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An insight into the ecology of *Woodsia alpina* newly recorded for the flora of the Balkan Peninsula

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ABSTRACT:
The arctic-alpine species, *Woodsia alpina* (Woodsiaceae), was recorded on the Balkan Peninsula for the first time as a result of an intensive floristic and phytocoenological investigation of the rocky habitats located on the Stara Planina Mt. The record represents the first finding of this species and the family Woodsiaceae in general for the flora of Serbia. This new finding shifts the southern limit of its distribution in Southeastern Europe significantly. Five small subpopulations, consisting of a few up to dozens of specimens, were found above the forest belt, at an elevation range between 1671 and 1718 m a.s.l. They inhabit fissures in what are almost vertical rocks composed of Permian red sandstone with western exposition. *Woodsia alpina* shows affinities to semi-shaded places, which are moisture-rich, slightly acidic and poor in nutrients. It grows alongside mosses, other ferns (*Asplenium septentrionale*, *A. trichomanes*, *Asplenium* × *alternifolium*, *Cystopteris fragilis*) and flowering plants. According to the results of the cluster analysis, the communities of *W. alpina* recorded in Serbia are clearly distinguished from those of this species in other European countries regarding their floristic composition. Hence, it is necessary to clarify the syntaxonomical rank of this association within the class *Asplenietea trichomanis* (Br.-Bl. in Meier et Br.-Bl. 1934) Oberd. 1977 and the *Androsacetalia vandellii* order Br.-Bl. in Meier et Br.-Bl. 1934 in future research. Applying Huisman-Olff-Fresco models on a dataset from the Balkans, it is revealed that *W. alpina* has narrow ecological valences regarding elevation, exposition and 19 bioclimatic parameters. On the other hand, according to the literature, it grows successfully in a wide range of elevations in Europe, as a result of its affinity to colder climates and the arctic-alpine type of distribution.

Keywords:
fern, flora of Serbia, new record, Stara Planina Mountain, *Woodsia alpina*, Woodsiaceae

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INTRODUCTION

The floristically rich genus *Woodsia* belongs to the family Woodsiaceae (Smith *et al.* 2006; Rothfels *et al.* 2012). It includes 36 species inhabiting rocks and cliffs mainly in the montane areas of the Northern Hemisphere. *Woodsia montevidensis* (Spreng.) Hieron. is the only species distributed in the Southern Hemisphere (Brown 1964; Kruk *et al.* 2015). In Europe, five *Woodsia* species are present; four of them of arcto-alpine distribution type - *W. alpina* (Bolton) Gray, *W. caucasica* (C. A. Mey.) J. Sm., *W. glabella* Richardson and *W. pulchella* Bertol., and one with montane preferences - *W. ilvensis* (L.) R. Br. In Southeastern Europe and adjoining regions, *W. alpina*, *W. pulchella* and *W. ilvensis* were found in Slovenia (Jogan 2001) and Romania (Grinţescu 1952; Dihoru & Negrean 2009; Sabovljević *et al.* 2021), while *W. alpina* and *W. ilvensis* were recorded in Hungary (Farkas 1999; Király 2007). One species, *W. ilvensis*, has been reported so far on the Balkan Peninsula. More precisely, it was recorded in Croatia, on

Lomnik Hill near Samobor (Mayer & Horvatić 1967). However, according to Stevanović *et al.* (2009), none of the arcto-alpine species of the genus *Woodsia* have been reported for the Balkan Peninsula.

Woodsia alpina belongs to the section *Alpinae* (Shmakov) Shmakov and subfamily Woodsioideae Shmakov (Shmakov 2018). The species from the mountains of Wales in Britain is described as *Acrostichum alpinum* Bolton (Bolton 1790). Later, Gray (1821) renamed it *Woodsia alpina*. It has an arcto-alpine type of distribution, restricted to arctic areas and higher mountain belts (the upper montane, subalpine and lower alpine belt) (Poelt 1952; Mayer 1959; Zięba 2018) in the northern parts of North America, Greenland, Iceland, Britain, the Pyrenees, the Alps, the Carpathians, the Caucasus, Norway, Sweden, Finland, Siberia and the Himalayas (Shmakov 2018). The populations with high density can be found in Norway, the Palearctic tundra and the Alps; on the other hand, *W. alpina* is rather rare in the other parts of its geographic range (Jalas & Suominen 1972; Elven *et al.* 2011).

