

Plant Diversity of Gornji Kamenjak (Istria, Croatia)

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Summary

The vascular flora of Significant Landscape Gornji Kamenjak in Istria was investigated in different vegetation periods from 2012 to 2013, and a total of 507 plant taxa (468 species and 39 subspecies) were recorded. Part of them were previously registered, while some are recorded for the first time. The studied area was poorly investigated in the past, therefore there was a need for this study, representing a very detailed floristic survey of the area. The most dominant families were grasses (*Poaceae*, 11.8%), legumes (*Fabaceae*, 10.6%), daisies (*Asteraceae*, 6.5%) and mints (*Lamiaceae*, 5.5%). The domination of therophytes (37.0%) indicates that the climate of Gornji Kamenjak shows a high influence of the Mediterranean climate, followed by hemicryptophytes (30.8%) and geophytes (12.6%). We recorded a total of 11 invasive species across the whole investigated area, as well as the occurrence of 15 endangered and 13 endemic plant taxa. The results of our research of autochthonous vascular flora indicate high richness and diversity of plant species in the studied area.

Key words

Istria, Premantura, Significant Landscape, vascular flora

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Introduction

According to the Nature Protection Act (Anonymous, 2013), Gornji Kamenjak is a protected area in the category of Significant Landscape. Gornji Kamenjak is located at the southernmost point of the Istrian Peninsula between two small villages, Premantura in the South and Volme in the North (Fig. 1). It is an integral part of the unity of the local residents known as “Kamenjak”, which besides Significant Landscape Gornji Kamenjak also encompasses Significant Landscape Donji Kamenjak and Medulin archipelago. Both areas have been declared as protected in 1996 by the Assembly of the County of Istria (Anonymous, 1996) owing to landscape and natural and cultural values (Nikolić et al., 2010).

The area of Gornji Kamenjak covers 380 ha and includes two islands in the Bay of Medulin; Premanturski and Pomerski Školjić (Fig. 1). The aquatorium surrounding the Kamenjak Peninsula is protected with two adjacent Sites of Community Interest (SCI) as part of the ecological network NATURA 2000: „Akvatorij zapadne Istre i Medulinski zaljev“. In addition, the aquatorium is as well protected as Special Protection Area (SPA) for birds.

Gornji Kamenjak was an important strategic area for the Austro-Hungarian army due to its location, hilly terrain and significantly higher altitude in relation to the wider surroundings. This is evidenced by numerous military facilities: tunnels, batteries and bunkers.

Over the territory of Premantura and the surrounding area the prevalent soil type is Eutric Cambisol on Eolian deposits and relict terra rossa, typical and anthropogenized followed by Luvisol, on Eolian deposits, typical and anthropogenized, and Rigosol (Vidaček, 1979; Škorić and Bogunović, 1987). The central part of Gornji Kamenjak with deeper soils is dominated by agricultural landscapes, while on the edges with shallow soil stony grasslands and garigues prevail. Step by step, the coastal zone has been planted with *Pinus halepensis* and vegetation succession took place. The garigue development was slow, due to shallow skeletal soil and arid climate. The investigated area is characterized by a typical Mediterranean climate (Horvat, 1949). Accordingly, recent anthropogenic influence is rather small, excluding the tourists/visitors on beaches in summer (Topić and Šegulja, 2000).

Despite numerous floristic studies carried out across the southern part of Istria (Tommasini, 1873; Freyn, 1877; Perko, 1998; Starmühler, 1998, 2004, 2010; Topić and Šegulja, 2000; Hršak et al., 2011; Vuković et al., 2011, 2013) where more than 500 plant taxa have been recorded in previous investigations, flora of Gornji Kamenjak has not been investigated in detail until presented study.

The aim of this study was to perform an updated inventory of the vascular flora and flora mapping, as well as analysis of plant diversity of Gornji Kamenjak, which would benefit species protection and conservation management of this ecologically valuable area.

Materials and methods

Floristic study of vascular flora of Gornji Kamenjak was carried out from 2012 to 2013 during the entire vegetation seasons. The standard methods for flora inventory and mapping were used according to Nikolić (2006) and Nikolić et al. (1998) within seven MTB 1/64 fields. Geographical coordinates for each locality were recorded using Garmin vista e-Trex GPS (Fig. 1).

Nomenclature of plant taxa follows the Flora Croatica Database (Nikolić, 2018). Families, genera, species and subspecies are listed

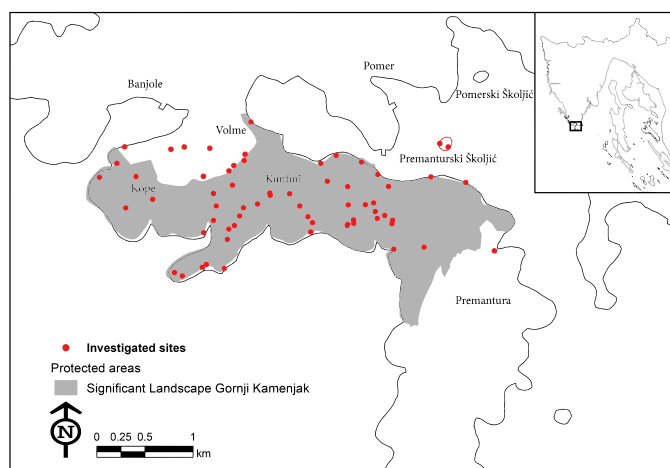


Figure 1. Geographical position of Significant Landscape Gornji Kamenjak with investigated sites

in alphabetical order and organized according to higher systematic units according to Nikolić (2013).

The analysis of life forms was conducted according to Raunkiaer (1934), Horvat (1949) and Pignatti (1982). In the floristic list, life forms are marked with the following abbreviations: *Chamaephyta* (Ch), *Geophyta* (G), *Hemicryptophyta* (H), *Phanerophyta* (Ph), *Therophyta* (T) and *Hydrophyta* (Hy).

Endemic taxa (End) are determined according to Nikolić et al. (2015) and Flora Croatica Database (Nikolić 2018), while invasive species (Inv) are determined according to Boršić et al. (2008). The status of endangered plant taxa: critically endangered (CR), endangered (EN), vulnerable (VU), least concern (LC), near threatened (NT) and data deficient (DD) was assigned according to Nikolić and Topić (2005) and Flora Croatica Database (Nikolić, 2018).

For the purpose of floristic mapping of the Significant Landscape Gornji Kamenjak, we obtained permission from the Ministry of Environment and Nature Protection to collect plant material. Collected herbarium specimens are deposited in ZAGR herbarium and are accessible through the Virtual Herbarium (<http://herbarium.agr.hr>) according to Bogdanović et al. (2016).

Results

During the floristic research of Gornji Kamenjak a total of 507 vascular plant taxa were recorded, out of which 13 plant taxa are endemic, 15 taxa are endangered (CR, EN, VU) and 11 taxa are classified as invasive plant species (Tab. 1).

Analysis of vascular flora

A total of 507 taxa (468 species and 39 subspecies) were recorded within 291 genera and 77 families (Tab. 2). Across the area of Gornji Kamenjak, five species from *Monilophyta* section and 503 taxa from *Spermatophyta* section were identified. Four species belong to the group of *Gymnospermae* and 461 species and 39 subspecies to the group of *Angiospermae*. There was a greater representation of the *Eudicotyledonae* (three times more) compared to the *Lilianae*. Although less represented by the number of species, the group of *Lilianae* occupied a large part of the open areas of Gornji Kamenjak.

