

New localities of the subendemic species *Berberis croatica*, *Teucrium arduini* and *Micromeria croatica* in the Dinaric Alps

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Abstract – New localities of three subendemic species (*Berberis croatica*, *Teucrium arduini* and *Micromeria croatica*) have been found in the Dinaric Alps. *Berberis croatica* was found at ten new locations, nine of them in Croatia and one in Bosnia and Herzegovina. *Teucrium arduini* was found on Mt Učka, Mt Velebit, Mt Biokovo and Mt Sniježnica, at nine new locations while *Micromeria croatica* was found at four new locations, only on Mt Velebit.

Key words: *Berberis croatica*, *Teucrium arduini*, *Micromeria croatica*, Velebit, Učka, Biokovo, Sniježnica, Dinaric Alps

Abbreviations: NHC – National habitat classification

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Introduction

Berberis croatica Horvat is a mountainous deciduous shrub distinguished by its small, thick, rigid leaves, 1–3 cm long, and short and erect inflorescences with fewer flowers (5–12 in inflorescence) than the common barberry. The occurrence of this species in Croatia was first reported by BORBÁS (1886) under the name *Berberis aetnensis* Presl var. *brachyacantha* Strobl. Its taxonomic status still remains uncertain (KARLOVIĆ et al. 2010, ZOVKO KONČIĆ et al. 2010), and AKEROYD and WEBB (1993) in *Flora Europaea* recognize only *B. vulgaris* L. and *B. cretica* L. as European barberries. According to ŠILJIĆ (2005) the distribution range of *B. croatica* includes the western part of the Balkan Peninsula (Croatia, Bosnia and Herzegovina, Montenegro and Macedonia). In Croatia it could be found on Mt Učka, Mt Obruč, Gorski kotar (Mt Risnjak, Mt Viševica, Mt Bjelolasica, Čabar, Prezid, Vrbovsko), Mt Velebit, Mt Lička Plješivica, Mt Dinara, Mt Kamešnica and Mt Biokovo (DEGEN 1938:151, KUŠAN 1969b, MARTINIS 1994, NIKOLIĆ 2008) at altitudes ranging from 1000 (even below) to 1700 m a.s.l. KREMER et al. (2008) described eleven new localities of *B. croatica* in Croatia with altitudes ranging from 840 to 1600 m a.s.l. The distribution of *B. croatica* on Mt Kamešnica was not clear until now, because there was no specific information concerning whether Croatian barberry grows in Croatia, Bosnia or both.

Teucrium arduini L. is a semi-woody plant from the *Lamiaceae* family with erect or ascending stems, ovate leaves and dense inflorescences with small whitish flowers. It is an endemic Illyrian Balkan species with a distribution range extending from the Istria Peninsula in the north of Croatia to Albania, within the restricted area of the Western Balkans (ŠILJIĆ 1990, LAKUŠIĆ et al. 2007). Populations of *T. arduini* mainly grow in localities with Mediterranean (Adriatic Mediterranean) and sub-Mediterranean influence, even though some isolated populations inhabit limestone canyons and gorges in the transitional sub-Mediterranean-Central-European climatic zone with strong Mediterranean influence (LAKUŠIĆ et al. 2007). Altitudinal distribution stretches from the sea level up to 1600 m a.s.l.

From about 70 species belonging to the genus *Micromeria* Benth (MEIMBERG et al. 2006), 21 are recognized for the European region (CHATER and GUINEA 1972) and nine for Croatia (LOVAŠEN-EBERHARDT 2000). One of the species documented in Croatia is *Micromeria croatica* (Pers.) Schott for which two varieties and four forms, published so far, are listed by BRÄUCHLER et al. (2008). *Micromeria croatica* is a perennial plant with numerous, 5–30 cm long stems; hairy, stalkless leaves and flowers with pink-purple corollas appearing from (June) July till August (September). *Micromeria croatica* grows in the crevices of carbonate rocks predominantly in the alpine and the sub-alpine range, extending from the altitude of 150 m to more than 2000 m a.s.l (ŠILJIĆ 1979, ŠILJIĆ 1990). It is an endemic species of the Dinaride mountains. In Croatia it could be found in Gorski kotar, Lika, Krbava, Klek, along the massif of Velebit and on Mt Poštak (DEGEN 1938:635, ŠILJIĆ 1979, FORENBACHER 1990). Also, it was mentioned in literature for Mt Risnjak (ŠEGULJA et al. 1994, PELIVAN 1997), Mt Dinara (ALEGRO and RUŠČIĆ 2010) and the lower part of the Cetina basin (RUŠČIĆ 2010). Data about its presence on Mt Kalnik (Kranjčev, personal communication) need confirmation.

The aim of this paper is to present new localities of *Berberis croatica*, *Teucrium arduini* and *Micromeria croatica* which are so far unpublished but also to report the lack of these species at some of the localities that are mentioned in the older literature but were not found during our field work.