It is a member of chasmophytic vegetation, mainly in siliceous rock crevices in the Alps, the High Tatras, the Sudetenland and the Carpathians, and calcareous rock crevices in North Europe (Poelt 1952). In Slovenia, it occurs on the Kamnik-Savinja Alps in the subalpine zone within the vegetation of andesitic rock crevices (Mayer & Horvatić 1967). In Romania, it inhabits rock crevices within the vegetation of *Androsacion alpinae* Br.-Bl. in Br.-Bl. et Jenny 1926 at an elevation of about 1800 m a.s.l. on Maramureşului Mt. (Dihoru & Negrean 2009), and according to recent findings, it participates in the composition of open vegetation cover in the rock crevices on the Ţarcu Mts. at an elevation of 2030 m a.s.l. (Sabovljević *et al.* 2021) (Fig. 1).

In Europe, it is not under threat and is assessed as being of low conservation interest (Christenhusz *et al.* 2017; García Criado *et al.* 2017). However, *W. alpina* was assumed to be "Rare" in Slovenia (Wraber & Skoberne 1989), "Extinct" in Hungary (Király 2007) and "Endangered" in Romania (Dihoru & Negrean 2009) before a recent reassessment when its threatened status was changed from EN to CR B2ab(ii,iii,iv); C2a(i); D1 (Sabovljević *et al.* 2021).

The main aims of this study are: representing the morphological and biogeographical characteristics of *W. alpina* and defining its ecological affinities regarding particular environmental variables.

MATERIAL AND METHODS

Study area. The floristic and phytocoenological investigation of rocky habitats was conducted on the Stara Planina Mt. (Eastern Serbia) (Fig. 1), on the territory between Jabučko ravnište and Midžor peak. After Midžor (2165 m a.s.l.), the second-highest peak in the examined area is Žarkova Čuka (1848 m a.s.l.), located west of Midžor peak. The geological substrate consists of Permian red sandstones

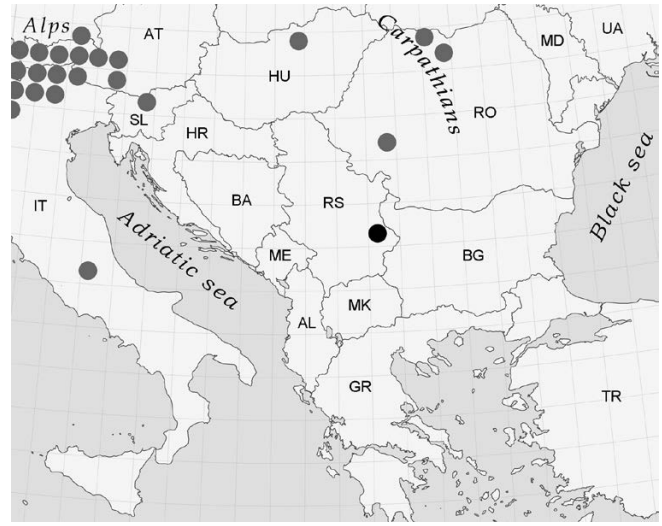

Fig. 1. Distribution of *W. alpina* in Southeast Europe (l) (according to Jalas & Suominen 1972 and Sabovljević et al. 2021) and the Balkan Peninsula (l). Abbreviations: RS - Srbija, BA - Bosnia-Herzegovina, HR - Croatia, RO - Romania, ME - Montenegro, SI - Slovenia, IT - Italy, AT - Austria, HU - Hungary, AL - Albania, GR - Greece, TR - Turkey, MD - Moldavia, UA - Ukraine

forming cliffs, rocky outcrops and cracks, where the chasmophytic alliances *Silenion lerchenfeldianae* Simon 1958 and *Asplenion septentrionale* Lois. 1968 develop (Mišić *et al.* 1978; Mijović *et al.* 2007). These rocks can be completely dry during the summer season, while soaking by water running into nearby streams occurs during the wet season.

Plant material. The voucher specimens of the collected plant material, including *W. alpina* and accompanying species, were deposited in the Herbarium Moesiacum Niš (HMN).