Table 1. The list of vascular plant taxa identified in the area of Gornji Kamenjak in Istria. Abbreviations are given for life forms: *Chamaephyta* (Ch), *Geophyta* (G), *Hemicryptophyta* (H), *Phanerophyta* (Ph), *Therophyta* (T) and *Hydrophyta* (Hy); status: critically endangered (CR), endangered (EN), vulnerable (VU), least concern (LC), near threatened (NT), data deficient (DD); and endemic (End) and invasive plant taxa (Inv)

Taxon name	Life form	Status		
Monilophyta				
Ophioglossaceae				
<i>Ophioglossum lusitanicum</i> L.	G	CR		
Polypodiaceae				
<i>Asplenium ceterach</i> L.	H			
<i>Asplenium onopteris</i> L.	H			
<i>Asplenium ruta-muraria</i> L.	H			
<i>Asplenium trichomanes</i> L.	H			
Spermatophyta				
Gymnospermae				
Cupressaceae				
<i>Juniperus oxycedrus</i> L.	Ph			
<i>Juniperus phoenicea</i> L.	Ph			
Pinaceae				
<i>Pinus halepensis</i> Mill.	Ph			
<i>Pinus pinea</i> L.	Ph			
Eudicotyledonae				
Aceraceae				
<i>Acer obtusatum</i> Waldst. et Kit. ex Willd.	Ph			
Anacardiaceae				
<i>Pistacia lentiscus</i> L.	Ph			
<i>Pistacia terebinthus</i> L.	PH			
Apiaceae				
<i>Bupleurum praealtum</i> L.	T			
<i>Bupleurum veronense</i> Turra	T			
<i>Crithmum maritimum</i> L.	Ch			
<i>Daucus carota</i> L.	H			
<i>Eryngium amethystinum</i> L.	H			
<i>Eryngium campestre</i> L.	H			
<i>Foeniculum vulgare</i> Mill. ssp. <i>piperitum</i> (Ucria) Coutinho	G			
<i>Foeniculum vulgare</i> Mill. ssp. <i>vulgare</i>	G			
<i>Oenanthe pimpinelloides</i> L.	H			
<i>Orlaya grandiflora</i> (L.) Hoffm.	T			
<i>Scandix pecten-veneris</i> L.	T			
<i>Seseli montanum</i> L. ssp. <i>tommasinii</i> (Rchb. f.) Arcang.	H	End		
<i>Seseli tortuosum</i> L.	H			
<i>Tordylium apulum</i> L.	T			
<i>Torilis arvensis</i> (Huds.) Link	T			
<i>Torilis nodosa</i> (L.) Gaertn.	T			
Araliaceae				
<i>Hedera helix</i> L.	Ph			
Asclepiadaceae				
<i>Vincetoxicum hirsundinaria</i> Medik. ssp. <i>adriaticum</i> (Beck) Markgr.	H	End		
Asteraceae				
<i>Achillea millefolium</i> L.	H			
<i>Anthemis arvensis</i> L.	T			
<i>Artemisia alba</i> Turra	Ch			
<i>Artemisia caerulescens</i> L.	Ch			
<i>Artemisia vulgaris</i> L.	H			
<i>Bellis perennis</i> L.	H			
<i>Bellis sylvestris</i> Cirillo	H			
<i>Bombycilaena erecta</i> (L.) Smoljan.	T			
<i>Carduus micropterus</i> (Borbás) Teyber	H			
<i>Carduus pycnocephalus</i> L.	H			
<i>Carlina corymbosa</i> L.	H			
<i>Centaurea jacea</i> L.	H			
<i>Centaurea solstitialis</i> L.	H			
<i>Centaurea spinosociliata</i> Seenus	H	End		
<i>Cirsium vulgare</i> (Savi) Ten.	H			
<i>Coryza canadensis</i> (L.) Cronquist	T	Inv		
<i>Crupina vulgaris</i> Cass.	T			
<i>Dittrichia viscosa</i> (L.) Greuter	H			
<i>Evax pygmaea</i> (L.) Brot.	T			
<i>Filago pyramidata</i> L.	T			
<i>Filago vulgaris</i> Lam.	T			
<i>Helichrysum italicum</i> (Roth) G.Don	Ch			
<i>Inula conyza</i> DC.	H			
<i>Inula crithmoides</i> L.	Ch			
<i>Pallenis spinosa</i> (L.) Cass.	T			
<i>Senecio bicolor</i> (Willd.) Tod. ssp. <i>cineraria</i> (DC.) Chater	Ch			
<i>Senecio vulgaris</i> L.	T			
<i>Tanacetum cinerariifolium</i> (Trevir.) Sch.Bip.	H	End		
<i>Tussilago farfara</i> L.	G			
<i>Tyrimnus leucographus</i> (L.) Cass.	T			
<i>Xanthium spinosum</i> L.	T	Inv		
<i>Xanthium strumarium</i> L. ssp. <i>italicum</i> (Moretti) D.Löve	T	Inv		
Boraginaceae				
<i>Echium italicum</i> L.	T			
<i>Lithospermum officinale</i> L.	H			
<i>Lithospermum purpureoaeeruleum</i> L.	Ch			
<i>Myosotis ramosissima</i> Rochel	T			
<i>Neatostema apulum</i> (L.) I.M.Johnst.	T			
<i>Onosma echioides</i> (L.) L. ssp. <i>dalmatica</i> (Scheele) Peruzzi et N.G.Passal.	Ch	End		
Brassicaceae				
<i>Alliaria petiolata</i> (M. Bieb.) Cavara et Grande	H			
<i>Arabidopsis thaliana</i> (L.) Heynh.	T			
<i>Arabis hirsuta</i> (L.) Scop.	H			
<i>Brassica napus</i> L. ssp. <i>oleifera</i> (DC.) Janch.	T			
<i>Brassica oleracea</i> L. ssp. <i>capitata</i> (L.) Duchesne	Ch			
<i>Cakile maritima</i> Scop.	T			
<i>Calepina irregularis</i> (Asso) Thell.	T			
<i>Capsella bursa-pastoris</i> (L.) Medik.	H			
<i>Capsella rubella</i> Reut.	T			
<i>Cardamine hirsuta</i> L.	T			
<i>Cardaria draba</i> (L.) Desv.	G			
<i>Diplotaxis tenuifolia</i> (L.) DC.	Ch			
<i>Erophila verna</i> (L.) Chevall.	T			
<i>Eruca vesicaria</i> (L.) Cav. ssp. <i>sativa</i> (Mill.) Thell.	T			
<i>Hornungia petraea</i> (L.) Rchb.	T			
<i>Lepidium graminifolium</i> L.	H			
<i>Lunaria annua</i> L.	T			
<i>Sinapis alba</i> L.	T			
<i>Sinapis arvensis</i> L.	T			
<i>Thlaspi perfoliatum</i> L.	T			
Campanulaceae				
<i>Campanula rapunculus</i> L.	H			
<i>Campanula rapunculus</i> L. f. <i>verruculosa</i> Freyn	H			
<i>Legousia speculum-veneris</i> (L.) Chaix	T			
Caprifoliaceae				
<i>Lonicera etrusca</i> Santi	Ph			
<i>Lonicera implexa</i> Aiton	Ph			
<i>Lonicera xylosteum</i> L.	Ph			
Caryophyllaceae				
<i>Agrostemma githago</i> L.	T			
<i>Arenaria leptoclados</i> (Reichenb.) Guss.	T			
<i>Arenaria serpyllifolia</i> L.	T			
<i>Cerastium pumilum</i> Curtis ssp. <i>glutinatum</i> (Fries) Jalas	T			
<i>Dianthus ciliatus</i> Guss.	H			

