).



Figure 1. Geographical position of Metohian Prokletije

Owing to its specific position and the wide altitudinal range, Metohian Prokletije is characterized by a transitional climate with a per-humid sub-Mediterranean at lower elevations to a humid mountain climate of the Alpine type at higher altitudes (Stevanović & Stevanović, 1995).

In geological terms, Metohian Prokletije is composed of sediment, magmatic and metamorphic rocks (Belij, 1999; 2003), which are predominantly represented by three types of geological substrates (limestone, silicate, and serpentinite) (Šehovac, 2003). As a result of geological heterogeneity and variations of climatic conditions along the vertical profile, a complex pedology cover was formed. Soils vary from alkaline on carbonate rocks and serpentinite to acidic on siliceous rocks (Antonović, 2003).

These high mountainous areas are dominated by coniferous forests of endemorelict Macedonian pine, molika (*Pinus peuce* Grsb.) and Bosnian Pine, munika (*Pinus heldreichii* Crist). At very high altitudes over 2,000 m, above the tree line, there is a pronounced belt of transitional shrubby vegetation of mountain pine (*Pinus mugo*) (Janković and Amidžić, 2003).

Analysis of floristic data

An inventory and floristic analysis of endemic plant species found in communities of mountain pine (*Pinus mugo* Turra) within Metohian Prokletije was performed based on intensive long-standing field study conducted sporadically from 1995 to 2015. Literature data and herbarium materials are deposited in the Herbarium of the Institute for Nature Conservation of Serbia and the Institute for Nature Conservation of Vojvodina province.

The determination of endemic taxa is made using standard regional and national floristic literature such as: Josifović (1964–1977), Sarić (1986; 1992), Tutin et al. (1968–1980), Tutin et al. (1993), Jordanov/Йорданов (1963–1979), Velčev/Велчев (1982–1989), Micevski/Мицевски (1985–2005), and Jávorka and Csapody (1975).

The classification of floristic elements follows Gajić (1980), Meusel et al. (1965; 1978), Meusel and Jäger (1992) and corresponds to the phytogeographical regionalization of the Balkan peninsula into the floristic provinces given by Horvat et al. (1974), additionally modified for the territory of Serbia according to Stevanović (1992a). Taxon affiliation to appropriate life forms was determined according to the system of Raunkier (1934), which was supplemented by Ellenberg and Mueller-Dombois (1974), and was adjusted for taxa in Serbia by Stevanović (1992b).

Concerning the natural habitat types, the shrub communities of *Pinus mugo* were classified according to EUNIS habitat classification (EC, 2013).

RESULTS AND DISCUSSION

Pinus mugo Turra, known as mountain pine, is a species of conifer, native to high elevation habitats (between 1,800 m.a.s.l. to 2,600 m.a.s.l.) which range from Southwestern to Central and Eastern Europe. In Serbia, scrub mountain pine communities are found only on a few localities on high mountains of east, southeast and southern Serbia – Stara Mountain, Suva Mountain, Šar Mountain and Metohian Prokletije (Jovanović, 1955a, 1995b; Janković and Bogojević, 1974; Mišić et al., 1978; Janković, 1981; Rexhepi, 1991; Jovanović, 1992; Stevanović et al., 1994).

On Metohian Prokletije *Pinus mugo* is growing within the forest zone and above the timberline on open spaces. Below the upper forest limit as subedificatory, it grows in an adequate community (forest of *Pinus heldreichii*, *Pinus peuce*, *Picea abies*, *Abies alba*, *Sorbus aucuparia*), and it may form the shrub layer or grow individually, mainly in the limestone and dolomites. The soils on limestone bedrock are chernozems whereas on silicate rocks there are rankers and shallow acid-brown soils (Janković, 1998b).

The flattened physiognomy of the dwarf mugo pine tree growing up to 5 m and with laying, intertwined branches (Ballian et al., 2016), has emerged as a result of adaptation to the strong winds and deep and long-lasting snow cover, climatic conditions occurring at the above-mentioned elevations.

