NAT. CROAT. | VOL. 24 | No 2 | 191–213 | ZAGREB | December 31, 2015

original scientific paper / izvorni znanstveni rad
DOI: 10.302/NC.2015.24.12

# PLANT TAXA AND COMMUNITIES ON THREE ISLETS IN SOUTH CROATIA, NE MEDITERRANEAN

**Nenad Jasprica[1]*, Katija Dolina[1] & Milenko Milović[2]**

[1]Institute for Marine and Coastal Research, University of Dubrovnik, P.O. Box 83, HR-20000 Dubrovnik, Croatia (*Corresponding author: nenad.jasprica@unidu.hr)

[2]Antun Vrančić Grammar School, Put Gimnazije 64, HR-22000 Šibenik, Croatia (E-mail: milenko.milovic@si.t-com.hr)

**Jasprica, N., Dolina, K. & Milović, M.: Plant taxa and communities on three islets in south Croatia, NE Mediterranean. Nat. Croat., Vol. 24, No. 2, 191–213, 2015, Zagreb.**

The flora and vegetation of three small islets with surface areas from 1.04 to 3.31 hectares, lying between the mainland and the Pelješac peninsula in south Croatia, were investigated in 2014 and 2015. The floristic data have been used to analyze life-form and chorological spectra and to assess species-area relationship, the occurrence of islet specialists and to assess the risk of alien plants invasion. Altogether, 126 vascular plant taxa (species and infraspecific units) were recorded on all the islets combined. The richest islet is Gospin Škoj with 72 taxa, followed by Srednjak (68) and Goljak (48). A total of five plant associations, one subassociation and two stands within five vegetation classes have been identified on the islets. Benthic cormophyte communities in the eulittoral and infralittoral zones are represented by *Posidonietum oceanicae*, *Cymodocetum nodosae* and *Nanozosteretum noltii*. The halophytic vegetation of the coastal rocks belongs to the proposed new subassociation *Limonietum anfracti helichrysetosum italici*. Shrubland vegetation was composed of the *Myrto communis-Pistacietum lentisci* and *Oleo sylvestris-Pistacietum lentisci* associations, macchia with *Erica arborea* and the *Olea sylvestris-Narcissus tazetta* community. Clear signs of the degradation of the macchia, due to the high anthropogenic influence, particularly the presence of European rabbit populations have been observed.

**Key words:** islets, vascular plants, diversity, phytosociology, new subassociation, eastern Adriatic

**Jasprica, N., Dolina, K. & Milović, M.: Biljne svojte i zajednice na tri otočića u južnoj Hrvatskoj, SI Sredozemlje. Nat. Croat., Vol. 24, No. 2, 191–213, 2015, Zagreb.**

Flora i vegetacija tri mala otočića površine od 1,04 do 3,31 hektara, smještenih između kopna i poluotoka Pelješca u južnoj Hrvatskoj, istraživani su 2014. i 2105. Analizirani su spektri životnih oblika i koroloških elemenata, diskutiran je odnos broja svojta i površine otočića, prisutnost biljaka svojstvenih samo za otočiće te opasnost od unosa i širenja alohtonih biljaka. Na sva tri otočića ukupno je utvrđeno 126 svojta (vrsta i nižih taksonomskih kategorija) vaskularnih biljaka. Floristički je najbogatiji Gospin Škoj (72 svojte), zatim Srednjak (68) i Goljak (48). Utvrđeno je ukupno pet biljnih asocijacija, jedna subasocijacija i dvije sastojine unutar pet vegetacijskih razreda. Morske pridnene kormofitske asocijacije u eulitoralu i infralitoralu su *Posidonietum oceanicae*, *Cymodocetum nodosae* i *Nanozosteretum noltii*. Halofitska vegetacija niskih obalnih stijena pripada novopredloženoj subasocijaciji *Limonietum anfracti helichrysetosum italici*. Vegetaciju makije čine asocijacije *Myrto communis-Pistacietum lentisci* i *Oleo sylvestris-Pistacietum lentisci*, makija s vrstom *Erica arborea* te sastojine *Olea sylvestris-Narcissus tazetta*. Zbog značajnog antropogenog utjecaja, poglavito uslijed unesenog patuljastog kunića, utvrđena je značajna degradacija vegetacije makije.