<i>Dianthus sylvestris</i> Wulfen in Jacq. ssp. <i>tergestinus</i> (Reichenb.) Hayek	H	End	<i>Fumana ericifolia</i> Wallr.	Ch
<i>Herniaria glabra</i> L.	T		<i>Fumana procumbens</i> (Dunal) Gren. et Godr.	Ch
<i>Minuartia hybrida</i> (Vill.) Schischkin in Komarov	T		<i>Fumana thymifolia</i> (L.) Spach ex Webb	Ch
<i>Minuartia verna</i> (L.) Hiern	Ch		<i>Helianthemum nummularium</i> (L.) Mill.	Ch
<i>Petrorhagia saxifraga</i> (L.) Link	H		<i>Helianthemum salicifolium</i> (L.) Mill.	T
<i>Polycarpon tetraphyllum</i> (L.) L.	T		Clusiaceae	
<i>Sagina apetala</i> Ard.	T		<i>Hypericum perforatum</i> L.	H
<i>Sagina maritima</i> G. Don	T		<i>Hypericum perforatum</i> L. ssp. <i>veronense</i> (Schränk) H. Lindb.	H
<i>Silene dioica</i> (L.) Clairv.	H		Convolvulaceae	
<i>Silene gallica</i> L.	T		<i>Calystegia sepium</i> (L.) R. Br.	H
<i>Silene italica</i> (L.) Pers.	H		<i>Convolvulus althaeoides</i> L. ssp. <i>tenuissimus</i> (Sibth. et Sm.) Stace	H
<i>Silene latifolia</i> Poir. ssp. <i>alba</i> (Mill.) Greuter et Bourdet	H		<i>Convolvulus arvensis</i> L.	G
<i>Silene vulgaris</i> (Moench) Garcke	H		<i>Convolvulus cantabrica</i> L.	H
<i>Silene vulgaris</i> (Moench) Garcke ssp. <i>angustifolia</i> Hayek	H		Cornaceae	
<i>Spergularia salina</i> J. Presl et C. Presl	T		<i>Cornus sanguinea</i> L.	Ph
<i>Stellaria media</i> (L.) Vill.	T		Crossulaceae	
Celastraceae			<i>Sedum acre</i> L.	Ch
<i>Euonymus europaeus</i> L.	Ph		<i>Sedum hispanicum</i> L.	T
Chenopodiaceae			<i>Sedum ochroleucum</i> Chaix	Ch
<i>Amaranthus albus</i> L.	T		<i>Sedum sexangulare</i> L.	Ch
<i>Amaranthus retroflexus</i> L.	T	Inv	Dipsacaceae	
<i>Arthrocnemum fruticosum</i> (L.) Moq.	Ch		<i>Cephalaria leucantha</i> (L.) Roem. et Schult.	H
<i>Arthrocnemum macrostachyum</i> (Mor.) C. Koch	Ch		<i>Knautia illyrica</i> Beck	H
<i>Atriplex patula</i> L.	T		<i>Scabiosa columbaria</i> L.	H
<i>Atriplex prostrata</i> Boucher ex DC. in Lam. et DC.	T		<i>Scabiosa triandra</i> L.	H
<i>Beta vulgaris</i> L. ssp. <i>maritima</i> (L.) Arcang.	H		<i>Sixalix atropurpurea</i> (Forssk.) Greuter et Burdet ssp. <i>maritima</i> (L.) Greuter et Burdet	H
<i>Chenopodium album</i> L.	T		Ericaceae	
<i>Chenopodium murale</i> L.	T	DD	<i>Erica arborea</i> L.	Ph
<i>Halimione portulacoides</i> (L.) Aellen	Ch		Euphorbiaceae	
<i>Salicornia perennans</i> Willd. ssp. <i>perennans</i>	T		<i>Euphorbia chamaesyce</i> L.	T
<i>Salsola soda</i> L.	T	VU	<i>Euphorbia cyparissias</i> L.	G
<i>Suaeda maritima</i> (L.) Dumort.	T	VU	<i>Euphorbia esula</i> L.	H
Cichoriaceae			<i>Euphorbia exigua</i> L.	T
<i>Aetheorhiza bulbosa</i> (L.) Cass.	G		<i>Euphorbia fragifera</i> Jan	Ch
<i>Chondrilla juncea</i> L.	H		<i>Euphorbia helioscopia</i> L.	T
<i>Cichorium intybus</i> L.	H		<i>Euphorbia myrsinites</i> L.	Ch
<i>Crepis capillaris</i> (L.) Wallr.	T		<i>Euphorbia nicaeensis</i> All.	G
<i>Crepis neglecta</i> L.	T		<i>Euphorbia peploides</i> Gouan	T
<i>Crepis sancta</i> (L.) Babc.	T		<i>Euphorbia pinea</i> L.	Ch
<i>Crepis zacintha</i> (L.) Babc.	T		<i>Euphorbia prostrata</i> Aiton	T
<i>Hedypnois cretica</i> (L.) Dum.Cours.	T		<i>Mercurialis annua</i> L.	T
<i>Hieracium pilosella</i> L.	H		Fabaceae	
<i>Hieracium praealtum</i> Vill. ex Gochnat	H		<i>Anthyllis vulneraria</i> L. ssp. <i>praepropera</i> (A.Kern.) Bornm.	T
<i>Hieracium praealtum</i> Vill. ex Gochnat ssp. <i>bauhinii</i> (Besser) Petunn.	H		<i>Argyrobium zanonii</i> (Turra) P. W. Ball	Ch
<i>Lactuca serriola</i> L.	H		<i>Coronilla emerul</i> L. ssp. <i>emeroides</i> Boiss. et Spruner	Ph
<i>Leontodon crispus</i> Vill.	H		<i>Dorycnium hirsutum</i> (L.) Ser.	Ch
<i>Picris hieracioides</i> L.	H		<i>Hippocrepis comosa</i> L.	Ch
<i>Reichardia picroides</i> (L.) Roth	H		<i>Lathyrus annuus</i> L.	T
<i>Rhagadiolus stellatus</i> (L.) Gaertn.	T		<i>Lathyrus aphaca</i> L.	T
<i>Scolymus hispanicus</i> L.	T		<i>Lathyrus cicera</i> L.	T
<i>Scorzonera villosa</i> Scop.	G		<i>Lathyrus latifolius</i> L.	H
<i>Sonchus arvensis</i> L.	G		<i>Lathyrus ochrus</i> (L.) DC.	T
<i>Sonchus asper</i> (L.) Hill	T		<i>Lathyrus setifolius</i> L.	T
<i>Taraxacum laevigatum</i> auct. croat.	H		<i>Lotus angustissimus</i> L.	T
<i>Taraxacum officinale</i> Weber	H		<i>Lotus corniculatus</i> L. ssp. <i>corniculatus</i>	H
<i>Tragopogon porrifolius</i> L.	H		<i>Lotus corniculatus</i> L. ssp. <i>hirsutus</i> Rothm.	H
<i>Urospermum dalechampii</i> (L.) Scop. ex F.W.Schmidt	H		<i>Lotus cytisoides</i> L.	Ch
<i>Urospermum picroides</i> (L.) Scop. ex F.W.Schmidt	T		<i>Lupinus micranthus</i> Guss.	T
Cistaceae			<i>Marrubium incanum</i> Desr.	H
<i>Cistus incanus</i> L.	Ph		<i>Marrubium vulgare</i> L.	Ch
<i>Cistus monspeliensis</i> L.	Ph		<i>Medicago arabica</i> (L.) Huds.	T
			<i>Medicago arborea</i> L.	Ph
			<i>Medicago lupulina</i> L.	T
			<i>Medicago minima</i> (L.) Bartal.	T
			<i>Medicago orbicularis</i> (L.) Bartal.	T