The dwarf pine is also known as a pioneer species and a hasmophyte fully adapted to rocky habitats and different types of geological substrates, covering steep, exposed and often barren slopes (Ellenberg 1988; Vidaković, 1991). Owing to its extensive root system, *Pinus mugo* has an ability to consolidate loose soils which makes it superior in reducing soil erosion in comparison with other pines (Ballian et al., 2016).

Syntaxonomic analysis

In terms of syntaxonomy, community of mountain pine belongs to the class *Vaccinio-Piceetea* Br.-Bl. 1939, order *Vaccinio-Piceetalia* Br.-Bl. 1939, and alliance *Pinion mugi* Pawl. 1928.

On the basis of previous floristic research, communities of mountain pine, which were described within this mountain complex, include:

***Wulfenio carinthiacae-Pinetum mugi* Grebenščikov 1943. (syn: *Wulfenio-Pinetum mugi* (Grebenščikov 43) Janković & Bogojević 1967)** endemorelict community on the Koprivnik, Streočka Mountain, Starac and Rusolija, mainly at an altitude of 2,040 to 2,100 m. The community occurs on calcareous and siliceous bedrocks. The soils can be designated as humus-silicate with the transition to the organic-mineral rendzinas on the limestone deposits. The stands occupy steep north-western, northern and western slopes with an inclination of over 30° (Janković and Bogojević, 1967).

***Pinetum mugi* Janković 1972. (syn: *Pinetum mugi typicum* Janković 1972)** community on the Mokra gora, Hajla, Rusolija, Koprivnik, Lumbardska Mountain, Bogdaš, Nedžinat, Maja Rops, Štedim, Streočke Mountain, mainly at an altitude of 1,700 to 2,300 m. These monodominant communities prevail on the limestone terrains, mostly on skeletal mountain soils or well developed rendzinas (Amidžić et al., 2003).

***Homogyno alpinae-Pinetum mugi* Pavlović-Muratspahić & Janković 1998. (syn: *Homogyno-Pinetum mugi-Vaccinietum* Pavlović-Muratspahić & Janković 1998)** community on the Mokra gora, Hajla, Rusolija, Koprivnik, Lumbardska Mountain, Štedim and Maja Rops, mainly at an altitude of 1,700 m to 2,150 m. The community is developed on siliceous bedrock, occurring on the slopes with distinct inclinations and aspects (Šibík et al., 2005).

***Pinetum mughi-Geum bulgaricum* Amidžić, 1997. (syn: *Geo bulgarici-Pinetum mugi* Amidžić 2003)** community on the Nedžinat, Lumbardska Mountain, Bogdaš, Koprivnik, Rusolija and Hajla, mainly at an altitude of 2,020 m to 2,340 m. The community is well developed on limestone–dolomite rocks and shallow brown soils. The stands mainly occupy cold northeastern slopes, with an inclination of 5° to 75° (Amidžić, 1997).

Taxonomic analysis

Plant communities dominated by *Pinus mugo* are characterized by a great richness of plant species and a high percentage of endemism. In the area of Metohian Prokletije, 283 endemic species and subspecies have been registered so far (Amidžić et al., 2013), out of which 118 (42%) can be found within these communities of mountain pine. Among these, one belongs to Gymnospermae taxa while the remaining 117 are Angiospermae (Dicotyledones class with 107 plant taxa and Monocotyledones class with ten plant taxa).

In a taxonomic sense, endemic taxa of this transitional zone between the forest and herbaceous highland vegetation belong to 31 families. The highest

number of endemic taxa within the zone of mountain pine belongs to the families Caryophyllaceae (16 sp.), Asteraceae (11 sp.), Fabaceae (10 sp.), Scrophulariaceae (9 sp.), Saxifragaceae (6 sp.), Brassicaceae (6 sp.), Lamiaceae (6 sp.), Poaceae (6 sp.), Violaceae (5 sp.) Campanulaceae (5 sp.) and Rosaceae (5 sp.). The most species-rich genera are *Saxifraga* (6 sp.), *Dianthus*, *Viola* (5 sp.), *Pedicularis* (4 sp.), *Heliosperma*, *Silene*, *Trifolium*, *Hieracium*, *Sesleria* and *Festuca* (each with 3 sp.).