Materials and methods

The new localities were discovered during several field trips undertaken from May 2008 till September 2010. All the locations, except one (Kamešnica) are in Croatia. Several specimens of each species were taken from each locality for identification and for further research (unconnected with this paper). Voucher specimens of *Berberis croatica* were deposited in the Herbarium Collection of the Department of Ornamental Plants, Landscape Architecture and History of Garden Art, Faculty of Agriculture University of Zagreb, Zagreb while voucher specimens of *Teucrium arduini* and *Micromeria croatica* were deposited in the Herbarium of the Department of Pharmaceutical Botany with the »Fran Kušan«, Pharmaceutical Botanical Garden Faculty of Pharmacy and Biochemistry, University of Zagreb, Zagreb. Standard keys for identification were used (CHATER and GUINEA 1972, TRINAJSTIĆ 1973, ŠILIĆ 1979, DOMAC 1994). LOVAŠEN-EBERHARDT (1994) and ERHARDT (2002) were employed as a standard for the nomenclature of the species. Each locality was described by providing data about the altitude and position: Latitude and longitude were obtained using 1:25000 maps, Gauss-Krüger coordinates system and the software package MapSource – Garmin.

Habitat types are defined by National habitat classification codes (NARODNE NOVINE 2009, FLORA CROATICA DATABASE – Habitats 2009).

Since all three analyzed species are listed as strictly protected native taxa (NARODNE NOVINE 2006) the general condition of the plants is given as well as the problems observed and possible causes for any reduction in numbers of plants. Absence of the species at the localities that have already been mentioned in the literature was also recorded.

Results and discussion

All newly found localities of the three investigated species, with their specific identification numbers are listed in table 1.

1. Localities of *Berberis croatica*

New localities of *Berberis croatica* were found at a few distinct geographical sites: the hinterland mountains of Rijeka, Mt Velebit, Mt Biokovo and Mt Sniježnica. In the hinterland mountains of Rijeka, *B. croatica* was found at three locations (Fig. 1).

Mlični vrh between Platak and Gornje Jelenje

Several small groups of shrubs of *Berberis croatica* grow on grassy, rocky ridge of eastern branch of Mlični vrh (45°24' N, 14°35' E) at 1190 m a.s.l. This locality is exposed to strong winds and is weakly vegetated. Plants of Croatian barberry are up to 30 cm high, in poor health and with reduced fructification. They are surrounded by grassland formed by narrow-leaved moor grass (*Sesleria tenuifolia* Schrad.). Among the plants of *B. croatica* grow: *Satureja subspicata* Bartl ex Vis. ssp. *liburnica* Šilić, *Daphne alpina* L., *Carex humilis* Leyss., *Cotoneaster nebrodensis* (Guss.) K. Koch, *Teucrium montanum* L., *Knautia* L. sp. and *Allium ericetorum* Thore. Habitat type, according to the National Habitat Classification (NHC), belongs to east-Mediterranean rocky grassland of the epi-Mediterranean zone (*Saturejon subspicatae* H-ić 1975 community) (C.3.5.2.) on its upper elevation limit and in a distinctive succession phase of overrun by the small shrubs.

Tab. 1. Newly found localities of *Berberis croatica*, *Teucrium arduini* and *Micromeria croatica*.

Loc. no.	Location description	Taxon	x coordinate	y coordinate
1	Mlični vrh, between Platak and Gornje Jelenje	<i>B. croatica</i>	5467377	5029483
2	Unnamed rocky peak, between Crni vrh and Gornik	<i>B. croatica</i>	5462190	5035069
3	Mala kosa, near railway station Drivenik (Gorski kotar)	<i>B. croatica</i>	5477764	5014619
4	Unnamed peak, between Kita and Zečjak	<i>B. croatica</i>	5499795	4950940
5	Budakovo brdo	<i>B. croatica</i>	5506784	4937308
6	Cliff Kuk od Špiljić plane	<i>B. croatica</i>	5513901	4933556
7	Đuđinovac near Prezid	<i>B. croatica</i>	5565395	4901709
8	Kamešnica	<i>B. croatica</i>	6412673	4841060
9	Vošac (Mt Biokovo)	<i>B. croatica</i>	6421497	4790947
10	Mt Sniježnica	<i>B. croatica</i>	6528739	4714640
11	Argun	<i>T. arduini</i>	5438524	5014879
12	Šušanj Cesarički	<i>T. arduini</i>	5509300	4931298
13	Panos	<i>T. arduini</i>	5522823	4920284
14	Veliki Vaganac	<i>T. arduini</i>	5535451	4910288
15	Veliko Rujno	<i>T. arduini</i>	5534823	4912368
16	Bojinac	<i>T. arduini</i>	5533647	4911924
17	Đuđinovac near Prezid	<i>T. arduini</i>	5565395	4901709
18	Štrbina (Mt Biokovo)	<i>T. arduini</i>	6421561	4796502
19	Mt Sniježnica	<i>T. arduini</i>	6528739	4714640
20	Cliff Rossijev kuk	<i>M. croatica</i>	5499399	4958006
21	Cliff Rujjičin kuk	<i>M. croatica</i>	5509937	4935696
22	Cliff Kuk od Špiljić plane	<i>M. croatica</i>	5513901	4933556
23	Đuđinovac near Prezid	<i>M. croatica</i>	5565395	4901709

One group of more vital shrubs grows at the edge of a common beech forest (*Fagus sylvatica* L.). These plants of *B. croatica* are up to 60 cm high and more vital than the previously mentioned group of plants. Plant species that grow nearby are: *Lonicera alpigena* L., *Satureja subspicata* ssp. *liburnica*, *Clematis alpina* (L.) Mill., *Carex humilis*, *Sesleria tenuifolia*, *Knautia illyrica* G. Beck, *Dianthus monspessulanus* L., *Convallaria majalis* L., *Pimpinella saxifraga* L., *Vicia cracca* L., *Phyteuma orbiculare* L., *Ligusticum lucidum* Mill., *Seseli libanotis* (L.) K. Koch, *Rubus saxatilis* L. and *Aconitum* L. sp.