**Ključne riječi:** otočići, vaskularne biljke, raznolikost, fitocenologija, nova subasocijacija, istočni Jadran

## INTRODUCTION

The circum-Mediterranean countries contain almost one tenth of the world's vascular flora and are therefore one of the major centres of botanical diversity of the globe (Greuter, 1994). Within the Mediterranean region, islands are recognized as 'hot spots' of biodiversity (Médail & Quézel, 1997). These centres of diversity occur where geological and climatic histories have played crucial roles in shaping plant diversity, and one of three major poles of diversity is the mountain and island region of the Balkans and the Aegean. In the Mediterranean there are about 5,000 islands, varying in size from a few metres square to the size of Sicily, with all degrees of complexity, diversity, age, geological structure, etc. They are closed systems and can be considered as natural laboratories in which to study the processes of island colonisation and species turnover. Additionally, islet ecosystems are known to be extremely vulnerable, and half of the documented extinctions of the Mediterranean island endemics concern small islets (Greuter, 1995).

For these reasons, awareness of the importance of exploring and safeguarding the floristic diversity of the Mediterranean islands has increased dramatically in the last two decades in the Adriatic Basin (Bogdanović & Mitić, 2003; Nikolić *et al*., 2008, 2015; Jasprica & Ruščić, 2013; Milović *et al*., 2013, and references therein) and throughout the Mediterranean (cf. Bocchieri, 1992; Greuter, 2001; Biel, 2002; Arrigoni *et al*., 2003; Troia *et al*., 2012; Carta *et al*., 2013; etc.).

Besides the Greek coast that of the eastern Adriatic is, one of the most diverse in the Mediterranean region. The Croatian archipelago consists of 1,151 islands, islets and reefs and, depending on the tides, 80 additional reefs periodically appearing above sea level. Generally, the Dalmatian coast could be defined as a hot spot, but the data are incomplete (Médail & Quézel, 1997). Nikolić *et al*. (2008), using the species-area relationship (SAR) analysis for 106 Adriatic islands, estimated that 1,807 plant taxa grow on the Croatian islands. However, the total number of species on these islands is still unknown, and there naturally remain islands and islets that have not yet been floristically and ecologically investigated. Among these are the three small islets enclosed by the mainland and the Pelješac peninsula in south Croatia that are the subject of this study (Fig. 1).

The present paper offers a contribution to the knowledge of the insular vascular flora, a description of the vegetation units, and phytogeographical comments. In addition, the floristic data have been used to analyze life-form and chorological spectra and to assess species-area relationship, the occurrence of islet specialists and to assess the risk of alien plant invasion.

## THE STUDY AREA

The three small islets Gospin Škoj (GŠ; surface area 1.57 ha; perimeter 527 m; max. altitude 15 m a.s.l.), Srednjak (S; 1.04 ha; 374 m; 8 m a.s.l.) and Goljak (GO; 3.31 ha; 686 m; 8 m a.s.l.) belong to a group of 13 islands and islets located along the northern side of the Pelješac peninsula in the vicinity of the village of Sreser, within the Special Marine Reserve of Mali Ston Bay and Malo More in south Croatia (Fig. 1). The coasts of the three islets are low and rocky. Because they are so low, they are sometimes washed over by the sea. Sea depths around the islets are 2-13 m. The lithology is the same for all and consists of the same type of highly permeable Cretaceous limestones as the Pelješac peninsula. Mediterranean limestone soils, i.e. Mediterranean Brown Soils (S, GO) and Terra Rossa (GŠ), are developed on this geological substrate (Bašić, 2013).

The islets are not inhabited. In the summer months the islet of GŠ is a goal for tourists on day trips. Goats were occasionally reared on the GŠ islet in different periods after the Second World War, but for the last five years there have been none on the islet. Considerable populations of European rabbits are found on all the islets (Long, 2003) where they were introduced ca 40 years ago. The local authority has stated its intention to declare all three islets as being particularly valuable natural landscapes (APO, 2014).