Phytogeographical analysis

The chorological spectrum shows that the Balkan endemic taxa of this zone predominantly belong to the South-European mountainous (SEM), Central-European mountainous (CEM) chorological groups, and to a lesser degree to the Mediterranean-Submediterranean (MED-SMED) chorological group.

The prevalence of endemic orophytes from the SEM and CEM chorological groups, demonstrates a decisive influence of mountainous areas of these floristic chorions on the florogenesis and plants preservation during the Pleistocene periods of glaciations (Stevanović, 1996; Tomović et al., 2014).

Phytogeographical analysis of the Balkan endemic taxa in the investigated area indicates that the most numerous floristic elements of the CEM and SEM groups are: 1) Dinaric-Scardo-Pindhian-Moesian, 2) Dinaric-Scardo-Pindhian, 3) Dinaric, and 4) Dinaric-Moesian elements. Dinaric-Scardo-Pindhian-Moesian elements are the most abundant with 44 taxa (37%), followed by Dinaric-Scardo-Pindhian with 40 taxa (34%), Dinaric with 24 taxa (20%) and Dinaric-Moesian elements represented with only ten taxa or 9% of the overall chorological spectrum of the Balkan endemic flora in the study area (Figure 2).

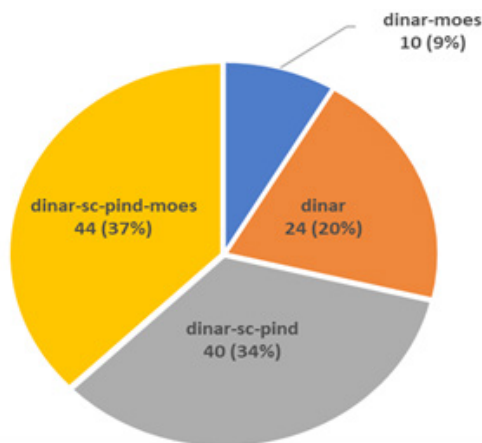


Figure 2. Chorological spectrum of the Balkan endemic flora within communities of mountain pine (*Pinus mugo* Turra) at Metohian Prokletije
 Legend: dinar-sc-pind-moes – Dinaric-Scardo-Pindhian-Moesian, dinar-sc-pind – Dinaric-Scardo-Pindhian, dinar – Dinaric, dinar-moes – Dinaric-Moesian

Considering the distribution of the endemic orophytic flora belonging to SEM and CEM chorological groups in the Balkans, it can be concluded that they are widely distributed in the mountains of the Dinaric and Scardo-Pindhic systems.

The floristic list of the Balkan endemics recorded from the study area is presented in Table 1.

Table 1. The list of the registered endemic flora arranged in the alphabetical order