According to the NHC, this habitat type belongs to the forest edge of southeastern Alpine-Illyrian thermophile beech forest (E.4.6.).

Unnamed rocky peak between Crni vrh and Gornik

This unnamed rocky peak (45°27' N, 14°31' E; 1333 m a.s.l.) is situated between Crni vrh (1335 m) and Gornik (1320 m) in the mountains above Grobničko polje. A few shrubs of *Berberis croatica* grow about ten meters below the peak, on a somewhat sheltered site exposed to the sun, covering an area of several square meters. The biggest shrub of *B. croatica* is about 40 cm high while the others are stunted. The plants grow surrounded by

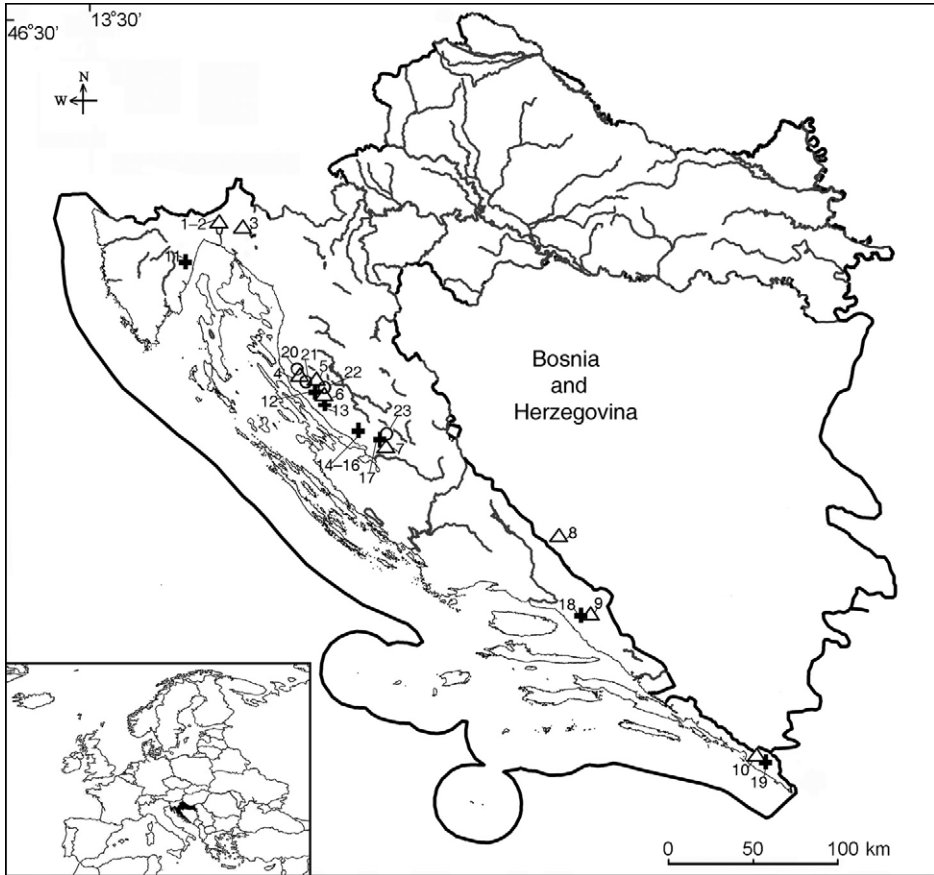


Fig. 1. Newly found localities of *Berberis croatica* (triangles; a), *Teucrium arduini* (crosses; b) and *Micromeria croatica* (circles; c) in Croatia and Bosnia and Herzegovina. For number explanation see table 1.

grassland of *Sesleria tenuifolia*. In the nearby vegetation *Fagus sylvatica*, *Rhododendron hirsutum* L. and *Salix appendiculata* Vill. dominate. This narrow micro-locality with shrubs of *B. croatica*, according to NHC could be described as overrun grassland of *Saturejon subspicatae* (C.3.5.2) community, at the upper limit of its altitudinal distribution, with many characteristic thermophile species lacking.

Mala kosa near railway station Drivenik (Gorski kotar)

Based on altitude (840 m a.s.l.) and habitat conditions, this population of *Berberis* L. connects the *B. croatica* population on Viševica with *B. vulgaris* population in Ličko polje. Shrubs of *B. croatica* grow near the railway station Drivenik, on the eastern slope of Mala kosa (45°16' N, 14°43' E), on big limestone rocks, surrounded by shrubby vegetation and European silver fir (*Abies alba* Mill.) forest. Habitat type is Dinaric fir forest on calcareous block (E.7.1.1.), i.e. the narrow micro-locality belongs to the rocky glade within this forest type. Croatian barberry was found on four new localities on Mt Velebit.