The average annual air temperature is 15.6°C and precipitation averages 1085.3 mm $yr^{-1}$ (data from the nearby town of Ploče station for 1984-2013, Croatian Meteorological and Hydrological Service). The highest daily average temperature is 25.4°C in July, and the lowest falls below 6.9°C in January. The absolute minimum temperature (-8.9°C) was recorded on January 13, 1985, and the absolute maximum (38.8°C) on July 24, 2007. The greatest rainfall is in November (average 158.9 mm) and December (average 143.3 mm). In the period from June to August the total rainfall is 123.0 mm. Northern winds prevail throughout the year. The sum of the per mille frequencies of each of these directions is for: N – 56.1, NNE – 149.5 and NE – 97.8. The highest winds speed is in March (average 2.4 m $s^{-1}$). This area has 2676.7 hours of sunshine per year. On average the relative air humidity is 68% (data for Opuzen station for 1970-1990, cf. Jasprica *et al*., 2005).

Phytoclimatic indices were calculated according to Rivas-Martínez *et al*. (1999, 2004): annual positive temperature (Tp) is 1,877; continentality index (Ic) is 18.5; thermicity index (It) is 300; ombrothermic index (Io) is 5.78. On the basis of these indices, Ploče station can be classified in the Mediterranean pluviseasonal-oceanic bioclimatic region, lower meso-Mediterranean phytoclimatic belt, upper subhumid ombrotype.

Since they are part of the Pelješac peninsula, they belong among the Important Plant Areas (IPAs) in Croatia (Jasprica & Kovačić, 2010). In addition, they are located within the NATURA 2000 network of protected sites in Croatia (site code HR4000015, the Mali

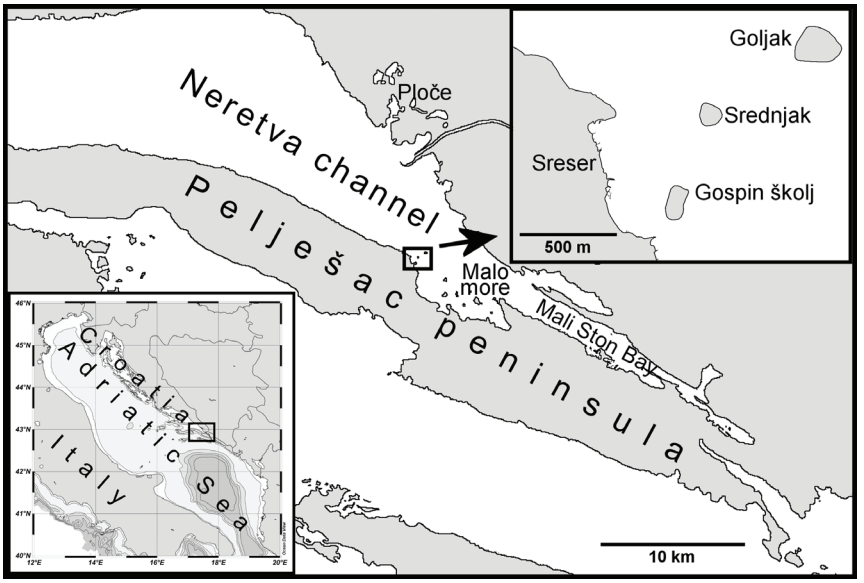


**Fig. 1**. Geographical position of the study area in south Croatia, eastern Adriatic.

Ston Bay) due to the presence of large shallow inlets and bays (habitat type code 1160) and reefs (code 1170) (Jasprica, 2011).

Phytogeographically, the islets belong to the steno-Mediterranean vegetation zone of the *Oleo sylvestris-Ceratonion siliquae* alliance (Jasprica & Kovačić, 2011).

## MATERIAL AND METHODS

### Flora

The study was carried out in 2014 and 2015 in different seasons (early and late spring, early summer and autumn). Whenever possible, a specimen of each taxa encountered in the flowering state was collected and pressed. Herbarium specimens are deposited in the herbarium collection of the Laboratory for Terrestrial Flora and Fauna of the University of Dubrovnik. Collections were made only if ten or more individuals were present in a plant population. The GPS (Global Positioning System) locations are included and expressed in Gauss-Krüger coordinates. Data on the surface area and perimeter of the islands were obtained from the Croatian Programme for the protection and use of small inhabited and uninhabited islands and the surrounding sea (Anonymous, 2007). The highest altitudes were determined using topographic maps to the scale 1:25000 (TK25, TOPO HR). Floristic surveys were conducted using the standard method described by Nikolić *et al*. (1998) and Nikolić (2006). Biological form was verified in the field and denoted according to categories reported in Pignatti (1982), these being based on the classification of Raunkiaer (1934). Regarding chorological forms, reference was made to Jasprica & Kovačić (1997), as well as to the monographs used for taxonomic nomenclature.