The voucher specimens of *W. alpina* (all of them collected on the Stara Planina Mt., Žarkova Čuka peak, UTM FP30): **Locality 1**: N 43.391282°, E 22.640153°, leg. V. Ranđelović & J. Stojanović, 12.08.2020, HMN-14401; **Loc. 2:** N 43.391258°, E 22.640276°, leg. V. Ranđelović & J. Stojanović, 12.08.2020, HMN-14402; **Loc. 3:** N 43.391040°, E 22.641025°, leg. V. Ranđelović & J. Stojanović, 12.08.2020, HMN-14403; **Loc. 4:** N 43.390969°, E 22.641097°, leg. V. Ranđelović & J. Stojanović, 12.08.2020, HMN-14404; **Loc. 5:** N 43.391424°, E 22.639523°, leg. V. Ranđelović & J. Ranđelović, 31.07.2020, HMN-14405.

The nomenclature is in accordance with Niketić & Tomović (2018) and the Euro+Med Plantbase (2006-) (vascular plants), Ros *et al.* (2007) (liverworts), Ros *et al.* (2013) (mosses), and Savić & Tibell (2006) (lichens), while the syntaxonomical nomenclature follows Mucina *et al.* (2016).

Phytocoenological investigation. The phytocoenological investigation of the microhabitats characterised by the presence of *W. alpina* followed Braun-Blanquet (1951)

methodology. In addition, in order to adequately establish the ecological affinities of *W. alpina*, floristic and spatial data were collected in August 2020, including 52 rocky habitats where *W. alpina* could be expected by species composition, but which were not found during the present investigation.

Statistical analyses. Hierarchical cluster analysis was performed on the dataset composed of both the phytocoenological data collected during field investigation and the data published in the literature (Pichi-Sermolli 1955; Nardi 1974; Benito Alonso 1999, 2000; Juvan 2008; Kammer & Möhl 2008; Zięba 2018) (the dataset of mosses was not included). It was conducted using Ward's classification method on Sorensen resemblance matrices in the PC-ORD 6 software package (McCune & Mefford 2011). The optimal number of clusters was identified based on the crispness of the classification method (Botta-Dukát *et al.* 2005) using JUICE 7.0 software (Tichý 2002).

The species indicator values (i.e. light, temperature, continentality, moisture, soil reaction and nutrients) were calculated for each microhabitat species set where *W. alpina* was present, with the aim of determining its local ecological preferences. The species indicator values were based on Ellenberg *et al.* (1991) for vascular plants or approximately determined for the species that are missing from Ellenberg's list. They were weighted by species cover.

The ecological affinities of *W. alpina* regarding elevation, exposition (expressed in degrees) and bioclimatic parameters [extracted from the WorldClim2 dataset at a resolution of 30 seconds (Fick & Hijmans 2017) using ArcGIS 10.6.1 (ESRI 2018)] were determined based on the shape of the species response curves and the values of their ecological minimum, optimum and maximum. The responses of *W. alpina* to the analysed environmental variables were processed by the logistic regression models established by Huisman-Olff-Fresco (HOF) (Huisman *et al.* 1993). The HOF models were presented in a set of five models ranked according to the increasing complexity of the biological information contained (I - no significant trend in space or time, II - an increasing or decreasing trend where the maximum is equal to the upper bound, III - an increasing or decreasing trend where the maximum is below the upper bound, IV – an increase and decrease at the same rate: a symmetrical response curve and V – an increase and decrease at different rates: a skewed response curve) (Huisman *et al.* 1993). The univariate responses of *W. alpina* regarding the studied environmental factors were modelled based on its presence/absence on rocky habitats and the untransformed absolute values of environmental variables. In total, the floristic and spatial data for 57 rocky habitats were included in this analysis. The species response curves of *W. alpina* were modelled in JUICE 7.0 (Tichý 2002) software by using the script defined by Zelený & Tichý (https://www.davidzeleny.net/juice-r/doku.php/scripts:species-response-curves).

RESULTS

Woodsia alpina (Fig. 2) was reported for the first time for the flora of both Serbia and the Balkans (Euro+Med 2006-). Its five subpopulations, consisting of a few up to dozens of individuals, were recorded on the Permian red sandstone rocks below the Žarkova Čuka peak (Table 1) on the Stara Planina Mt. (Fig. 1).