Unnamed peak between Kita and Zečjak

The first prominent rocky peak (44°42' N, 14°60' E) on the left side of the hiking trail from Kita to Zečjak is a newly found locality of *B. croatica*. Plants of *B. croatica* grow from the fissures in limestone on the peak top covering a discontinuous area of about 20 m². Plants are vigorous, up to 80 cm high and are growing on the site exposed to the southeast together with *Juniperus communis* ssp. *alpina* (Sm.) Čelak, *Clematis alpina*, *Rosa pendulina* L., *Lonicera alpigena*, *Cotoneaster nebrodensis*, *Mercurialis perennis* L. and *Cirsium* Mill. sp. Common beech (*Fagus sylvatica*) dominates in the nearby vegetation. According to the NHC this habitat type belongs to subalpine scrub (D.2.).

Budakovo brdo

Budakovo brdo (44°35' N, 15°05' E; 1318 m a.s.l.) is one of the peaks situated in the middle section of Mt Velebit. Two bushes of *B. croatica* were found near the hiking trail (in the valley) in the direction of Soline peak (1267 m a.s.l.). Plants grow on the southeastern exposure, at 1215 m a.s.l. This locality is sheltered from the wind and plants are vigorous, up to 1.20 m high. Plant species that grow nearby are: *Corylus avellana* L., *Arctostaphylos uva-ursi* (L.) Spreng, *Cotoneaster integerrimus* Medik., *Lonicera glutinosa* Vis., *Viburnum lantana* L., *Fagus sylvatica*, *Clematis recta* L., *Vicia cracca*, *Vincetoxicum hirundinaria* Medik., *Iris variegata* L., *Lilium bulbiferum* L., *Anemone ranunculoides* L. and *Linum narbonense* L. Habitat type is difficult to define since there is a visible transition between forest edge, scrub and overrun grassland in advanced phase of secondary succession.

Kuk od Špiljić plane

Kuk od Špiljić plane (44°33' N, 15°11' E; 1255 m a.s.l.) is situated in the middle section of Mt Velebit, not far away from the village Baške Oštarije. Plants of *Berberis croatica* are spread among the limestone rocks exposed to the southeast. Plants are vigorous, up to 50 cm high and grow together with *Juniperus communis* ssp. *alpina*, *Juniperus sabina* L., *Corylus avellana*, *Amelanchier ovalis* Medik., *Micromeria thymifolia* (Scop.) Fritsch, *Gentiana lutea* L. ssp. *symphyandra* (Murb.) Hayek, *Satureja subspicata*, *Actaea spicata* L. and *Campanula* L. sp. Habitat type, according to the NHC, is submontane rocks overgrown with elements of *Micromerion croaticae* Ht. 1931 community and, in certain extent, thermophile shrubs which can be included in the habitat of lower altitudinal belt of subalpine scrub (D.2.).

Đuđinovac near Prezid

Đuđinovac is an area near Prezid pass in the south section of Mt Velebit. A few plants of *B. croatica* were found on the left side of the trail, at about 850 m a.s.l. (44°16' N; 15°50' E). Plants are about 1 m high and surrounded by *Ribes alpinum* L., *Juniperus sabina*, *Ostrya carpinifolia* Scop. and *Acer pseudoplatanus* L. Among other species *Fagus sylvatica*, *Satureja montana* L. and *Origanum vulgare* L. were noticed. The habitat represents a transitional zone between scrub vegetation (D.2.) and forest edge.

Beyond the northwest Dinaric Alps new localities of *B. croatica* were found on Mt Kamešnica, Mt Biokovo and Mt Sniježnica.

Kamešnica

A few plants of *Berberis croatica* were found in the part of Kamešnica Mountain that belongs to Bosnia and Herzegovina. *Berberis croatica* grows about 400 m away from the locality »Klanac«, at the altitude of 1421 m a.s.l. (43°42' N, 16°55' E). Plant species that grow nearby are *Fagus sylvatica*, *Abies alba*, *Ostrya carpinifolia*, *Acer pseudoplatanus*, *Juniperus communis* ssp. *alpina*, *Teucrium arduini*, *Rhamnus intermedia* Steud. et Hochst., *Daphne alpina* and *Gentiana lutea* ssp. *symphyandra*. Habitat type is subalpine scrub (D.2.).

Vošac (Mt Biokovo)

Vošac (43°18' N, 17°02' E; 1422 m a.s.l.) is one of the famous peaks of Mt Biokovo. *B. croatica* grows on the peak top, near the climbers' lodge, and on the southeast-exposed slope. The plants cover an area of a few square meters; they are averagely 40 cm high, vigorous and with regular fructification. Several plants were also found about one hundred meters below the top, near the hiking trail, in the direction of a car-park. Another group of plants grows below the rock situated about 200 m meters northeast of Vošac peak. Plant species that grow nearby are: *Satureja montana*, *Juniperus communis* ssp. *alpina*, *Arctostaphylos uva-ursi*, *Globularia cordifolia* L., *Carex humilis*, *Sesleria robusta* Schott, Nyman et Kotschy, *Edraianthus graminifolius* (L.) A. DC., *Helianthemum* Mill. sp. and *Hieracium* L. sp. Habitat belongs among transitional types i.e. the transition between east-Adriatic rocky grassland of the epi-Mediterranean zone (C.3.5.2.) and subalpine scrub (D.2.) whose elements are mosaically spread over the habitat.