Taxa were determined using the standard determination keys, books and guides: Bonnier (1911–1935), Fiori (1923–1929), Hayek (1924–1933), Hegi (1936–1987), Tutin *et al*. (1968–1980, 1993), Horvatić & Trinajstić (1967–1981), Trinajstić (1975–1986), Javorka & Csapody (1975), Pignatti (1982), Domac (1994), Delfroge (1995, 2006), etc. The nomenclature of plant taxa follows the Flora Croatica Database (Nikolić, 2015). The taxa in the list are given in alphabetical order of genera and species. Taxa listed in the Red Book of Vascular Flora of Croatia (Nikolić & Topić, 2005; Nikolić, 2015) are marked with their corresponding IUCN status (IUCN, 2014). Taxa considered to be endemic are denoted according to Nikolić *et al*. (2015). In addition, strictly protected taxa (SP) as defined by Croatian Law are also denoted (Anonymous, 2013a,b). Invasive plant taxa (IAS) have been defined according to Nikolić *et al*. (2014).

In order to obtain a better interpretation of the floristic similarity among the islets, unweighted average indicator values were used (Pignatti, 2005) calculated in JUICE 7.0. Average indicator values were presented with Box-Whiskers diagrams made in STATISTICA 7.1 (STATSOFT inc., 2005).

### Vegetation

Phytosociological analysis allowed the detection of some associations, understanding of their ecological characteristics and definition of their syntaxonomic positions. The studied vegetation is referred to two major groups: macchia and halophilous vegetation. Vegetation was studied in accordance with the principles of the Braun-Blanquet approach (Braun-Blanquet, 1964), adopting the International Code of Phytosociological Nomenclature (Weber *et al*., 2000; see also Dengler *et al*., 2008). Altogether, 18 phytocoeno-

logical relevés were collected on the islets. The plot size used to sample vegetation was established so as to represent full floristic composition, depending on plant density and homogeneity of vegetation cover. Geographical coordinates, elevation above sea level, aspect and slope inclination were noted for each relevé. The relevés were separated into associations/stands on the basis of the diagnostic and/or dominant species in line with the traditional syntaxonomic system of the communities. Place and date of relevés are listed in Appendix 1.

The system of characterizing species was derived from Ilijanić & Hećimović (1982), Hećimović (1984), Horvat *et al.* (1974), Jasprica *et al.* (2014a, 2015, and references therein), and also partly from Brullo *et al*. (2008) and Vukelić (2012). For the arrangement of the plant associations in the upper hierarchic levels (see the syntaxonomic listing) the scheme proposed by Biondi *et al*. (2014) for Italy was mainly followed.

## RESULTS

### Flora

One hundred and twenty six vascular plant taxa (species and infraspecific units) were recorded on all three islets combined (Tab. 1). The plant-richest islet is GŠ with 72 taxa, followed by S (68) and GO (48). Only 14 taxa were common to all islets: *Allium commutatum*, *A. subhirsutum*, *Anagallis arvensis*, *Arisarum vulgare*, *Asparagus acutifolius*, *Centaurium erythraea*, *Clematis flammula*, *Limonium dictyophorum*, *Myrtus communis*, *Olea europaea* var. *sylvestris*, *Pistacia lentiscus*, *Romulea bulbocodium*, *Sonchus tenerrimus* and *Valantia muralis*. Three taxa can be considered as endemic: *Carduus micropterus* ssp. *micropterus*, *Limonium dictyophorum* and *Vincetoxicum hirundinaria* ssp. *adriaticum*.

Altogether, 60 families and 108 genera were noted. Among them, the most represented families were: *Poaceae* (9), *Fabaceae* (8), *Cichoriaceae* (7), *Caryophyllaceae* (6), *Asteraceae* (5), and *Amaryllidaceae* and *Ranunculaceae* (4 in each family) (Tab. 1).