A detailed morphological description of *W. alpina* is already given in the literature (Gray 1821; Grinţescu 1952; Mayer 1959; Mayer & Horvatić 1967). It is clearly morphologically different when compared to the other *Woodsia* species distributed in Southeastern Europe. *Woodsia alpina* differs from *W. pulchella* in the presence of dense scales on the stipe and rachis, the absence of glandular hairs on the rachis (Kruk *et al.* 2015) and the colour of the rachides (redish-brown in *W. alpina* and green in *W. pulchella*) (Jogan 1993). *Woodsia alpina* and *W. ilvensis* can be distinguished based on the density of the indumentum (sparsely hairy in *W. alpina* and densely hairy in *W. ilvensis*), the length and width ratio of their frond segments (less than 1.5 times longer than broad in *W. alpina*, 2-3 times longer than broad in *W. ilvensis*) and the number of lobes (2-3 in *W. alpina,* 4-6 in *W. ilvensis*) (Jogan 1993).

The floristic similarity between *W. alpina* habitats in Europe. On the Stara Planina Mt., *W. alpina* grows in alongside other ferns (*Asplenium septentrionale* (L.) Hoffm., *Asplenium trichomanes* L., *Asplenium* × *alternifolium* Wulfen and *Cystopteris fragilis* (Lam.) Bernh. ex Desv.), mosses (*Riccia gougetiana* Durieu & Mont., *Amphidium mougeotii* (Schimp.) Schimp. and *Ceratodon purpureus* (Hedw.) Brid.), lichens (*Umbilicaria grisea* Hoffm., *Cladonia fimbriata* (L.) Fr., *C. rangiferina* (L.) Weber ex F. H. Wigg., *C. foliacea* (Huds.) Willd., *Xanthoparmelia conspersa* (Ehrh. ex Ach.) Hale, *Caloplaca sp.*, *Rhizocarpon geographicum* (L.) DC., *Lasallia pustulata* (L.) Mérat, *Peltigera canina* (L.) Willd., and *Solorina saccata* (L.) Ach.), and flowering plants given in Table 1.

There is a lack of data on the floristic composition of the communities containing *W. alpina* in the literature (Pichi-Sermolli 1955; Nardi 1974; Benito Alonso 1999, 2000; Juvan 2008; Kammer & Möhl 2008; Zięba 2018). The cluster analysis results of the qualitative data reveal a clear floristic separation between the stands from the Stara Planina Mt. and those recorded in other European countries (data presented in Supplementary material 1). *Woodsia alpina*, *A. septentrionale*, *C. fragilis* and *Saxifraga paniculata* Miller are the only species mutual for these two main cluster groups.

The ecological preferences of *Woodsia alpina*. Individuals of *W. alpina* were found above the timber belt along the western slopes (Table 1; Fig. 3) on Permian red sandstone rocky places with subterranean water seepage. It shows an affinity for semi-shaded, moist, mildly acidic and nutrient-poor habitats, located in the alpine-subnival belt,