Mt Sniježnica

Mt Sniježnica is the southernmost mountain in Croatia, situated near the border with Bosnia and Herzegovina and Montenegro. *Berberis croatica* was found on the right (several plants) and left (one plant) side of a trail (heading from the peak towards Kuna Konavoska), approximately at 1125 m a.s.l. (42°34' N, 18°21' E). Plants grow from fissures in limestone, they are up to 1 m high, vigorous and fructifying. Plant species that grow nearby are: *Teucrium arduini*, *Rhamnus intermedia*, *Frangula rupestris* (Scop.) Schur, *Ostrya carpinifolia*, *Moltkia petraea* (Tratt.) Griseb. and *Viburnum lantana*. The habitat of poorly vegetated rocks with elements of Dalmatian calcareous rocks (B.1.4.2.) and vegetation of thermophile scrub could be recognized.

2. Localities of *Teucrium arduini*

New localities of *Teucrium arduini* were also found at a few distinct geographical sites of the Dinaric Alps: Mt Učka, Mt Velebit, Mt Biokovo and Mt Sniježnica. During the collection of plant material of *T. arduini* on Mt Kozjak we failed to find plants between the climbers' lodge called »Putalj« and St. Ivan Biranj church (and a few hundred meters more in the direction on Malačka pass) although this locality is mentioned in the references (KAMENJARIN 1996).

Argun

Argun is one of the peaks on Suhi vrh ridge (1321 m a.s.l.) on Mt Učka, situated south of Vela Učka. Several plants of *Teucrium arduini* grow on the rocky southeast slope of Argun (45°16' N, 14°13' E) at the altitude of about 1200 m. They are up to 35 cm high and vigorous. Nearby vegetation belongs to thermophilous *Fagus sylvatica* forest with *Sesleria autumnalis* (Scop.) F. W. Schultz. Habitat type represents poorly vegetated and weakly differentiated Illyrian-Adriatic littoral calcareous scree (B.2.2.) surrounded by littoral beech forest (E.4.6.3). *Teucrium arduini* was found at six new localities on Mt Velebit.

Šušanj Cesarički

Locality Šušanj is known from the literature (DEGEN 1938:583, FORENBACHER 1990), but previously there was no precise information where *T. arduini* really grows. *Teucrium arduini* was found in an old quarry (44°32' N, 15°07' E; 600 m a.s.l.) situated near the position where the road for Ravni Dabar diverges from the Karlobag – Baške Oštarije – Gospić road. Several plants of *T. arduini* grow separately on rocks, on the south-eastern facing slope. The locality has been almost completely destroyed by the building of a car-park on a small lookout point and the carting of sawdust from a nearby saw-mill. Plants of *T. arduini* are, generally, in a bad state. They are up to 30 cm high and grow almost completely alone on rocks. Among other plant species that grow nearby, *Satureja montana* is the most frequent. Other plant species that grow on the nearby rocks and the lookout spot are: *Pinus nigra* J. F. Arnold, *Satureja subspicata*, *Juniperus communis* L., *Marrubium incanum* Desr., *Onosma* L. sp., *Campanula fenestrellata* Feer, *Silene saxifraga* L., *Scrophularia heterophylla* Willd. ssp. *laciniata* (Waldst. et Kit.) Maire et Petitm, *Cephalaria leucantha* (L.) Schrad. ex Roem. et Schult., *Centaurea deusta* Ten. ssp. *concolor* (DC.) Hayek and *Achillea* L. sp. Habitat type, according to the NHC, is poorly vegetated calcareous rock (B.1.), more precisely bare karren and abandoned quarry (J.4.3.2.1.).

Panos

Panos (1258 m a.s.l.) is one of the notable peaks in the south section of Mt Velebit. *Teucrium arduini* was found on both sides of a gravel road in the direction of Panos (44°26' N; 15°17' E), approximately 500 m after the gravel road crossing Jelova ruja – Šugarska duliba or fifteen minutes before the trail crossing Panos – Šugarska duliba. Plants of *T. arduini* grow on, and near the road, on a rocky slope, with south – southeastern exposure. They are very vigorous, up to 50 cm high and with regular fructification. Plant species that grow nearby are: *Micromeria thymifolia*, *Satureja subspicata*, *Rhamnus fallax* Boiss., *Fagus sylvatica* and *Campanula* sp. Habitat type belongs to infrastructure areas (J.4.4.) i.e. forest road edge.