**Tab. 1.** List of taxa on the three islets (LF – life form, FE – floral element, IUCN – IUCN status, SPT – strictly protected taxa, IAS – Invasive plant taxa, GŠ – Gospin Škoj, S – Srednjak, GO – Goljak).

| Taxa | LF* | FE* | Family | IUCN | SPT | Endem | IAS | GŠ | S | GO |
|---|---|---|---|---|---|---|---|---|---|---|
| *Aetheorhiza bulbosa* (L.) Cass. | G | CIME | *Cichoriaceae* | | | | | | ● | |
| *Allium commutatum* Guss. | G | CIME | *Amaryllidaceae* | | | | | ● | ● | ● |
| *Allium guttatum* Steven ssp. *dalmaticum* (A. Kern. ex Janch.) Stearn | G | ILBE | *Amaryllidaceae* | | | | | ● | | |
| *Allium subhirsutum* L. | G | CIME | *Amaryllidaceae* | | | | | ● | ● | ● |
| *Anagallis arvensis* L. | T | WISP | *Primulaceae* | | | | | ● | ● | ● |
| *Anchusella cretica* (Mill.) Bigazzi, E. Nardi et Salvi | T | CIME | *Boraginaceae* | | | | | ● | | |
| *Anemone hortensis* L. | G | CIME | *Ranunculaceae* | | | | | | ● | |
| *Arabis hirsuta* (L.) Scop. | H | WISP | *Brassicaceae* | | | | | | ● | |
| *Arenaria leptoclados* (Reichenb.) Guss. | T | EUAS | *Caryophyllaceae* | | | | | | ● | |
| *Arisarum vulgare* O. Targ. Tozz. | G | CIME | *Araceae* | | | | | ● | ● | ● |
| *Aristolochia clematitis* L. | G | SEPO | *Aristolochiaceae* | | | | | | | ● |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| *Arum italicum* Mill. | G | MEAT | *Araceae* | | | | | ● | ● | |
| *Asparagus acutifolius* L. | G | CIME | *Asparagaceae* | | | | | ● | ● | ● |
| *Asplenium ceterach* L. | H | SEME | *Aspleniaceae* | | | | | ● | | |
| *Atriplex prostrata* Boucher ex DC. in Lam. et DC. | T | WISP | *Chenopodiaceae* | | | | | | | ● |
| *Beta vulgaris* L. ssp. *maritima* (L.) Arcang. | H | MEAT | *Chenopodiaceae* | | | | | | ● | |
| *Blackstonia perfoliata* (L.) Huds. ssp. *perfoliata* | T | MEAT | *Gentianaceae* | | | | | | ● | ● |
| *Brachypodium distachyon* (L.) P.Beauv. | T | CIME | *Poaceae* | | | | | | | ● |
| *Brachypodium retusum* (Pers.) P. Beauv. | H | CIME | *Poaceae* | | | | | | ● | |
| *Bromus madritensis* L. | T | MEAT | *Poaceae* | | | | | | ● | |
| *Calamintha nepetoides* Jord. | H | SEPO | *Lamiaceae* | | | | | ● | | |
| *Cardamine hirsuta* L. | T | WISP | *Brassicaceae* | | | | | | ● | |
| *Carduus micropterus* (Borbás) Teyber ssp. *micropterus* | H | ILAE | *Asteraceae* | | ● | ● | | | ● | |
| *Carex extensa* Gooden. | H | MEAT | *Cyperaceae* | EN | ● | | | ● | | |
| *Carex hallerana* Asso | H | SEME | *Cyperaceae* | | | | | ● | | ● |
| *Carlina corymbosa* L. | H | CIME | *Asteraceae* | | | | | ● | ● | |
| *Centaurium erythraea* Rafn | H | WISP | *Gentianaceae* | | | | | ● | ● | ● |
| *Centaurium pulchellum* (Sw.) Druce | T | EUAS | *Gentianaceae* | | | | | | | ● |
| *Clematis flammula* L. | P | CIME | *Ranunculaceae* | | | | | ● | ● | ● |
| *Clematis vitalba* L. | P | EURO | *Ranunculaceae* | | | | | ● | | |
| *Convolvulus althaeoides* L. ssp. *tenuissimus* (Sibth. et Sm.) Stace | H | EAME | *Convolvulaceae* | | | | | | ● | |
| *Convolvulus cantabrica* L. | H | SEME | *Convolvulaceae* | | | | | | ● | |
| *Conyza canadensis* (L.) Cronquist | T | CUAD | *Asteraceae* | | | | ● | ● | | |
| *Crepis sancta* (L.) Babc. | T | EAME | *Cichoriaceae* | | | | | | ● | |
| *Crithmum maritimum* L. | Ch | MEAT | *Apiaceae* | | | | | ● | ● | |
| *Cymodocea nodosa* (Ucria) Asch. | Hy | MEAT | *Cymodoceaceae* | DD | | | | ● | | |
| *Cynodon dactylon* (L.) Pers. | G | WISP | *Poaceae* | | | | | | ● | ● |