<i>Medicago prostrata</i> Jacq.	H		<i>Satureja montana</i> L.	Ch
<i>Medicago sativa</i> L.	H		<i>Sideritis romana</i> L.	T
<i>Medicago truncatula</i> Gaertn.	T		<i>Stachys cretica</i> L. ssp. <i>salviifolia</i> (Ten.) Rech. f.	H
<i>Ononis antiquorum</i> (L.) Arcang.	Ch		<i>Stachys recta</i> L.	H
<i>Ononis reclinata</i> L.	T		<i>Stachys sylvatica</i> L.	H
<i>Ononis spinosa</i> L.	Ch		<i>Stachys thirkei</i> K.Koch	H
<i>Robinia pseudoacacia</i> L.	Ph	Inv	<i>Teucrium chamaedrys</i> L.	Ch
<i>Scorpiurus muricatus</i> L.	T		<i>Teucrium flavum</i> L.	Ch
<i>Securigera securidaca</i> (L.) Degen et Dörfl.	T		<i>Teucrium montanum</i> L.	Ch
<i>Spartium junceum</i> L.	Ph		<i>Teucrium polium</i> L.	Ch
<i>Trifolium angustifolium</i> L.	T		<i>Teucrium polium</i> L. ssp. <i>capitatum</i> (L.)	Ch
<i>Trifolium arvense</i> L.	T		Arcang.	
<i>Trifolium campestre</i> Schreber	T		<i>Thymus longicaulis</i> C.Presl	Ch
<i>Trifolium cherleri</i> L.	T		Lauraceae	
<i>Trifolium lappaceum</i> L.	T		<i>Laurus nobilis</i> L.	Ph
<i>Trifolium nigrescens</i> Viv.	T		Linaceae	
<i>Trifolium pratense</i> L.	H		<i>Linum bienne</i> Mill.	T
<i>Trifolium repens</i> L.	Ch		<i>Linum narbonense</i> L.	H
<i>Trifolium scabrum</i> L.	T		<i>Linum strictum</i> L. ssp. <i>corymbulosum</i> (Rchb.)	H
<i>Trifolium stellatum</i> L.	T		Riony	
<i>Trifolium subterraneum</i> L.	T		<i>Linum strictum</i> L. ssp. <i>strictum</i>	T
<i>Trigonella gladiata</i> M. Bieb.	T		<i>Linum usitatissimum</i> L.	T
<i>Vicia bithynica</i> (L.) L.	T		Lythraceae	
<i>Vicia cracca</i> L.	H		<i>Lythrum salicaria</i> L.	H
<i>Vicia hirsuta</i> (L.) Gray	T		Malvaceae	
<i>Vicia hybrida</i> L.	T		<i>Malva sylvestris</i> L.	H
<i>Vicia lutea</i> L.	T		Moraceae	
<i>Vicia parviflora</i> Cav.	T		<i>Ficus carica</i> L.	Ph
<i>Vicia sativa</i> L. s.l.	T		Myrtaceae	
<i>Vicia sativa</i> L. ssp. <i>cordata</i> (Hope) Batt.	T		<i>Myrtus communis</i> L.	Ph
<i>Vicia villosa</i> Roth	T		Oleaceae	
Fagaceae			<i>Fraxinus ornus</i> L.	Ph
<i>Quercus ilex</i> L.	Ph		<i>Ligustrum vulgare</i> L.	Ph
<i>Quercus pubescens</i> Willd.	Ph		<i>Olea europaea</i> L.	Ph
Fumariaceae			<i>Olea europaea</i> L. var. <i>sylvestris</i> Brot.	Ph
<i>Fumaria officinalis</i> L.	T		<i>Phillyrea latifolia</i> L.	Ph
Gentianaceae			<i>Phillyrea media</i> L.	Ph
<i>Blackstonia perfoliata</i> (L.) Huds.	T		Oxalidaceae	
<i>Centaureum erythraea</i> Rafn	H		<i>Oxalis corniculata</i> L.	H
<i>Centaureum tenuiflorum</i> (Hoffmanns. et Link)	T		<i>Oxalis deppei</i> Loddiges ex Sweet	H
Fritsch			Papaveraceae	
Geraniaceae			<i>Papaver hybridum</i> L.	T
<i>Erodium acaule</i> (L.) Becherer et Thell.	H		<i>Papaver rhoeas</i> L.	T
<i>Erodium cicutarium</i> (L.) L. Hér.	T		Phytolaccaceae	
<i>Geranium columbinum</i> L.	T		<i>Phytolacca americana</i> L.	G
<i>Geranium dissectum</i> L.	T		Plantaginaceae	
<i>Geranium molle</i> L.	T		<i>Plantago bellardii</i> All.	T
<i>Geranium purpureum</i> Vill.	T		<i>Plantago coronopus</i> L.	T
<i>Geranium robertianum</i> L.	T		<i>Plantago holosteum</i> Scop.	H
<i>Geranium rotundifolium</i> L.	T		<i>Plantago lagopus</i> L.	T
Globulariaceae			<i>Plantago lanceolata</i> L.	H
<i>Globularia punctata</i> Lapeyr.	H		<i>Plantago major</i> L.	H
Lamiaceae			Plumbaginaceae	
<i>Acinos arvensis</i> (Lam.) Dandy	T		<i>Limonium cancellatum</i> (Bernh. ex Bertol.)	H
<i>Ajuga chamaepitys</i> (L.) Schreb.	T		Kuntze	End
<i>Ajuga genevensis</i> L.	H		<i>Limonium narbonense</i> Mill.	H
<i>Betonica officinalis</i> L. ssp. <i>serotina</i> (Host)	H		<i>Limonium virgatum</i> (Willd.) Fourr.	H
Murb.			Polygalaceae	DD
<i>Calamintha nepetoides</i> Jord.	H		<i>Polygala nicaeensis</i> Risso ex Koch	H
<i>Lamium amplexicaule</i> L.	T		<i>Polygonum aviculare</i> L.	T
<i>Lamium hybridum</i> Vill.	T		<i>Rumex crispus</i> L.	H
<i>Lamium purpureum</i> L.	T		<i>Rumex pulcher</i> L.	T
<i>Melissa officinalis</i> L.	H		Portulacaceae	
<i>Micromeria juliana</i> (L.) Benth. ex Rchb.	Ch		<i>Portulaca oleracea</i> L.	T
<i>Prasium majus</i> L.	Ch		Primulaceae	
<i>Prunella laciniata</i> (L.) L.	H		<i>Anagallis arvensis</i> L.	T
<i>Salvia bertolonii</i> Vis.	H		<i>Anagallis coerulea</i> Schreb.	T
<i>Salvia officinalis</i> L.	Ch		<i>Asterolinon linum-stellatum</i> (L.) Duby	T
<i>Salvia pratensis</i> L.	H		Ranunculaceae	
<i>Salvia verbenaca</i> L.	H		<i>Anemone hortensis</i> L.	G