Floristic elements
Dinaric-Scardo-Pindhian-Moesian
1. <i>Achillea ageratifolia</i> (Sm.) Benth. & Hooker subsp. <i>serbica</i> (Nyman) Heimerl
2. <i>Acinos alpinus</i> L. subsp. <i>dinaricus</i> Šilić
3. <i>Aconitum burnatii</i> Gayer subsp. <i>pentheri</i> (Hayek) J alas
4. <i>Alchemilla bulgarica</i> Rothm.
5. <i>Androsace hedraeantha</i> Griseb.
6. <i>Anthyllis aurea</i> Welden
7. <i>Armeria rumelica</i> Boiss.
8. <i>Astragalus glycyphylloides</i> DC. subsp. <i>serbicus</i> (Reinchenb.) Vasić & Niketić
9. <i>Atocion asterias</i> (Griseb.) Tzvelev
10. <i>Campanula persicifolia</i> L. subsp. <i>sessiliflora</i> (C. Koch) Velen.
11. <i>Carduus scardicus</i> (Griseb) Wettst.
12. <i>Cerastium malyi</i> (Georgiev) Niketić subsp. <i>Malyi</i>
13. <i>Cicerbita pancicii</i> (Vis.) Beauverd
14. <i>Corydalis solida</i> (L.) Clairv. subsp. <i>incisa</i> Lidén
15. <i>Crocus veluchensis</i> Herbert
16. <i>Dactylorhiza cordigera</i> (Fries) Soó subsp. <i>bosniaca</i> (G. Beck) Soó
17. <i>Dianthus cruentus</i> Griseb. subsp. <i>Cruentus</i>
18. <i>Dianthus tristis</i> Velen.
19. <i>Festuca koritnicensis</i> Hayek & Vetter
20. <i>Heliosperma pusillum</i> (Waldst. & Kit.) Hoffmanns. subsp. <i>albanicum</i> (K. Malý) Neumayer
21. <i>Knautia midzorensis</i> Form.
22. <i>Lamium garganicum</i> L. subsp. <i>pictum</i> (Boiss. & Heldr.) P. W. Ball
23. <i>Linum capitatum</i> Kit. ex Schult. subsp. <i>capitatum</i>
24. <i>Melampyrum scardicum</i> Wettst.
25. <i>Minuartia bosniaca</i> (G. Beck) K. Malý
26. <i>Myosotis alpestris</i> F. W. Schmidt sups. <i>suaveolens</i> (Waldst. & Kit.) Strid
27. <i>Onobrychis montana</i> DC. subsp. <i>scardica</i> (Griseb.) P. W. Ball.
28. <i>Pedicularis brachyodonta</i> Schlosser & Vuk. subsp. <i>grisebachii</i> (Wettst.) Hayek
29. <i>Phyteuma pseudorbiculare</i> Pant.
30. <i>Pinguicula balcanica</i> Casper
31. <i>Pinus peuce</i> Griseb.
32. <i>Saxifraga rotundifolia</i> L. subsp. <i>chrysosplenifolia</i> (Boiss.) D. A. Webb.
33. <i>Sesleria comosa</i> Velen.
34. <i>Sesleria latifolia</i> (Adamović) Degen
35. <i>Sedum alpestre</i> Vill. subsp. <i>erythraeum</i> (Griseb.) 't Hart
36. <i>Stachys scardica</i> (Griseb.) Hayek
37. <i>Thymus praecox</i> Opiz subsp. <i>jankae</i> (Čelak.) J alas
38. <i>Thymus praecox</i> Opiz subsp. <i>zygiformis</i> (H.Braun) J alas
39. <i>Trifolium medium</i> subsp. <i>balcanicum</i>
40. <i>Trifolium velenovskyi</i> Vandas.

41. *Viola aetolica* Boiss. & Heldr. subsp. *denticulata* Tomović & Niketić
42. *Viola grisebachiana* Vis.
43. *Viola macedonica* Boiss & Heldr. subsp. *macedonica*
44. *Viola orphanidis* Boiss.