| *Dactylis glomerata* L. ssp. *hispanica* (Roth) Nyman | H | CIME | *Poaceae* | | | | | | ● | |
| *Daucus carota* L. | H | EUAS | *Apiaceae* | | | | | | ● | |
| *Desmazeria marina* (L.) Druce | T | MEAT | *Poaceae* | VU | ● | | | ● | | ● |
| *Desmazeria rigida* (L.) Tutin | T | MEAT | *Poaceae* | | | | | | ● | |
| *Dittrichia viscosa* (L.) Greuter | H | CIME | *Asteraceae* | | | | | ● | | ● |
| *Dorycnium germanicum* (Gremli) Rikli | H | SEME | *Fabaceae* | | | | | | ● | |
| *Ephedra fragilis* Desf. ssp. *campylopoda* (C.A. Mayer) Asch. et Graeb. | P | EAME | *Ephedraceae* | NT | | | | ● | ● | |
| *Erica arborea* L. | P | CIME | *Ericaceae* | | | | | | ● | ● |
| *Euphorbia peplus* L. | T | WISP | *Euphorbiaceae* | | | | | | | ● |
| *Ficus carica* L. | P | CIME | *Moraceae* | | | | | ● | | ● |
| *Fumaria capreolata* L. | T | MEAT | *Fumariaceae* | | | | | ● | ● | |
| *Galium aparine* L. | T | WISP | *Rubiaceae* | | | | | | ● | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| *Galium murale* (L.) All. | T | CIME | *Rubiaceae* | | | | | ● | | |
| *Geranium molle* L. | T | WISP | *Geraniaceae* | | | | | ● | | |
| *Geranium purpureum* Vill. | T | SEME | *Geraniaceae* | | | | | | ● | |
| *Geranium robertianum* L. | T | WISP | *Geraniaceae* | | | | | ● | | |
| *Gladiolus illyricus* W.D.J.Koch | G | SEME | *Iridaceae* | | | | | | | ● |
| *Hedera helix* L. | P | EURO | *Araliaceae* | | | | | ● | | |
| *Helichrysum italicum* (Roth) G. Don | Ch | CIME | *Asteraceae* | | | | | | ● | ● |
| *Hypericum perforatum* L. | H | WISP | *Clusiaceae* | | | | | | ● | ● |
| *Juncus acutus* L. | H | MEAT | *Juncaceae* | | | | | | | ● |
| *Juncus bufonius* L. | T | WISP | *Juncaceae* | | | | | ● | | |
| *Juncus maritimus* Lam. | G | WISP | *Juncaceae* | | | | | ● | | |
| *Lactuca serriola* L. | H | WISP | *Cichoriaceae* | | | | | | | ● |
| *Laurus nobilis* L. | P | CIME | *Lauraceae* | | | | | | ● | |
| *Limonium dictyophorum* (Tausch) Degen | H | ILAE | *Plumbaginaceae* | NT | ● | ● | | ● | ● | ● |
| *Limonium narbonense* Mill. | H | CIME | *Plumbaginaceae* | | | | | | | ● |
| *Linaria pelisseriana* (L.) Mill. | T | MEAT | *Scrophulariaceae* | | | | | ● | ● | |
| *Lonicera implexa* Aiton | P | CIME | *Caprifoliaceae* | | | | | ● | | |
| *Lotus corniculatus* L. ssp. *hirsutus* Rothm. | H | SEME | *Fabaceae* | | | | | ● | ● | |
| *Lotus cytisoides* L. | Ch | CIME | *Fabaceae* | | | | | ● | ● | |
| *Malva sylvestris* L. | H | WISP | *Malvaceae* | | | | | | ● | |
| *Melica ciliata* L. | H | EUAS | *Poaceae* | | | | | | ● | |
| *Melilotus officinalis* (L.) Lam. | H | EUAS | *Fabaceae* | | | | | ● | | |
| *Mercurialis annua* L. | T | WISP | *Euphorbiaceae* | | | | | ● | | |
| *Muscari comosum* (L.) Mill. | G | SEME | *Asparagaceae* | | | | | | ● | |
| *Myosotis arvensis* (L.) Hill | T | EUAS | *Boraginaceae* | | | | | | ● | |
| *Myosotis ramosissima* Rochel | T | EUAS | *Boraginaceae* | | | | | | ● | |
| *Myrtus communis* L. | P | CIME | *Myrtaceae* | | | | | ● | ● | ● |
| *Narcissus tazetta* L. | G | CIME | *Amaryllidaceae* | NT | | | | ● | ● | ● |
| *Olea europaea* L. | P | CUAD | *Oleaceae* | | | | | ● | | |
| *Olea europaea* L. var. *sylvestris* Brot. | P | CIME | *Oleaceae* | | | | | ● | ● | ● |
| *Opopanax chironium* (L.) Koch | H | CIME | *Apiaceae* | | | | | ● | | |
| *Opuntia vulgaris* Miller | Ch | CUAD | *Cactaceae* | | | | | | | ● |
| *Orobanche minor* Sm. | T | SEME | *Orobanchaceae* | | | | | | ● | |
| *Paliurus spina-christi* Mill. | P | ILSE | *Rhamnaceae* | | | | | ● | | |