<i>Clematis flammula</i> L.	Ph		<i>Solanum tuberosum</i> L.	T	
<i>Clematis vitalba</i> L.	Ph		Ulmaceae		
<i>Ranunculus ficaria</i> L.	G		<i>Celtis australis</i> L.	Ph	
<i>Ranunculus muricatus</i> L.	T		<i>Ulmus minor</i> Miller	Ph	
<i>Ranunculus neapolitanus</i> Ten.	H		Urticaceae		
<i>Ranunculus paludosus</i> Poir.	H		<i>Parietaria judaica</i> L.	H	
<i>Ranunculus parviflorus</i> L.	T		Valerianaceae		
Resedaceae			<i>Valerianella echinata</i> (L.) DC.	T	
<i>Reseda lutea</i> L.	H		<i>Valerianella locusta</i> (L.) Laterrade	T	
Rhamnaceae			Verbenaceae		
<i>Paliurus spina-christi</i> Mill.	Ph		<i>Verbena officinalis</i> L.	T	
<i>Rhamnus alaternus</i> L.	Ph		<i>Vitex agnus-castus</i> L.	Ph	
<i>Rhamnus intermedius</i> Steud. et Hohst.	Ph	End	Violaceae		
Rosaceae			<i>Viola hirta</i> L.	H	
<i>Agrimonia eupatoria</i> L.	H		<i>Viola suavis</i> M.Bieb.	H	
<i>Crataegus monogyna</i> Jacq.	Ph		Lilianaes		
<i>Filipendula vulgaris</i> Moench	H		Amaryllidaceae		
<i>Potentilla cinerea</i> Chaix ex Vill.	H		<i>Allium chamaemoly</i> L.	G	
<i>Potentilla hirta</i> L.	H		<i>Allium commutatum</i> Guss.	G	
<i>Potentilla recta</i> L.	H		<i>Allium flavum</i> L.	G	
<i>Prunus domestica</i> L. ssp. <i>insititia</i> (L.) C. K. Schneid.	Ph		<i>Allium moschatum</i> L.	G	
<i>Prunus spinosa</i> L.	Ph		<i>Allium neapolitanum</i> Cirillo	G	
<i>Pyracantha coccinea</i> M. J. Roemer	Ph		<i>Allium roseum</i> L.	G	
<i>Pyrus amygdaliformis</i> Vill.	Ph		<i>Allium lusitanicum</i> Lam.	G	
<i>Rosa canina</i> L.	Ph		<i>Allium sphaerocephalon</i> L.	G	
<i>Rosa sempervirens</i> L.	Ph		<i>Allium tenuiflorum</i> Ten.	G	
<i>Rubus ulmifolius</i> Schott	Ph		<i>Narcissus pseudonarcissus</i> L.	G	
<i>Sanguisorba minor</i> Scop. ssp. <i>muricata</i> Briq.	H		<i>Narcissus tazetta</i> L.	G	
<i>Sorbus domestica</i> L.	Ph		Araceae		
Rubiaceae			<i>Arum italicum</i> Mill.	G	
<i>Asperula aristata</i> L.f.	H		Asparagaceae		
<i>Asperula aristata</i> L.f. ssp. <i>scabra</i> (J.Presl et C.Presl) Nyman	H		<i>Asparagus acutifolius</i> L.	G	
<i>Asperula cynanchica</i> L.	H		<i>Asphodelus aestivus</i> Brot.	G	
<i>Cruciata laevipes</i> Opiz	H		Cymodoceaceae		
<i>Galium aparine</i> L.	T		<i>Cymodocea nodosa</i> (Ucria) Asch.	Hy	
<i>Galium corrudifolium</i> Vill.	H		Cyperaceae		
<i>Galium lucidum</i> All.	H		<i>Carex caryophyllea</i> Latourr.	H	
<i>Galium mollugo</i> L.	H		<i>Carex distachya</i> Desf.	H	
<i>Rubia peregrina</i> L.	Ph		<i>Carex divisa</i> Huds.	G	EN
<i>Sherardia arvensis</i> L.	T		<i>Carex extensa</i> Gooden.	H	EN
<i>Valantia muralis</i> L.	T		<i>Carex flacca</i> Schreb.	G	
Rutaceae			<i>Carex hallerana</i> Asso	H	
<i>Ruta graveolens</i> L.	Ch		<i>Carex muricata</i> L.	H	
Santalaceae			<i>Carex sylvatica</i> Huds.	H	
<i>Osyris alba</i> L.	Ph		<i>Schoenus nigricans</i> L.	H	
Saxifragaceae			Dioscoreaceae		
<i>Saxifraga tridactylites</i> L.	T		<i>Tamus communis</i> L.	G	
Scrophulariaceae			Iridaceae		
<i>Bellardia trixago</i> (L.) All.	T		<i>Crocus reticulatus</i> Steven ex Adams	G	
<i>Cymbalaria muralis</i> P.Gaertn., B.Mey. et Scherb.	T		<i>Gladiolus illyricus</i> W.D.J.Koch	G	
<i>Kickxia commutata</i> (Bernh. ex Rchb.) Fritsch	Ch		<i>Iris germanica</i> L.	G	
<i>Odontites lutea</i> (L.) Clairv.	T		<i>Romulea bulbocodium</i> (L.) Sebast. et Mauri	G	
<i>Parentucellia latifolia</i> (L.) Caruel	T		Juncaceae		
<i>Scrophularia canina</i> L.	H		<i>Juncus acutus</i> L.	H	
<i>Scrophularia canina</i> L. ssp. <i>bicolor</i> (Sibth. et Sm.) Greuter	H		<i>Juncus maritimus</i> Lam.	G	
<i>Verbascum phoeniceum</i> L.	H		Lemnaceae		
<i>Verbascum sinuatum</i> L.	H		<i>Lemna gibba</i> L.	Hy	EN
<i>Veronica arvensis</i> L.	T		Liliaceae		
<i>Veronica chamaedrys</i> L.	H		<i>Muscari comosum</i> (L.) Mill.	G	
<i>Veronica persica</i> Poir.	T	Inv	<i>Muscari neglectum</i> Guss. ex Ten.	G	
Simaroubaceae			<i>Ornithogalum comosum</i> L.	G	
<i>Ailanthus altissima</i> (Mill.) Swingle	Ph	Inv	<i>Ornithogalum kochii</i> Parl.	G	LC
Solanaceae			<i>Ornithogalum sphaerocarpon</i> A.Kern.	G	
<i>Datura stramonium</i> L.	T	Inv	<i>Ruscus aculeatus</i> L.	Ch	
<i>Solanum dulcamara</i> L.	Ph		<i>Scilla autumnalis</i> L.	G	
<i>Solanum nigrum</i> L.	T		Orchidaceae		
			<i>Limodorum abortivum</i> (L.) Sw.	G	
			<i>Ophrys apifera</i> Huds.	G	EN
			<i>Ophrys incantata</i> Devillers et Devillers-Tersch.	G	End
			<i>Ophrys incubacea</i> Bianca	G	

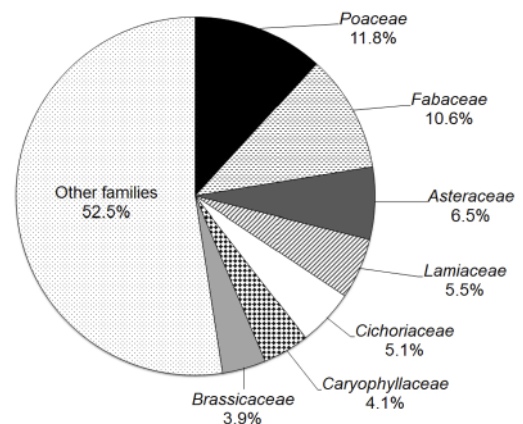
<i>Ophrys medea</i> Devillers et Devillers-Tersch.	G	End	<i>Desmazeria rigida</i> (L.) Tutin	T
<i>Ophrys untchjii</i> (M.Schulze) P.Delforge	G	End	<i>Echinochloa crus-galli</i> (L.) P.Beauv.	T
<i>Orchis italica</i> Poir.	G	EN	<i>Elymus hispidus</i> (Opiz) Melderis	H
<i>Orchis morio</i> L. ssp. <i>morio</i>	G	NT	<i>Elymus pycnanthus</i> (Godr.) Melderis	G
<i>Orchis morio</i> L. ssp. <i>picta</i> (Loisel.) K.Richt.	G		<i>Festuca lapidosa</i> (Degen) Markgr.-Dann.	End
<i>Orchis papilionacea</i> L.	G	VU	<i>Festuca rupicola</i> Heuff.	H
<i>Orchis provincialis</i> Balb. ssp. <i>pauciflora</i> (Ten.) Camus	G		<i>Gastridium ventricosum</i> (Gouan) Schinz et Thell.	T
<i>Orchis simia</i> Lam.	G	VU	<i>Holcus lanatus</i> L.	H
<i>Orchis tridentata</i> Scop.	G	VU	<i>Hordeum bulbosum</i> L.	H
<i>Orchis x gennarii</i> Rchb.f.	G		<i>Hordeum murinum</i> L. ssp. <i>leporinum</i> (Link) Arcang.	T
<i>Serapias lingua</i> L.	G		<i>Hyparrhenia hirta</i> (L.) Stapf	H
<i>Serapias x todaroi</i> Tineo	G		<i>Koeleria australis</i> A.Kern.	H
<i>Spiranthes spiralis</i> (L.) Chevall.	G		<i>Koeleria splendens</i> C.Presl	H
Poaceae			<i>Lagurus ovatus</i> L.	T
<i>Aegilops neglecta</i> Req. ex Bertol.	T		<i>Lolium perenne</i> L.	H
<i>Aegilops triuncialis</i> L.	T		<i>Lolium rigidum</i> Gaudin	T
<i>Aegilops uniaristata</i> Vis.	T	NT	<i>Lophochloa cristata</i> (L.) Hyl.	T
<i>Agrostis stolonifera</i> L.	H		<i>Melica ciliata</i> L.	H
<i>Aira elegantissima</i> Schur	T		<i>Parapholis incurva</i> (L.) C.E.Hubb.	T
<i>Anthoxanthum odoratum</i> L.	H		<i>Phalaris canariensis</i> L.	T
<i>Arundo donax</i> L.	G		<i>Phleum echinatum</i> Host	T
<i>Avena barbata</i> Pott ex Link	T		<i>Phleum pratense</i> L.	H
<i>Avena sterilis</i> L.	T		<i>Piptatherum miliaceum</i> (L.) Coss.	H
<i>Brachypodium distachyon</i> (L.) P.Beauv.	T		<i>Poa annua</i> L.	T
<i>Brachypodium sylvaticum</i> (Huds.) P.Beauv.	H		<i>Poa bulbosa</i> L.	H
<i>Briza maxima</i> L.	T		<i>Poa compressa</i> L.	H
<i>Bromus erectus</i> Huds.	H		<i>Poa infirma</i> Kunth	T
<i>Bromus hordeaceus</i> L. ssp. <i>hordeaceus</i>	T		<i>Poa pratensis</i> L.	G
<i>Bromus madritensis</i> L.	T		<i>Sclerochloa dura</i> (L.) P.Beauv.	T
<i>Bromus sterilis</i> L.	T		<i>Sesleria autumnalis</i> (Scop.) F.W.Schultz	H
<i>Chrysopogon gryllus</i> (L.) Trin.	H		<i>Setaria viridis</i> (L.) P.Beauv.	T
<i>Cynodon dactylon</i> (L.) Pers.	G		<i>Sorghum halepense</i> (L.) Pers.	G
<i>Cynosurus echinatus</i> L.	T		<i>Stipa bromoides</i> (L.) Dörf.	H
<i>Dactylis glomerata</i> L. ssp. <i>glomerata</i>	H		<i>Vulpia ciliata</i> Dumort.	T
<i>Dactylis glomerata</i> L. ssp. <i>hispanica</i> (Roth) Nyman	H		<i>Zea mays</i> L.	T
<i>Dasypyrum villosum</i> (L.) P.Candargy	T		Smilacaceae	
<i>Desmazeria marina</i> (L.) Druce	T	VU	<i>Smilax aspera</i> L.	Ph
<i>Desmazeria pauciflora</i> Merino	T			