Veliki Vaganac

The locality Veliki Vaganac (44°19' N, 15°28' E; 700 m a.s.l.) is situated in the south section of Mt Velebit, above the small town Starigrad Paklenica. *Teucrium arduini* grows individually on an area of a several dozen square meters, between rocks and gravel, on a site exposed predominantly to the south and southeast, along a small car-park and nearby gravel road. Plants of *T. arduini* are in a good state in spite of the fact that the habitat is ruined by the building of a gravel road. Among other species we noticed *Rhamnus intermedia*, *Daphne alpina*, *Frangula rupestris*, *Drypis spinosa* L., *Teucrium chamaedrys* L., *Satureja*

montana, *Cotinus coggygria* Scop., *Ostrya carpinifolia* and *Campanula pyramidalis* L. Habitat type belongs to infrastructure areas (J.4.4.)

Veliko Rujno

Veliko Rujno is a famous shrine (Gospa od Rujna) situated in the south section of Mt Velebit, several kilometers from the locality Veliki Vaganac. *Teucrium arduini* was found most abundantly at the end of a gravel road leading from Veliki Vaganac to Veliko Rujno (44°22' N; 15°26' E; 880 m a.s.l.). Plants grow on the rocks near the gravel road, on sites with predominantly south and south eastern exposure. Plant species that grow nearby are *Satureja montana*, *Fraxinus ornus* L., *Prunus spinosa* L., *Cornus mas* L., *Acer monspesulanum* L. and *Eryngium amethystinum* L. Habitat type, according to the NHC, belongs to infrastructure areas (J.4.4.), and poorly vegetated calcareous rocks (B.1.).

Bojinac

Bojinac is a small area in the western part of Paklenica National Park. *Teucrium arduini* was found on a trail, 25 minutes from Veliko Rujno at approximately 1000 m a.s.l. (44°21' N; 15°26' E). Plants grow on the rocky slope, predominantly on the eastern exposure. They are up to 50 cm high, vigorous and with regular fructification. Among other species we noticed *Satureja subspicata*, *Rhamnus intermedia*, *Fraxinus ornus*, *Ostrya carpinifolia*, *Stachys recta* L., *Campanula waldsteiniana* Schult., *Campanula fenestrellata* and *Scrophularia* L. sp. Habitat type is poorly vegetated rock (B. 1.), i.e. round rocky calcareous mass with scarce elements of vegetation of rocky crevices.

Đuđinovac near Prezid

Only two plants of *Teucrium arduini* were found on a huge rock on the left side of a trail, about 45 minutes from the beginning of the hiking trail to Crnopac (44°16' N, 15°50' E; 880 a.s.l.). The plants are up to 35 cm high, in a good state and with regular fructification. Among other species we noticed *Fagus sylvatica*, *Ostrya carpinifolia*, *Satureja montana*, *Juniperus sabina* and *Sorbus aria* (L.) Crantz. Habitat type is poorly vegetated rock (B.1.).

Štrbina (Mt Biokovo)

Štrbina (43°18' N, 17°02' E) is a small belvedere situated a few hundred meters south-east of Vošac peak. The locality Vošac is known from the literature (KUŠAN, 1969a), but during our field work *Teucrium arduini* was not found there. It is also possible that KUŠAN (1969a) found *T. arduini* bellow Štrbina but described the new locality using the name of a more famous peak Vošac. The population of *T. arduini* is located five to ten minutes (on foot) from the lookout point called Štrbina in the direction of Makarska town. *T. arduini* grows on scree and rocks beside the trail, predominantly on sites with southern exposure. Plants which grow on the scree are mostly up to 25 cm high and stunted, while a few plants which grow on rocks are up to 40 cm high and more vigorous. Among other plants, we noticed *Fagus sylvatica*, *Ostrya carpinifolia*, *Sorbus aria*, *Satureja montana*, *Moltkia petraea*, *Valeriana montana* L., *Rumex* L. sp. and *Onosma* L. sp.

Teucrium arduini was also noticed on a few sites near the road which connects entrance of Nature Park »Biokovo« and Vošac (43°18' N, 17°03' E). On these sites *T. arduini* grows on a scree, but plants are very vigorous and fructify. Also, *T. arduini* grows from the fissures in limestone and in the gravel near the road, as well as on the rocks. Habitat type predominantly is classified as Illyrian-Adriatic littoral scree (B.2.2.1.).

Mt Sniježnica

On Mt Sniježnica *Teucrium arduini* was found on the left side of the trail (heading from the peak towards Kuna Konavoska), approximately at 1125 m a.s.l. (42°34' N; 18°21' E). Several plants grow on rocks with a southeastern exposure. They are up to 40 cm high and relatively vigorous. Another group of plants grows on the right side of the trail (heading from the peak towards Kuna Konavoska). Plants from this group grow on rocks with southern exposures. They are more robust, up to 65 cm high, very vigorous and with regular fructification. Plant species that grow nearby are: *Berberis croatica*, *Rhamnus intermedia*, *Frangula rupestris*, *Ostrya carpinifolia*, *Moltkia petraea* and *Viburnum lantana*. Habitat type belongs to poorly vegetated rocks with elements of Dalmatian calcareous rocks (B.1.4.2.).

3. Localities of *Micromeria croatica*

During the field work we failed to find *Micromeria croatica* on Mt Risnjak, a location mentioned in the literature (ŠEGULJA et al. 1994, PELIVAN 1997). Nor was *M. croatica* found on Samarske stijene in Gorski kotar, nor did other field researches confirm the presence of *M. croatica* on Samarske stijene (Topić, personal communication). New localities of this species were recorded only on Mt Velebit.