| *Parietaria judaica* L. | H | SEME | *Urticaceae* | | | | | ● | | |
| *Petrorhagia saxifraga* (L.) Link | H | SEME | *Caryophyllaceae* | | | | | ● | | |
| *Phillyrea latifolia* L. | P | CIME | *Oleaceae* | | | | | ● | | ● |
| *Pinus halepensis* Mill. | P | CIME | *Pinaceae* | | | | | | ● | ● |
| *Pistacia lentiscus* L. | P | CIME | *Anacardiaceae* | | | | | ● | ● | ● |
| *Pistacia terebinthus* L. | P | CIME | *Anacardiaceae* | | | | | ● | | ● |
| *Pittosporum tobira* (Thunb.) Aiton f. | P | CUAD | *Pittosporaceae* | | | | | ● | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| *Plumbago europaea* L. | Ch | CIME | *Plumbaginaceae* | | | | | ● | | |
| *Polycarpon tetraphyllum* (L.) L. | T | SEME | *Caryophyllaceae* | | | | | ● | | |
| *Posidonia oceanica* (L.) Delile | Hy | CIME | *Zosteraceae* | DD | | | | | ● | ● |
| *Punica granatum* L. | P | CIME | *Punicaceae* | | | | | ● | | |
| *Quercus ilex* L. | P | CIME | *Fagaceae* | | | | | ● | | |
| *Ranunculus peltatus* Schrank | Hy | EURO | *Ranunculaceae* | | | | | ● | | |
| *Reichardia picroides* (L.) Roth | H | CIME | *Cichoriaceae* | | | | | ● | ● | |
| *Romulea bulbocodium* (L.) Sebast. et Mauri | G | CIME | *Iridaceae* | | | | | ● | ● | ● |
| *Rosa sempervirens* L. | P | CIME | *Rosaceae* | | | | | ● | | ● |
| *Rubus ulmifolius* Schott | P | MEAT | *Rosaceae* | | | | | ● | | ● |
| *Sagina maritima* G. Don | T | MEAT | *Caryophyllaceae* | | | | | | ● | |
| *Scolymus hispanicus* L. | H | CIME | *Cichoriaceae* | | | | | | ● | |
| *Selaginella denticulata* (L.) Spring. | Ch | CIME | *Selaginellaceae* | | | | | | | ● |
| *Sideritis romana* L. | T | CIME | *Lamiaceae* | | | | | | ● | |
| *Silene vulgaris* (Moench) Garcke ssp. *angustifolia* Hayek | H | SEME | *Caryophyllaceae* | | | | | | ● | |
| *Smilax aspera* L. | P | CIME | *Smilacaceae* | | | | | ● | | ● |
| *Sonchus asper* (L.) Hill ssp. *glaucescens* (Jord.) Ball | T | CIME | *Cichoriaceae* | | | | | | ● | ● |
| *Sonchus tenerrimus* L. | T | CIME | *Cichoriaceae* | | | | | ● | ● | ● |
| *Spergularia salina* J. Presl et C. Presl | T | WISP | *Caryophyllaceae* | | | | | ● | | |
| *Tamarix gallica* L. | P | WEME | *Tamaricaceae* | | | | | ● | | |
| *Tamus communis* L. | G | SEME | *Dioscoreaceae* | | | | | ● | ● | ● |
| *Teucrium polium* L. | Ch | MEPO | *Lamiaceae* | | | | | | ● | ● |
| *Theligonum cynocrambe* L. | T | SEME | *Theligonaceae* | | | | | ● | | |
| *Trifolium campestre* Schreber | T | WISP | *Fabaceae* | | | | | | ● | ● |
| *Trigonella esculenta* Willd. | T | EUME | *Fabaceae* | | | | | ● | | |
| *Ulmus minor* Miller | P | WISP | *Ulmaceae* | | | | | ● | | |
| *Umbilicus horizontalis* (Guss.) DC. | G | CIME | *Crassulaceae* | | | | | ● | | |
| *Valantia muralis* L. | T | CIME | *Rubiaceae* | | | | | ● | ● | ● |
| *Valerianella muricata* (Stiven ex M. Bieb.) J. W. Loudon | T | EAME | *Valerianaceae* | | | | | | ● | |
| *Viburnum tinus* L. | P | CIME | *Caprifoliaceae* | | | | | ● | | |
| *Vicia peregrina* L. | T | SEME | *Fabaceae* | | | | | | ● | |
| *Vicia villosa* Roth ssp. *varia* (Host) Corb. | T | EEUP | *Fabaceae* | | | | | ● | ● | |
| *Vincetoxicum hirundinaria* Medik. ssp. *adriaticum* (Beck) Markgr. | H | ILAE | *Asclepiadaceae* | LC | ● | ● | | | ● | ● |
| *Vitis vinifera* L. ssp. *sylvestris* (C.C.Gmel.) Hegi | P | SEME | *Vitaceae* | LC | | | | ● | | |
| *Vulpia ciliata* Dumort. | T | SEME | *Poaceae* | | | | | | | ● |
| *Zostera noltii* Hornem. | Hy | MEAT | *Zosteraceae* | | | | | ● | | |