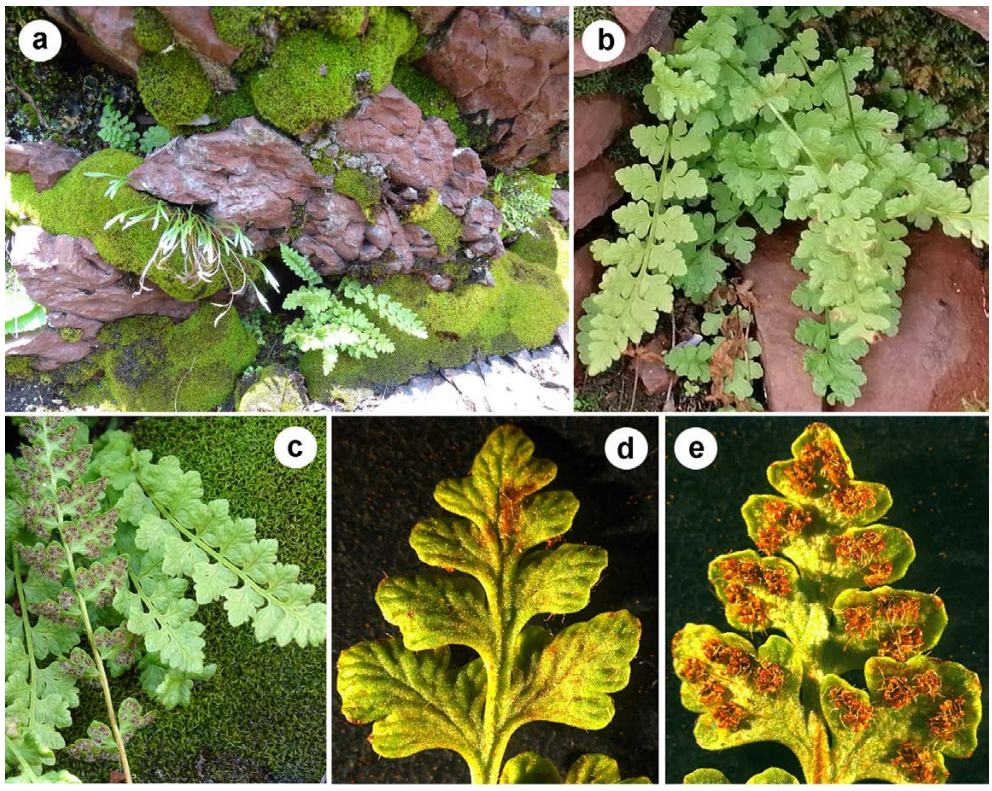

Fig. 2. Morphological characteristics of *W. alpina*: a) habitat; b) habitus; c) lower and upper surfaces of the leaves; d) upper and e) lower surface of the pinnae (Photo: V. Ranđelović).

at elevations in the range between 1671 and 1718 m a.s.l. (Table 1). Regarding the phenomenon of continentality, *W. alpina* is positioned between oceanic and sub-oceanic species. It is scattered throughout large parts of Central Europe, but the distribution area also extends to its eastern regions (Fig. 1).

The response curves formed by HOF models IV were the only ones present in this dataset (Fig. 3). The results revealed that *W. alpina* has narrow ecological valences concerning all of the 19 bioclimatic variables analysed. Detailed information about the optimal, minimal, maximal and interval values of its responses are given in Fig. 3. In general, *W. alpina* shows affinities for places characterized by an optimal annual mean temperature of ca. 3.5˚C with annual precipitation of ca. 850 mm.

DISCUSSION

Pichi-Sermolli (1955) described *W. alpina* as a circumpolar species with orophilic tendencies, causing its discontinuous distribution. It has never been reported for the Balkan Peninsula territory so far, although it was found in neighbouring countries (Grinţescu 1952; Farkas 1999; Jogan 2001; Király 2007; Dihoru & Negrean 2009; Sabovljević *et al.* 2021). The record represented in this study is of particular phytogeographical significance because it presents the southernmost stand of *W. alpina* within its geographic range, as well as in Southeastern Europe (Fig. 1). Glaciations are believed to have played a major role in the spreading its geographic range towards the south, while refugial, rocky habitats have provided favourable microclimatic conditions for its growth. The recently published finding of *W. alpina* individuals on the western group of the Southern Carpathians (Ţarcu Mts.) (Sabovljević *et al.* 2021) indicates the likely pathway of its spread from the north to the south along the Carpathian Mts.

Woodsia alpina is an acidophilic alpine species (Juvan 2008), mostly found on siliceous rocks (Juvan 2008; Kammer & Möhl 2008; Kruk *et al.* 2015; Zięba 2018), such as granites and mylonitized granites (Benito Alonso 1999; Guardiola *et al.* 2009; Kruk *et al.* 2015; Zięba 2018), sandstones (Pichi-Sermolli 1955) and andesites (Mayer 1959; Juvan 2008). Its affinity to acid substrates is also confirmed in this study (Table 1). However, in some other parts of its geographic range in Northern Europe, *W. alpina* was noticed on calcareous rocks as well (Poelt 1952), while in Scandinavia and the southern part of the Alps, it occurs on limestones (Mayer 1959). This species usually grows in vertical rock fissures or those with 80 degrees of inclination (Table 1) (Benito Alonso 1999; Juvan 2008). Although *W. alpina* was found along the western slopes of rocky fragments on the Stara Planina Mt., it was usually recorded along the northern or northeast slopes in other European countries (Nardi 1974; Juvan 2008; Guardiola *et al.* 2009). The statistical analysis showed that *W. alpina* prefers habitats near 1740 m a.s.l. (Fig. 3), while previous investigations indicated the wide ecological niche of this variable. It grows successfully at elevations in the range

Table 1. Phytocoenological table of the association *Woodsio alpinae-Asplenietum septentrionale* ass. prov. on Žarkova Čuka peak (Stara Planina Mt.) in Serbia.