Rossijev kuk

Rossijev kuk (44°46' N, 14°60' E; 1615 m a.s.l.) is one of the peaks situated beside the footway Premužičeva staza in the northern section of Mt Velebit (Northern Velebit National Park), 5–10 minutes on foot from the climbers' shelter Rossijeva koliba (1580 m a.s.l.). Plants of *Micromeria croatica* grow on a rocky slope with a southwestern exposure. Among other species we noticed *Pinus mugo* Turra, *Rosa pendulina*, *Achillea clavennae* L., *Scutellaria alpina* L., *Gentiana lutea* ssp. *symphyandra*, *Ranunculus platanifolius* L., *Lamium galeobdolon* (L.) L., *Melittis melissophyllum* L., *Lilium carniolicum* Bernh. ex W. D. J. Koch and *Silene* L. sp. Habitat type is Illyrian-Dinaric calcareous rocks (*Micromerion croaticae* Ht. 1931 community) (B.1.3.3.).

Rujičin kuk

Rujičin kuk (44°34' N, 15°08' E; 946 m a.s.l.) is one of the peaks situated near the gravel road which connects Kučišta Cesarička and Kugina kuća. This peak is close to Ravni Dabar (723 m a.s.l.). Plants of *M. croatica* were found on the rocks at the base of Rujičin kuk (eastern exposure), beside the gravel road heading in the direction towards Ravni Dabar. Plant species that grow nearby are: *Fagus sylvatica*, *Micromeria thymifolia*, *Rubus fruticosus* L. agg., *Campanula waldsteiniana*, *Vincetoxicum hircundinaria* and *Campanula fenestrellata*. Habitat type, according to NHC is rock, partly shaded by beech forest and poorly vegetated by elements of Illyrian-Dinaric calcareous rock vegetation (*Micromerion croaticae* community); (B.1.3.3.).

Kuk od Špiljić plane

Several plants of *Micromeria croatica* can be found on a slope with a southeastern exposure, on limestone rocks open to the influence of strong winds (44°33' N, 15°11' E; 1255 m a.s.l.). Plant species that grow nearby are: *Juniperus communis* ssp. *alpina*, *Juniperus sabina*, *Corylus avellana*, *Amelanchier ovalis*, *Micromeria thymifolia*, *Gentiana lutea* ssp.

symphyandra, *Satureja subspicata*, *Actaea spicata* and *Campanula* sp. As well as on Kuk od Špiljić plane, *M. croatica* grows individually at several micro locations in this area, especially abundantly on rocks on the left side of the gravel road from Stupačinovo to Jadičevac and Položine. The habitat could be characterized as poorly vegetated calcareous rock with elements of *Micromerion croaticae* (B.1.3.3.) community.

Duđinovac near Prezid

A few plants of *M. croatica* were found on the huge rocks on the both sides of a trail to Crnopac, about one hour on foot from the beginning of the hiking trail (44°16' N, 15°50' E; 900 m a.s.l.). Plant species that grow nearby are: *Fagus sylvatica*, *Ostrya carpinifolia*, *Juniperus communis* ssp. *alpina*, *Juniperus sabina*, *Sorbus aria*, *Satureja subspicata* and *Sedum* L. sp. Habitat type belongs to poorly vegetated calcareous rock (B.1.).

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References

- AKERROYD, J. R., WEBB, A., 1993: *Berberis* L. In: TUTIN, T. G., HEYWOOD, V. H., BURGESS, N. A., VALENTINE, D. H., MOORE, D. M. (eds.), *Flora Europaea*, 1, 295–296. Cambridge University Press, Cambridge.
- ALEGRO, A., RUŠČIĆ, M., 2010: Mt. Dinara (In Croatian). In: NIKOLIĆ, T., TOPIĆ, J., VUKOVIĆ, N. (eds.), *Botanički važna područja Hrvatske*, 91–98. Prirodoslovno-matematički fakultet and Školska knjiga, Zagreb.
- BORBÁS, V., 1886: Notizen. *Österreichische Botanische Zeitschrift* 36, 247.
- BRÄUCHLER, C., RYDING, O., HEUBL, G., 2008: The genus *Micromeria* (Lamiaceae), a synoptical update. *Willdenowia* 38, 363–410.
- CHATER, A. O., GUINEA, E., 1972: *Micromeria*. In: TUTIN, T. G., HEYWOOD, V. H., BURGESS, N. A., MOORE, D. M., VALENTINE, D. H., WALTERS, S. M., WEBB, D. A. (eds.), *Flora Europaea*, 3, 167–170. Cambridge University Press, Cambridge.
- DEGEN, A., 1938: *Flora Velebitica*, 2, 151–152; 583; 635–636. Verlag der Ungarische Akademie der Wissenschaften, Budapest.
- DOMAC, R., 1994: *Croatian flora* (In Croatian). Školska knjiga, Zagreb.
- ERHARDT, W., GÖTZ, E., BÖDEKER, N., SEYBOLD, S., 2002: *Zander – Handwörterbuch der Pflanzennamen*. Eugen Ulmer GmbH und Co., Stuttgart.
- FORENBACHER, S., 1990: *Mt. Velebit and its plants* (In Croatian). Školska knjiga, Zagreb.
- FLORA CROATICA DATABASE OF HABITATS, 2009: <http://hirc.botanic.hr/fcd/>
- KAMENJARIN, J., 1996: Vascular flora of Mount Kozjak above Split. *Natura Croatica* 5, 119–144.
- KARLOVIĆ, K., KREMER, D., LIBER, Z., ŠATOVIĆ, Z., VRŠEK, I., 2009: Intra- and interpopulation variability and taxonomic status of *Berberis croatica* Horvat. *Plant Biosystems* 143, 40–46.