Dinaric-Scardo-Pindhian

1. *Achillea abrotanoides* (Vis.) Vis.
2. *Alchemilla ampliargyrea* Buser
3. *Alyssum markgrafii* O. E. Schulz ex Markgraf
4. *Alyssum scardicum* Wettst
5. *Amphoricarpus autariatus* Blečić & E. Mayer subsp. *bertisceus* Blečić & E. Mayer
6. *Asperula doerfleri* Wettst
7. *Athamanta turbith* (L.) Brot. subsp. *haynaldii* (Borbás & Uechtr.) Tutin
8. *Cardamine carnosa* Waldst. & Kit.
9. *Cerastium decalvans* Schlosser & Vuk. subsp. *decalvans*
10. *Draba korabensis* Kümmerle & Degen ex Jáv.
11. *Draba kummerlei* Stevanović & D. Lakušić
12. *Erysimum linariifolium* Tausch
13. *Festuca halleri* All. subsp. *scardica* (Griseb.) Markgr.-Dannenb.
14. *Galium breviramsum* F. Krendl
15. *Gentianella albanica* (Jáv.) J. Holub
16. *Hieracium gymnocephalum* Pant. subsp. *gymnocephalum*
17. *Lilium carniolicum* Bernh ex Koch subsp. *albanicum* (Griseb.) Hayek
18. *Lonicera formanekiana* Halácsy subsp. *formanekiana*
19. *Lotus stenodon* (Boiss. & Heldr.) Heldr.
20. *Minuartia graminifolia* (Ard.) Jáv. *clandestine* (Portenschl.) Mattf.
21. *Oxytropis dinarica* (Murb.) Wettst. subsp. *dinarica*,
22. *Oxytropis halleri* Bunge ex Koch subsp. *korabensis* (Kümmerle & Jáv.) Chrtk
23. *Pimpinella serbica* (Vis.) Drude
24. *Plantago reniformis* G. Beck
25. *Polygala croatica* Chodat
26. *Potentilla montenegrina* Pant.
27. *Potentilla speciosa* Willd. subsp. *illyrica* Soják
28. *Saxifraga blavii* (Engler) G. Beck
29. *Saxifraga federici-augusti* Biasol. subsp. *federici-augusti*
30. *Saxifraga scardica* Griseb.
31. *Saxifraga taygetea* Boiss. & Heldr.
32. *Scrophularia bosniaca* G. Beck
33. *Sempervivum kosaninii* Praeger
34. *Sempervivum macedonicum* Praeger
35. *Sesleria wettsteinii* Dörfler & Hayek
36. *Silene parnassica* Boiss. & Spruner subsp. *serbica* (Adamović & Vierh.) Greuter
37. *Silene schmuckeri* Wettst.
38. *Trifolium wettsteinii* Dörfler & Hayek
39. *Valeriana bertisceae* Pančić
40. *Viola elegantula* Schott

Dinaric

1. *Aquilegia bleicicii* Podobnik
 2. *Astragalus fialae* Degen
 3. *Crepis baldaccii* Halácsy subsp. *albanica* Jáv.
 4. *Dianthus integer* Vis. subsp. *integer*
 5. *Edraianthus montenegrinus* Horák
 6. *Euphorbia montenegrina* (Bald.) K. Malý ex Rohlena
 7. *Euphorbia pancicii* G. Beck.
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8. *Fritillaria messanensis* Rafin. subsp. *gracilis* (Ebel) Rix
 9. *Heliosperma macranthum* Pančić
 10. *Heliosperma pusillum* (Waldst. & Kit.) Hoffmanns. subsp. *monachorum* (Vis. & Pančić) Niketić & Stevanović
 11. *Hieracium bertisceum* Niketić
 12. *Hieracium pichleri* A. Kerner subsp. *chromoneurum* Zahn
 13. *Knautia dinarica* (Murb.) Borbás subsp. *dinarica*
 14. *Ligusticum albanicum* Jáv.
 15. *Pedicularis brachyodonta* Schlosser & Vuk. subsp. *montenegrina* D.A. Webb
 16. *Pedicularis ernesti-mayeri* Stevanović, Niketić & D. Lakušić
 17. *Ranunculus concinnatus* Schott
 18. *Rhinanthus asperulus* (Murb.) Soó
 19. *Rhinanthus rumelicus* Velen.
 20. *Saxifraga prenja* G. Beck
 21. *Thlaspi dacicum* Heuffel subsp. *montenegrinum* (F. K. Meyer) Greuter & Burdet
 22. *Valeriana pancicii* Halácsy & Bald
 23. *Verbascum nicolai* Rohlena
 24. *Wulfenia bleicii* Lakušić subsp. *bleicii*
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Dinaric-Moesian

1. *Asperula aristata* L. subsp. *condensata* (Heldr. Ex Boiss.) Ehrend. & Krendl
 2. *Campanula patula* L. subsp. *epigaea* (Janka) Hayek
 3. *Dianthus microlepis* Boiss. subsp. *microlepis*
 4. *Edraianthus jugoslavicus* Lakušić
 5. *Festuca panciciana* (Hackel) K. Richter
 6. *Geum bulgaricum* Pančić
 7. *Pedicularis heterodonta* Pančić
 8. *Senecio wagneri* Degen
 9. *Silene sendtneri* Boiss. subsp. *sendtneri*
 10. *Stachys alpina* L. subsp. *dinarica* Murb.
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Life form spectrum