Table 2. Flora analysis of Gornji Kamenjak area by systematic categories

Section Subclass	Monilophyta		Spermatophyta		
	<i>Psilotidae</i>	<i>Polypodiidae</i>	<i>Gymnospermae</i>	<i>Angiospermae</i>	
			<i>Pinidae</i>	<i>Eudicotyledonae</i>	<i>Lilianaee</i>
Family	1	1	2	60	13
Genus	1	1	2	221	66
Species	1	4	4	349	111
Subspecies				33	6
Total taxa (%)	5 (0.9%)		4 (0.8%)	381 (75.2%)	
				117 (23.0%)	

The representation of genera, species and subspecies within the respective families is shown in Fig. 2. According to the number of species and subspecies, the most represented were *Poaceae* (11.8%), followed by *Fabaceae* (10.6%), *Asteraceae* (6.5%) and *Lamiaceae* (5.5%).

Figure 2. Proportion of the most abundant families recorded in the area of Gornji Kamenjak.



Analysis of life forms (Fig. 3) shows a high ratio of therophytes (37.0%) and hemicryptophytes (30.8%), followed by percentage of geophytes (12.6%).

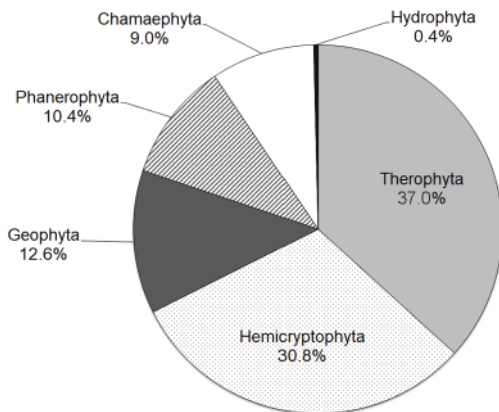


Figure 3. Spectrum of life forms recorded in the area of Gornji Kamenjak.

Discussion

The flora of the wider area of Donji Kamenjak, known also as Rt Kamenjak in the southernmost part of Istria was previously investigated by numerous authors including Tommasini (1873), Freyn (1877), Topić (1994, 1997), Topić et al. (1998), Starmühler (1998, 2004, 2010), Topić and Šegulja (2000) and Vuković et al. (2011, 2013). Former studies have identified more than 430 vascular plant taxa in this area. On the other hand, flora of the adjacent Gornji Kamenjak has never been a subject of systematic investigation and we here provide for the first time a detailed flora inventory that consists of a total of 507 vascular plant taxa recorded during this study.

The flora richness of the investigated area is high, in comparison to several Croatian islands, islets and reefs along the eastern Adriatic coast (Nikolić et al., 2008), especially considering the size of the area. The vascular flora of Gornji Kamenjak has a high biodiversity in terms of number of plant species; 507 plant taxa (468 species and 39 subspecies) have been recorded across the area of only 380 hectares. These results are comparable to Mediterranean territories of similar size, which are characterized by a great variety of habitats and a rather complex geomorphology (Gianguzzi et al., 2006; Minissale et al., 2007; Nikolić et al., 2008).

The domination of therophytes (187 species, 37.0%) indicates that the climate of the area of Gornji Kamenjak is typical Mediterranean (Horvat, 1949). Furthermore, therophytes were also well represented within the grassland communities indicating the aridity and Mediterranean climate of this region (Rauš and Šegulja, 1983; Tomašević, 2006) and considerable anthropogenic influence (Mitić et al., 2007). The high percentages of observed therophytes (37.0%) and hemicryptophytes (30.8%), congruent with other studies (Bogdanović and Mitić, 2003; Sciandrello et al., 2014), can be related to the considerable diffusion of seminatural habitats, such as dry grasslands, originated by anthropogenic disturbance, and uncultivated land. The area of Gornji Kamenjak can be compared with the North Adriatic islands (Cres, Krk and Pag) investigated

by Ljubičić (2012), as well as with some other Mediterranean areas (Giardina et al., 2007; Raimondo et al., 1994; Sciandrello et al., 2014), where there are not significant differences between percentages of life form spectrum. Habitats with low intensity of sheep grazing or high intensity of land abandonment are often subjected to the process of progressive succession where phanerophytes suppress therophytes (Škornik et al., 2010; Ljubičić, 2012). It is interesting that sheep grazing is not present in the area of Gornji Kamenjak. However, we found a high percentage of therophytes similarly to other Mediterranean regions (Melendo et al., 2003; Ljubičić, 2012). The share of 12.6% of geophytes is mostly related to plant taxa that grow in forest communities in the area of Gornji Kamenjak.

Intentional or unintentional human activity in recent periods helped in spreading invasive adventive plants in the autochthonous flora. Like other European countries, Croatia has been facing the increased problem of invasive alien species. Up to now, 74 invasive alien plant taxa have been recorded in Croatia (Boršić et al., 2008; Nikolić et al., 2014; Nikolić, 2018). On the area of Gornji Kamenjak, 11 invasive taxa were recorded (*Ailanthus altissima*, *Amaranthus retroflexus*, *Conyza canadensis*, *Datura stramonium*, *Euphorbia prostrata*, *Phytolacca americana*, *Robinia pseudoacacia*, *Sorghum halepense*, *Veronica persica*, *Xanthium spinosum* and *Xanthium strumarium* ssp. *italicum*), accounting for 14% of the total number of invasive plant taxa in Croatia. The fact that these invasive taxa are found in a relatively small area points out to the scale and is currently not posing any serious threats to the studied area. The species *Ailanthus altissima* is very aggressive due to the toxins that prevent growth of other species (allelopathy). This species usually forms dense populations, however we observed only a few individuals within the area of Gornji Kamenjak. The species *R. pseudoacacia* also represents a threat to the surrounding vegetation where it grows because of great dominance over indigenous taxa, while *Xanthium* taxa occurs sporadically in agricultural habitats such as vegetable gardens. Other invasive taxa such as *Amaranthus retroflexus*, *Conyza canadensis*, *Phytolacca americana*, *Sorghum halepense* and *Veronica persica* occur along roads, paths, abandoned agricultural land and similar ruderal habitats of Gornji Kamenjak.