Elevation	1703	1700	1676	1671	1718
Vegetation cover (%)	80	80	70	80	80
Vegetation cover regarding the whole rocky surface (%)	50	60	50	50	50
Surface area (m²)	5	5	5	5	5
Exposition	W	W	W	W	W
Inclination	90	80	90	80	90
Light (Ellenberg's indicator values)	8.10	8.00	7.30	8.30	8.10
Temperature (Ellenberg's indicator values)	4.40	4.70	3.70	4.10	4.40
Continentality (Ellenberg's indicator values)	3.20	3.50	3.40	2.90	3.20
Moisture (Ellenberg's indicator values)	3.20	3.50	3.30	2.80	3.20
Soil Reaction (Ellenberg's indicator values)	5.40	5.50	6.90	5.70	5.60
Nutrients (Ellenberg's indicator values)	2.00	1.80	2.10	1.70	2.00
Geological substrate	Permian red sandstone				
Relevés number (Locality)	1	2	3	4	5
Vascular non-flowering plants					
Woodsia alpina (Bolton) Gray	1	2	1	+	1
Asplenium septentrionale (L.) Hoffm.	1	1	1	1	1
Asplenium ×alternifolium Wulfen	1	+	+	1	+
Asplenium trichomanes L.	+	+	1	+	+
Cystopteris fragilis (Lam.) Bernh. ex Desv.	+	+	1	1	+
Vascular flowering plants					
Sedum album L.	2	2	1	3	2
Sedum annuum L.	1	+	+	+	1
Drymocallis rupestris (L.) Soják	+	2	1	+	+
Allium carinatum L. subsp. *pulchellum* (G. Don) Bonnier & Layens	+	+	1	1	+
Plantago holosteum Scop.	+	+	+	+	+
Carex kitaibeliana Degen ex Bech	+	+	+		+
Poa alpina L.	+		+	1	+
Ornithogalum kochii Parl.	+		+		+
Saxifraga paniculata Miller			3	1	
Euphrasia pectinata Ten.		+	+		
Veronica barrelieri Roem. & Schult.		+	+		
Allium schoenoprasum L. subsp. *schoenoprasum*			+	+	
Thymus praecox Opiz. subsp. *jankae* (Čelak) Jalas		1			
Festuca dalmatica (Hack.) K. Richt.			1		
Jovibarba heuffelii (Schott) A. & D. Löve			+		
Mosses					
Amphidium mougeotii (Schimp.) Schimp.	2	2	3	3	2
Riccia gougetiana Durieu et Mont.	1	2	1	1	1
Ceratodon purpureus (Hedw.) Brid.	1	1	+	+	+
Pellia endiviifolia (Dicks.) Dumort.	+	+			
Reboulia hemisphaerica (L.) Raddi	+				1
Plagiomnium affine (Blandow ex Funck) T. J. Kop.			+		

between 600 m a.s.l. and 2940 m a.s.l. (Pichi-Sermolli 1955; Nardi 1974; Juvan 2008; Guardiola *et al.* 2009; Zięba 2018), probably due to the similar local climatic conditions in the different parts of its geographic range. Apart from that, the populations from Stara Planina Mt. may be newly-established and have not yet managed to expand to all optimal habitats.

The preferences of *W. alpina* for different bioclimatic parameters have not been studied previously. However, species responses to climatic parameters have important implications in the understanding of the present and future distribution area of taxa (Gwitira *et al.* 2013). Statistical analyses confirm its affinity to places characterised by low mean annual temperature and relatively high humidity values during the year (Fig. 3). As a cold-adapted species, *W. alpina* inhabits suitable microclimatic conditions at both higher and lower elevations. Additionally, northern or western exposed rock cervices provide a narrow daily temperature range and a higher amount of moisture, successfully buffering extreme temperatures that occur during the vegetation season. This is one of the reasons why the rock crevices situated south of the arctic belt are such