The life-form spectrum of the endemic flora within communities of mountain pine in the study area is presented in Figure 3. Analysis of present life forms of endemic taxa reveals a high percentage of hemicryptophytes (64 taxa, i.e., 54.24%) and chamaephytes (45 taxa, i.e., 38.14%), with a significantly lower percentage of geophytes (5 taxa, 4.24% respectively), therophytes (2 or less than 2%) and phanerophytes (2 i.e., less than 2%).

Given the fact that life forms are adapted to the unfavorable period of the year in different ways, the biological spectrum provides a good insight into the ecological conditions (in particular climatic and edaphic) in which a certain phytocenosis has been developed (Stevanović and Janković, 2001). This ratio of life forms with the high percentage of hemicryptophytes and chamaephytes present in the study area indicates extreme environmental conditions, specifically reflected at low temperatures, mostly occurring during the year in high mountain regions. According to Raunkier (1934) hemicryptophytes as herbaceous perennials and chamaephytes as low-growing perennials and dwarf shrubs have their overwintering buds at the soil surface or close to the ground, where they are protected by the snow cover.

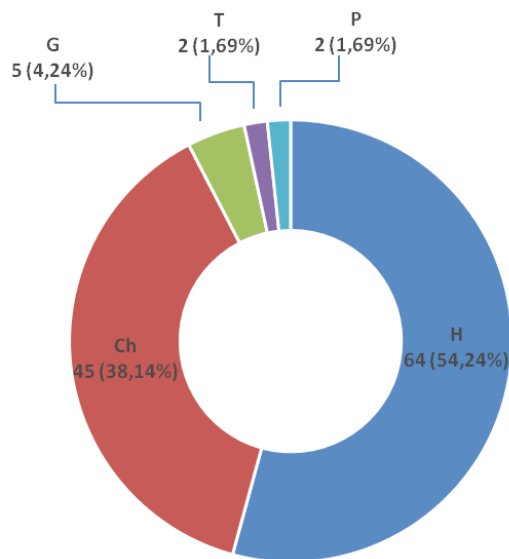


Figure 3. Life-form spectrum of the endemic flora recorded in studied area of Metohian Prokletije

Legend: H – Hemicryptophytes, Ch – Chamaephytes, G – Geophytes, T – Therophytes, P – Phanerophytes

Conservation status and importance

According to EUNIS habitat classification (EC, 2013) shrub communities of dwarf pine are categorized as Subalpine *Pinus mugo* scrub (EUNIS code F2.4). In addition, scrub formed by dwarf mountain pine are listed in Anex I of EU Habitats Directive (Directive 92/43/EEC) with Natura 2000 code 4070* – Bushes with *Pinus mugo* and *Rhododendron hirsutum* (*Mugo-Rhododendretum hirsuti*) and are assessed as natural habitat types of community interest where conservation requires the designation of special areas of conservation.

At the national level, *Pinus mugo* scrub (B 6.11) are considered as rare, endangered and fragile habitat types of high priority for protection (Anonymous, 2010b) included within protected area – NP Prokletije, whereas *Pinus mugo* Turra subsp. *mugo* is declared as strictly protected species (Anonymous, 2010a).

During the last decades, plant communities with *Pinus mugo* and associated endemic species were for the most part threatened by illegal logging of forests, human-caused fires, overexploitation, uncontrolled and unplanned constructions which have resulted in the habitat degradation and fragmentation or loss of the forest ecosystems (Menczer et al., 2018). The most critical situations are in steep terrain where deforestation intensified soil erosion. Some of the endemic species within dwarf pine communities are known as medicinal, aromatic and industrial plants wherefore they are subjected to uncontrolled collection and thereby in danger of becoming extinct.