According to the IUCN (International Union for Conservation of Nature) Threats Classification Scheme a total of 15 endangered plant species (Tab. 1), included in the online Red book of vascular flora of Croatia (Nikolić, 2018), were recorded in flora of Gornji Kamenjak. The species *Papaver hybridum*, *Lathyrus ochrus* and *Ophioglossum lusitanicum* are critically endangered (CR), *Carex divisa*, *C. extensa*, *Lemna gibba*, *Ophrys apifera* and *Orchis italica* are endangered (EN), while *Desmazeria marina*, *Orchis papilionacea*, *O. simia*, *O. tridentata*, *Parapholis incurva*, *Salsola soda* and *Suaeda maritima* are vulnerable (VU). In Croatian flora the largest share of endangered species belongs to the family *Orchidaceae* (Hršak, 2000; Bogdanović, 2004; Delforge, 2006; Nikolić, 2018), as well as in the wider area of Kamenjak (Kranjčev, 2005; Vuković, et al. 2011; 2013). Vuković et al. (2013) have found a very rare species *Ophrys speculum* growing along the macadam road running through the garrigue vegetation of the order *Cisto-Ericetalia* H-ić. 1958 in the area of Donji Kamenjak. Unfortunately, this species was not recorded during our study in the area of Gornji Kamenjak. Due to its specific climatological position, habitat diversity and other influences we can expect that the investigated area harbors more species than currently recorded.



Figure 4. Flowers of stenoendemic orchids, A – *Ophrys incantata* Devillers et Devillers-Tersch, B – *Ophrys untchjii* (M.Schulze) P.Delforge and C – *Ophrys medea* Devillers et Devillers-Tersch.

The area of Donji Kamenjak is known as one of the “Orchid islands” in Croatia due to high orchid richness (Kranjčev, 2005). Among others, we have found three stenoendemic orchids (*Ophrys incantata*, *Ophrys untchjii* and *Ophrys medea*) with very restricted distribution. The species *O. incantata* (Fig. 4A) is known from central and southern Dalmatia and our finding in southern Istria represents new locality outside the currently known Croatian distribution. The species *O. untchjii* (Fig. 4B) is described and already known from Istria and Kvarner archipelago, nevertheless the occurrence in the flora of Gornji Kamenjak is rather rare and sporadic, as well as the occurrence of the species *O. medea* (Fig. 4C).



Figure 5. Inflorescence of *Orchis* × *gennarii* Rchb. f.

The analysis of vascular flora of Gornji Kamenjak shows the occurrence of some very rare plant species in Croatian flora. Among them is a hybrid taxon *Serapias* × *todaroi* (= *S. parviflora* × *S. lingua*) of which we found only few individuals in the region of Kunfin. This is a very rare finding of this species for the Croatian flora. This taxon has been previously recorded at the islands of Mljet, Dugi Otok and Korčula (Šegota et al., 2012; Jeričević and Jeričević, 2016).

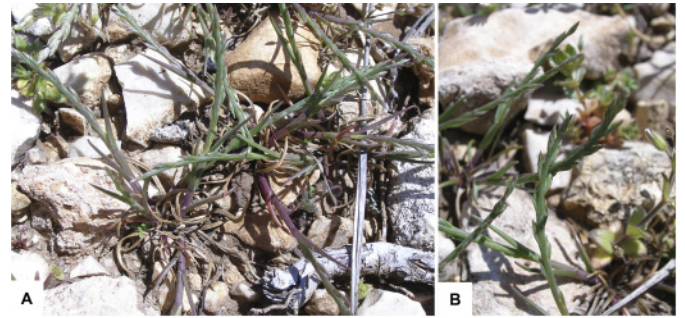


Figure 6. *Desmazeria pauciflora* Merino, A – habitus, B – inflorescence.

Another hybrid orchid worth mentioning is *Orchis* × *gennarii* (= *O. morio* × *O. papilionacea*), of which we found only few individuals (Fig. 5) in the vicinity of the village Volme at Monte Cope. A population of grass species *Desmazeria pauciflora* (Fig. 6A, B) we found in four localities in whole area of Kamenjak (Valmižeja, Crvene stine, Premanturski školjić and islet Ceja). This species has been found and cited as *Catapodium pauciflorum* (Merino) Brullo, Giusso, Miniss. & Spamp. for the first time in Croatian flora by Skelin et al. (2014) on the islet of Zečevo in Hvar archipelago. Afterwards it was recorded in Sabunike near the town of Nin and on the islands of Vis and Pag (Nikolić 2018). *Desmazeria pauciflora* is morphologically very similar to *D. marina* but it differs in having smaller spikelets (4-5.5 × 1.4-2 mm) that are closely appressed to inflorescence rachis (Brullo et al. 2003). The occurrence of *D. pauciflora* could be expected elsewhere along the eastern Adriatic coast and islands. During this floristic research we have found and confirmed a very rare and critically endangered fern species *Ophioglossum lusitanicum* that has not been recorded previously by Topić and Šegulja (2000) during their thoroughly botanical research of the southernmost part of Kamenjak but was recorded in recent times on Donji and Gornji Kamenjak by Brana et al. (2014). *Ophioglossum lusitanicum* was already noted for Kamenjak by Freyn (1877) and confirmed later by Blečić and Mayer in 1975 based on herbarium specimen that is deposited in Herbarium ZA-5527. Our study confirmed the occurrence of this very rare species in the area of Kunfin.

Conclusion

In the period from 2012 to 2013 flora inventory of Significant Landscape Gornji Kamenjak was carried out and a total of 507 vascular plant taxa (468 species and 39 subspecies) were recorded. The studied area was poorly investigated in the past, therefore there was the need for this study, representing a very detailed floristic survey of the area. This research confirmed the recent findings by other authors of very rare and critically endangered species of ferns (*Ophioglossum lusitanicum*). Prevalence of Mediterranean floral elements and the dominance of therophytes indicate influence of typical Mediterranean climate on the area of Gornji Kamenjak. The flora richness of the investigated area was high, particularly in comparison with several islands, islets and reefs along the eastern Adriatic coast, especially considering the size of the areas. Given that, on the area of Gornji Kamenjak we have recorded 11 invasive, 13 endemic and 15 endangered plant taxa. Endangered plant taxa belong primarily to orchid family.