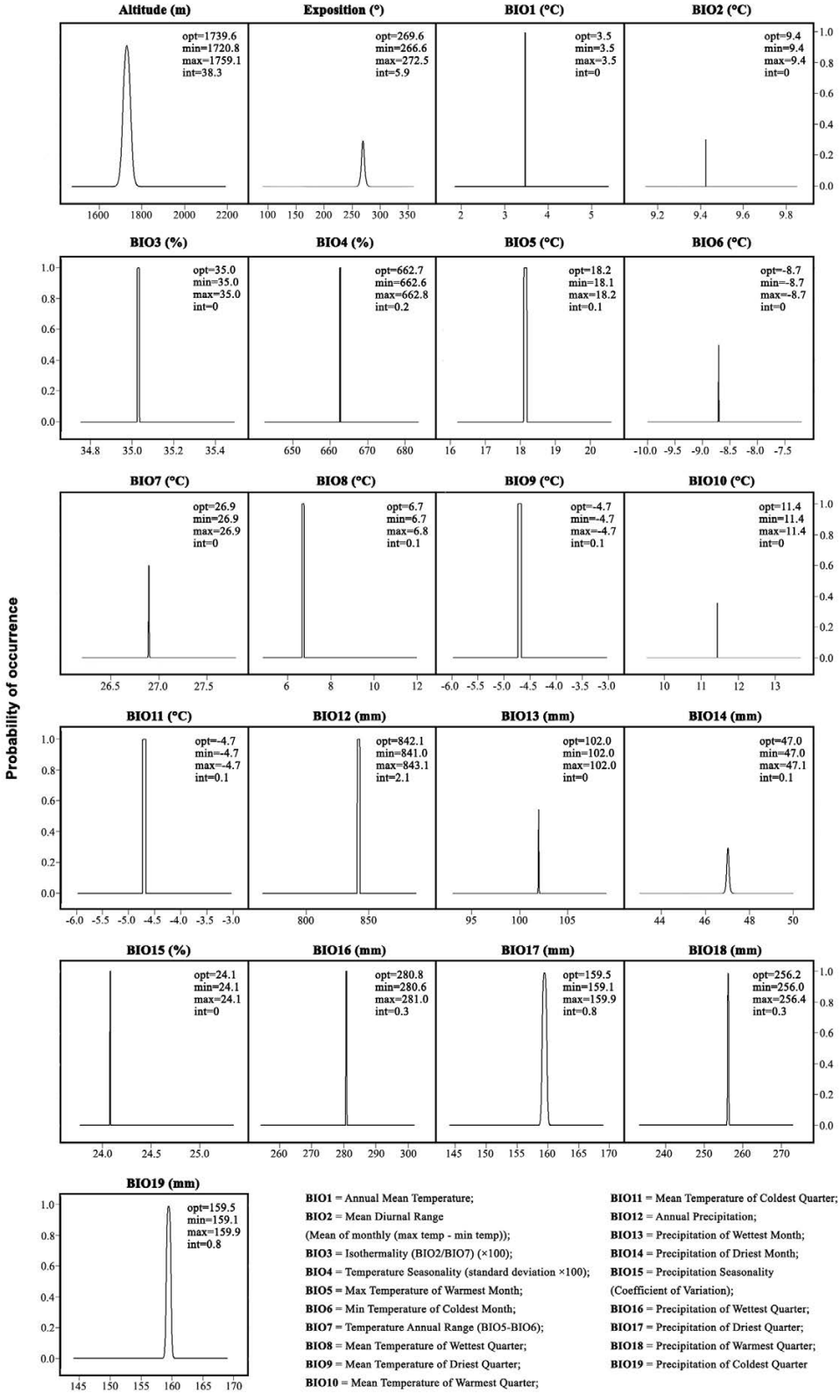

Fig. 3. The species response curves of *W. alpina* regarding elevation, exposition and 19 bioclimatic variables obtained by five HOF models. All species response curves were modelled by HOF model IV. The figure contains information about the optimal (opt), minimal (min), maximal (max) and interval values (int) of ecological valences concerning all of the investigated environmental variables.

significant refugia for the arctic-alpine species (García *et al.* 2020).