- KREMER, D., RANDIĆ, M., KOSALEC, KARLOVIĆ, K., 2008: New localities of *Berberis croatica* Horvat in Croatia. *Acta Botanica Croatica* 67, 237–244.
- KUŠAN, F., 1969a: Vegetation cover of Mt. Biokovo (In Croatian). JAZU, Zagreb.
- KUŠAN, F., 1969b: New barberry (*Berberis*) species in Croatian flora (In Croatian). *Acta Botanica Croatica* 28, 423–434.
- LAKUŠIĆ, B., LAKUŠIĆ, D., SLAVKOVSKA, V., STEVANOVIĆ, V., STEVANOVIĆ, B., 2007: Morpho-anatomical differentiation of the Balkan endemic species *Teucrium arduini* L. (*Lamiaceae*). *Archives of Biological Sciences* 59, 369–381.
- LOVAŠEN-EBERHARDT, Ž. 1994. *Berberis* L. – žutika. In: NIKOLIĆ, T. (ed.), *Index florae Croaticae* 1, Suppl. 2. *Natura Croatica* 3, 42.
- LOVAŠEN-EBERHARDT, Ž. 2000. *Micromeria* Benth. – bresina. In: NIKOLIĆ, T. (ed.) *Index florae Croaticae* 3, Suppl. 1. *Natura Croatica* 9, 19–20.
- MARTINIS, Z., 1994: *Berberis croatica* (Horvat) Kušan (In Croatian). In: ŠUGAR, I. (ed.), *Red data book of plant species of Republic of Croatia*, 63–65. *Ministarstvo graditeljstva i zaštite okoliša, Zavod za zaštitu prirode, Zagreb*.
- MEIMBERG, H., ABELE, T., BRÄUCHLER, C., MCKAY, J. K., PÉREZ DE PAZ, P. L., HEUBL, G., 2006: Molecular evidence for adaptive radiation of *Micromeria* Benth. (*Lamiaceae*) on the Canary Islands as inferred from chloroplast and nuclear DNA sequences and ISSR fingerprint data. *Molecular Phylogenetics and Evolution* 41, 566–578.
- NARODNE NOVINE, 2006: Regulation on designating wild taxa protected and strictly protected (In Croatian). *Narodne Novine* 7, 157.
- NARODNE NOVINE, 2009: Habitat types in Croatia (National habitat classification– NKS) (In Croatian). *Narodne Novine* 119, 21–52.
- NIKOLIĆ, T., ur., 2008: *Flora Croatica Database* (<http://hirc.botanic.hr/fcd>). *Prirodoslovno-matematički fakultet, Sveučilište u Zagrebu*.
- PELIVAN, A., 1997: National Park Risnjak (In Croatian). *Ekološki glasnik* 10, 6–20.
- RUŠČIĆ, M., 2010: Lower flow of Cetina river (In Croatian). In: NIKOLIĆ, T., TOPIĆ, J., VUKOVIĆ, N. (eds.), *Botanički važna područja Hrvatske*, 103–108. *Prirodoslovno-matematički fakultet i Školska knjiga, Zagreb*.
- ŠEGULJA, N., LOVAŠEN-EBERHARDT, Ž., HRŠAK, V., LUKAČ, G., 1994: Review of the state of research of flora in National Park 'Risnjak'. *Proceedings of the Symposium 40 years of the National Park 'Risnjak' (1953–1993)*, Crni Lug, 71–77.
- ŠILIĆ, Č., 1979: Monography of genera: *Satureja* L., *Calamintha* Miller, *Micromeria* Benth, *Acinos* Miller and *Clinopodium* L. in flora of Yugoslavia (In Croatian). *Zemaljski muzej BiH, Sarajevo*.
- ŠILIĆ, Č., 1990: Endemic plants (In Croatian). *IP Svjetlost, Sarajevo*.
- ŠILIĆ, Č., 2005: Atlas of woody plants (trees and shrubs) of Bosnia and Herzegovina (In Croatian). *Matica Hrvatska Čitluk and Franjevačka kuća Masna Luka, Čitluk*.
- TRINAJSTIĆ, I., 1973: *Berberis* L. (In Croatian). *Analitička flora Jugoslavije* 1, 377–381.
- ZOVKO KONČIĆ, M., KREMER, D., SCHÜHLY, W., BRANTNER, A., KARLOVIĆ, K., KALOĐERA, Z., 2010: Chemical differentiation of *Berberis croatica* and *B. vulgaris* using HPLC fingerprinting. *Croatica Chemica Acta* 83, 451–456.