References

- Anonymous (1996). Odluka o zaštiti područja donjeg Kamenjaka i medulinskog arhipelaga kao zaštićenog krajolika (Decision on the protection of areas of Lower Kamenjak and the Medulin archipelago as a protected landscape). Official Journal of the Istrian County No. 05/96.
- Anonymous (2013). Zakon o zaštiti prirode (Nature protection act). Official Gazette No. 80/2013.
- Bogdanović S., Mitić B. (2003). The flora of the volcanic island of Brusnik (central Dalmatia, Croatia). *Acta Bot. Croat.* 62(2): 103-113
- Bogdanović S. (2004). *Orchidaceae*. In: Bogdanović S., Nikolić T. (eds.), *Notulae ad Indicem Florae Croatiae* 4. *Nat. Croat.* 13: 407-420
- Bogdanović S., Britvec M., Ljubičić I., Dujmović Purgar D., Vitasović Kosić I. (2016). Herbarium ZAGR of the Faculty of Agriculture (Zagreb, Croatia). *Agric. conspec. sci.* 81(1): 1-5
- Boršić I., Milović M., Dujmović I., Bogdanović S., Cigić P., Rešetnik I., Nikolić T., Mitić B. (2008). Preliminary check-list of invasive alien plant species in Croatia. *Nat. Croat.* 17(2): 55-71
- Brana S., Vuković N., Kaligarić M. (2014). Least adder's-tongue (*Ophioglossum lusitanicum* L.) in Croatia – distribution, ecology and conservation. *Acta Bot. Croat.* 73(2): 471-480
- Brullo S., Giusso del Galdo G., Minissale P., Spampinato G. (2003). Considerazioni tassonomiche sui generi *Catapodium* Link, *Desmazeria* Dumort. e *Castellia* Tineo (Poaceae) in Italia. *Inform. Bot. Ital.* 35(1): 158-170
- Delforge P. (2006). *Orchids of Europe, North Africa and the Middle East*. Timber Press, Oregon
- Frey J. (1877). Die Flora von Süd Istrien. *Ver. Zool.-Bot. Ges. Wien* 27: 241-490
- Gianguzzi L., Scuderi L., Pasta S. (2006). The vascular flora of Marettimo island (Egadi Archipelago, Sicily Channel): update and phytogeographical analysis. *Webbia* 61: 359-402
- Giardina G., Raimondo F.M., Spadaro V. (2007). A catalogue of plants growing in Sicily. *Bocconea* 20:5-582
- Horvat I. (1949). *Nauka o biljnim zajednicama*. Nakladni zavod Hrvatske, Zagreb
- Hršak V. (1994). *Ophioglossaceae*. In Nikolić T. (Edit.): *Flora Croatica. Index Florae Croatiae*. *Nat. Croat.* 3: 32-33
- Hršak V. (2000). *Orchidaceae*. In: Nikolić T. (ed.), *Flora Croatica. Index Florae Croatiae* 3. *Nat. Croat.* 9(1): 163-173
- Hršak V., Brana S., Sedlar Z., Pejić I. (2011). Morphometric and molecular (RAPD) analysis of six *Serapias* taxa from Croatia. *Biologia* 66: 55-63
- Jeričević M., Jeričević N. (2016). Distribution of the *Serapias* species on the island of Korčula. 5th Croatian Botanical Symposium with international participation. Croatian Botanical Society, Primošten, 178
- Kranjčev R. (2005). Hrvatske orhideje. Agencija za komercijalnu djelatnost d.o.o., Zagreb
- Ljubičić I. (2012). Utjecaj ovčje ispaše na biljnu raznolikost kamenjarskih pašnjaka sjevernojadrijskih otoka. Doktorska disertacija. Sveučilište u Zagrebu, Prirodoslovno-matematički fakultet, Zagreb
- Melendo M., Giménez E., Cano E., Gómez-Mercado F., Valle F. (2003). The endemic flora in the south of the Iberian Peninsula: taxonomic composition, biological spectrum, pollination, reproductive mode and dispersal. *Flora* 198:260-276
- Minissale P., Sciandrello S., Spampinato G. (2007). Plant biodiversity analysis and mapping of the Nature Oriented Reserve "Pantalica, Valle dell'Anapo e Cava Grande" (south-eastern Sicily). *Quad. Bot. Amb. Appl.* 18:241-303
- Mitić B., Kajfeš A., Cigić P., Rešetnik I. (2007). The flora of Stupnik and its surroundings (Northwest Croatia). *Nat. Croat.* 16: 147-169
- Nikolić T. (2006). Priručnik za inventarizaciju i praćenje stanja. Državni zavod za zaštitu prirode, Zagreb
- Nikolić T. (2013). Sistematska botanika: Raznolikost i evolucija biljnog svijeta. ALFA d.d., Zagreb
- Nikolić T., ed. (2018). *Flora Croatica Database*. <http://hirc.botanic.hr/fcd> (accessed: 19 January 2015)
- Nikolić T., Antonić O., Alegro A.L., Dobrović I., Bogdanović S., Liber Z., Rešetnik I. (2008). Plant species diversity of Adriatic islands: An introductory survey. *Pl. Biosystems* 142(3): 435-445
- Nikolić T., Bukovec D., Šopf J., Jelaska S.D. (1998). Kartiranje flore Hrvatske – mogućnosti i standardi. *Nat. Croat. Suppl.* 1(7): 1-62
- Nikolić T., Topić J. (2005). Crvena knjiga vaskularne flore Republike Hrvatske. Kategorije EX, RE, CR, EN i VU. Ministarstvo kulture, Državni zavod za zaštitu prirode, Zagreb
- Nikolić T., Topić J., Vuković N. (2010). Botanički važna područja Hrvatske. Školska knjiga, Zagreb
- Nikolić T., Mitić B., Boršić I. (2014). *Flora Hrvatske – Invazivne biljke*. Alfa d.d., Zagreb
- Nikolić T., Milović M., Bogdanović S., Jasprica N. (2015). *Endemi u hrvatskoj flori*. Alfa d.d., Zagreb
- Perko M.L. (1998). Ergänzungen zur Flora von Istrien (Kroatien/Hrvatska): *Serapias istriaca* M. L. Perko, spec. nov. und *Serapias x pulae* M. L. Perko, nothospec. nat. nov. (Orchidaceae). *Ber. Arbeitskreis. Heimische Orchid.* 15: 13-27
- Pignatti S. (1982). *Flora d'Italia I-III*. Edagricole, Bologna
- Raimondo F.M., Domina G., Spadaro V. (1994). Checklist of the vascular flora of Sicily. *Quad. Bot. Amb. Appl.* 21:189-252
- Raunkiaer C. (1934). *The Life Forms of Plants and Statistical Plant Geography*, being the collected papers of C. Raunkaer. Reprinted 1978 (ed. by Frank N. Egerton), Oxford University Press, Oxford
- Rauš Đ., Šegulja N. (1983). The flora of Slavonia and Baranya (in Croatian). *Glasnik za šumske pokuse* 21: 179-211
- Sciandrello S., D'Agostino S., Minissale P. (2014). The vascular flora of the Taormina Region (Peloritani Mountains – northeast Sicily). *Webbia* 69(2): 301-324
- Skelin M., Ljubičić I., Skelin I., Vitasović Kosić I., Bogdanović S. (2014). The Flora of Zečevo (Hvar Archipelago, Croatia). *Agric. conspec. sci.* 79(2): 85-91
- Starmühler W. (ed.) (1998). Vorarbeiten zu einer »Flora von Istrien« 1. *Carinthia II* 188/108: 535-576
- Starmühler W. (ed.) (2004). Vorarbeiten zu einer »Flora von Istrien« 7. *Carinthia II* 194/114: 591-651
- Starmühler W. (ed.) (2010). Vorarbeiten zu einer »Flora von Istrien« 13. *Carinthia II* 200/120: 465-524
- Šegota V., Hršak V., Bogdanović S., Alegro A., Besendorfer V. (2012). Hybridogenous origin of *Serapias x todaroi* Tineo: morphological and karyological evidences. In: Rešetnik I., Bogdanović S., Alegro A. (ed.) *International Symposium on "Evolution of Balkan Biodiversity"*. Zagreb: BalkBioDiv Consortium and Croatian Botanical Society, p. 42
- Škorić A., Bogunović M. (1987). Geografija tala. In Škorić A. (Edit.): *Pedosfera Istre (sa pedološkom kartom)*. Projektni savjet pedološke karte Hrvatske, Posebna izdanja, knjiga 2, Zagreb
- Škornik S., Vidrih M., Kaligarić M. (2010). The effect of grazing pressure on species richness, composition and productivity in North Adriatic Karst pastures. *Pl. Biosystems* 144(2): 355-364
- Tomašević M. (2006). A new contribution to the flora of the Požega Valley and the surrounding mountains. *Nat. Croat.* 15: 43-60
- Tommasini M.R. (1873). Die Flora des südlichsten Theiles von Istrien bei Promontore und Medolino. *Oesterr. Bot. Z.* 23: 169-177, 219-227, 257-260
- Topić J. (1994). A new locality of *Convolvulus lineatus* L. in Croatia. *Acta Bot. Croat.* 53: 141-143
- Topić J. (1997). *Anthemis tomentosa* L. (Asteraceae): a new species in Croatian flora. *Nat. Croat.* 6: 119-123
- Topić J., Ilijanić Lj., Šegulja N. (1998). *Erodium acaule* (L.) Becherer (Geraniaceae), a new species in Croatian flora. *Nat. Croat.* 7: 359-362
- Topić J., Šegulja N. (2000). Floristic and ecological characteristics of the southernmost part of Istria (Croatia). *Acta Bot. Croat.* 59: 179-200
- Vidaček Ž. (1979). Osnovna pedološka karta sekcije Pula 1, mjerila 1:50 000. Projektni savjet za izradu pedološke karte SR Hrvatske, Zagreb
- Vuković N., Brana S., Mitić B. (2011). Orchid diversity of the cape of Kamenjak (Istria, Croatia). *Acta Bot. Croat.* 70(1): 23-40
- Vuković N., Tommasoni A., D'Onofrio T. (2013). The orchid *Ophrys speculum* Link (Orchidaceae) in Croatia. *Acta Bot. Croat.* 72(1): 185-191

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