Woodsia alpina occurs in the ecologically specific microhabitat of the studied area. It was found in very damp rock crevices characterised by a reduced amount of light and an increased level of moisture caused by the existence of weak subterranean seepage. *Woodsia alpina* was not found in floristically similar habitats nearby, due to both ecological (deficiency of the adequate amount of moisture in the soil) and time (the populations may be newly formed and have not had sufficient time to colonize these habitats) limits. Guardiola *et al.* (2009) stated that *W. alpina* always grows in partially shady fissures, while Kammer & Möhl (2008) pointed out its preferences in ecologically different habitats, developed on dry substrates in the community *Androsacetum vandellii* Braun-Blanquet in Braun-Blanquet & Jenny 1926. We consider that the confusing syntaxonomical affiliation of *W. alpina* represents the result of its description as a member of the plant communities covering the sunny fragments of rock crevices. According to the literature, *W. alpina* is confirmed as a member of three associations: *Campanulo cochleariifoliae-Primuletum villosae* Juvan, Čarni et Jogan 2011 (Juvan 2008; Juvan *et al.* 2011), *Cardamino resedifoliae-Primuletum hirsutae* (Turmel 1955) Benito Alonso 1999 (Benito Alonso 1999, 2000) and *Androsacetum vandellii* Braun-Blanquet in Braun-Blanquet & Jenny 1926 (Kammer & Möhl 2008), all belonging to the alliance *Androsacion vandellii* Br.-Bl. in Br.-Bl. et Jenny 1926 [order *Androsacetalia vandellii* Br.-Bl. in Meier et Br.-Bl. 1934, class *Asplenietea trichomanis* (Br.-Bl. in Meier et Br.-Bl. 1934) Oberd. 1977] which includes chasmophytic vegetation of siliceous rock crevices and ledges in the alpine and nival belts of the Central European mountains (Mucina *et al.* 2016). According to the obtained results, the community in which *W. alpina* occurs on the Stara Planina Mt. belongs to the same vegetation class and order but to a different alliance – that of *Silenion lerchenfeldianae* Simon 1958 (Mucina *et al.* 2016). Furthermore, we consider that it could be described under the name *Woodsio alpinae-Asplenietum septentrionalis* prov. (numerical analyses for a valid and precise syntaxonomical rank are the subject of another study in preparation).

CONCLUSIONS

The report of *W. alpina* within the borders of the Balkan Peninsula is significant not only from the aspect of biodiversity, but also in terms of gaining a better understanding of the biogeography of the Balkans. Further field surveys of sites with similar ecological characteristics should provide potentially new localities and help provide a precise definition of the species' geographic range in the Balkan Peninsula and Southeastern Europe. Considering the topographic and climatic variability, *W. alpina* is expected to be present in other parts of the Balkans (e.g. the Bulgarian part of the Stara Planina Mt). The current record represents the only one known for the whole territory of the Balkan Peninsula. Consequently, more detailed research of its biology, ecology and distribution is necessary to provide successful conservation of its small and ecologically specific habitats, both nationally and regionally.

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REZIME

Botanica SERBICA

Uvid u ekologiju vrste *Woodsia alpina*, novootkrivenu za floru Balkanskog poluostrva

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Arkto-alpska vrsta, *Woodsia alpina* (Woodsiaceae), zabeležena je po prvi put na teritoriji Balkanskog poluostrva kao rezultat intenzivnog florističkog i fitocenološkog istraživanja stenovitih staništa smeštenih na Staroj planini. Ovo je prvi nalaz ove vrste i porodice Woodsiaceae, uopšte, u srpskoj flori. Ovim nalazom je južna granica njenog rasprostranjenja, u jugoistočnoj Evropi, značajno pomerena. Pet malih populacija, sačinjenih od nekoliko do desetak individua, nađene su iznad šumskog pojasa, na nadmorskim visinama između 1671 i 1718 m. Populacije nastanjuju pukotine skoro vertikalnih, zapadno eksponiranih stena izgrađenih od crvenih Permskih peščara. *Woodsia alpina* pokazuje afinitete prema polusenovitim, vlažnim staništima, blago kisele reakcije i siromašnim hranljivim sastojcima. Raste u asocijaciji sa mahovinama, drugim papratima (*Asplenium septentrionale*, *A. trichomanes*, *Asplenium* × *alternifolium*, *Cystopteris fragilis*) i cvetnicama. Prema rezultatima klaster analize, zajednice vrste *W. alpina* zabeležene u Srbiji jasno se razlikuju prema svom florističkom sastavu od zajednica koje su zabeležene u drugim evropskim zemljama. Prema tome, neophodno je razjasniti sintaksonomski položaj ove asocijacije u okviru klase *Asplenietea trichomanis* (Br.-Bl. in Meier et Br.-Bl. 1934) Oberd. 1977) i reda *Androsacetalia vandellii* Br.-Bl. in Meier et Br.-Bl. 1934 u budućim istraživanjima. Primenom Huisman-Olff-Fresco modela na setu podataka sa Balkana, otkriveno je da *W. alpina* ima uske ekološke valence za nadmorsku visinu, ekspoziciju terena i 19 bioklimatskih parametara. Sa druge strane, sudeći po literaturnim podacima, ova vrsta u Evropi uspešno raste u širokom opsegu nadmorskih visina, što je rezultat njenog afiniteta prema hladnijoj klimi i arkto-alpskog tipa distribucije.

Ključne reči: paprat, flora Srbije, novi nalaz, Stara planina, *Woodsia alpina*, Woodsiaceae