Considering conservation importance, it is worth mentioning that *Pinus mugo* and its shrubby high-mountain communities in transition zone above the timberline form a characteristic vegetation belt that used to play a protective role in preventing avalanches, landslides and soil erosion (Janković, 1958; Alexandrov et al., 2011; Alexandrov et al., 2019).

CONCLUSIONS

Although Metohian Prokletije has been a subject of several intensive floristic and vegetation researches over the last several decades, there is still a lot to be investigated, particularly regarding the floristic diversity and endemism of its high mountainous areas. Apart from remarkable floristic richness, the special value of this mountain system is Balkan endemic vascular flora created as a result of diverse climatic, edaphic and orographic conditions. The high number of endemic flora (118) was recorded as well within communities of mountain pine (*Pinus mugo* Turra) in the so-called “battle zone” between coniferous forests on one side and low growing shrubs and herbaceous highland vegetation, on the other, above the tree line elevation.

Significant presence of Dinaric-Scardo-Pindhian-Moesian, Dinaric-Scardo-Pindhian and Dinaric floristic elements within the prevailing CEM and SEM chorological groups demonstrates the close phytogeographical connections of corresponding provinces and their strong impact on the genesis of the orophytic Balkan endemic flora of the investigated area.

The influence of the cold, windy and snowy mountainous climate is expressed in the prevalence of hemicryptophytes and chamaephytes in the biological spectrum.

The results of this study contribute to the overall knowledge of the endemic plant richness of the Metohian Prokletije and confirm their status as one of the major European centers of the Balkan floristic endemism.

The existence of a large number of endemic plants, along with both ecological and protective role of the dwarf pine communities on steep, mountainous terrain, in soil erosion control, water retention and maintenance of the forest biodiversity, including their economic benefits as well, are sufficient criteria to ascribe high conservation importance to this transition zone of *Pinus mugo* communities over the tree limit.

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ОРИГИНАЛНИ ЧЛАНАК

ЕНДЕМСКА ФЛОРА ЗАЈЕДНИЦЕ БОРА КРИВУЉА (*Pinus mugo* Turra) НА МЕТОХИЈСКИМ ПРОКЛЕТИЈАМА

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РЕЗИМЕ: Због свог специфичног положаја на ободу Средоземног мора, сло-
жених и разноврсних геоморфолошких, геолошких, орографских и климатских
одлика, Метохијске Проклетије су означене као један од главних центара балкан-
ског флористичког ендемизма у Европи. У раду су приказани резултати вишего-
дишњих интензивних флористичких истраживања ендемске флоре Метохијских
Проклетија, с посебним освртом на њихове високопланинске области изнад горње
шумске границе, где су концентрисане заједнице бора кривуља (*Pinus mugo*). Ови
екосистеми представљају прелазну зону између четинарских шума и високопла-
нинске жбунасте и зељасте вегетације, на надморској висини од 1.700 до 2.400 m.
На основу досадашњих детаљних теренских истраживања, у оквиру ових заједни-
ца бора кривуља забележено је 118 балканских ендемичних биљних таксона. Фи-
тогеографска анализа показује да ендемични таксони претежно припадају Јужно-
европској планинској (SEM) и Централноевропској планинској (CEM) хоролошкој
групи са следећим учешћем флористичких елемената: 1) Динарско-скардо-пинд-
ско-мезијски (44 таксона или 37%), 2) Динарско-скардо-пиндски (40 таксона или
34%), 3) Динарски (24 таксона или 20%) и 4) Динарско-мезијски (10 таксона или
9%). Биолошки спектар карактерише доминантна заступљеност хемикриптофита
и хамефита. Добијени подаци о присуству бројних ендемичних биљака на проу-
чаваном подручју могу послужити као одлична основа за даља флористичка истра-
живања, а информације о еколошком значају као и конзервационом статусу
угрожених биљних заједница бора кривуља имају за циљ подстицање ефикасније
заштите биодиверзитета и одрживог управљања природним ресурсима.

КЉУЧНЕ РЕЧИ: ендемска флора, заједнице бора кривуља (*Pinus mugo*),
Метохијске Проклетије