* see Tabs. 2 and 3 for explanation of the abbreviations.

**Tab. 2.** Life-form spectra (number of taxa and percentage in brackets) on the islets. (GŠ – Gospin Škoj, S – Srednjak, GO – Goljak).

| Life forms | GŠ | S | GO |
|---|---|---|---|
| Phanerophytes (P) | 23 (31.94) | 8 (11.77) | 12 (25.00) |
| Chamaephytes (Ch) | 3 (4.17) | 4 (5.88) | 4 (8.33) |
| Hemicryptophytes (H) | 14 (19.44) | 20 (29.41) | 9 (18.75) |
| Geophytes (G) | 11 (15.28) | 12 (17.65) | 10 (20.83) |
| Therophytes (T) | 18 (25.00) | 23 (33.82) | 12 (25.00) |
| Hydrophytes (Hy) | 3 (4.17) | 1 (1.47) | 1 (2.09) |
| Total taxa | 72 (100) | 68 (100) | 48 (100) |

**Tab. 3**. Floral elements (number of taxa and percentage in brackets) on the islets (GŠ – Gospin Škoj, S – Srednjak, GO – Goljak).

| Floral elements | GŠ | S | GO |
|---|---|---|---|
| 1. Mediterranean | 44 (61.12) | 44 (64.70) | 33 (68.76) |
| 1.1. Circum-Mediterranean (CIME) | 30 (41.67) | 27 (39.70) | 26 (54.18) |
| 1.2. East Mediterranean (EAME) | 1 (1.39) | 4 (5.88) | . |
| 1.3. West Mediterranean (WEME) | 1 (1.39) | . | . |
| 1.4. Illyrian-Mediterranean | 2 (2.78) | 3 (4.41) | 2 (4.17) |
| 1.4.1. Illyrian-South European plants (ILSE) | 1 (1.39) | . | . |
| 1.4.2. Illyrian-Adriatic plants | 1 (1.39) | 3 (4.41) | 2 (4.17) |
| 1.4.2.1. Illyrian-Adriatic endemic plants (ILAE) | 1 (1.39) | 3 (4.41) | 2 (4.17) |
| 1.5. Mediterranean-Atlantic (MEAT) | 9 (12.50) | 9 (13.24) | 4 (8.33) |
| 1.6. European Mediterranean plants (EUME) | 1 (1.39) | . | . |
| 1.7. Mediterranean-Pontic plants (MEPO) | . | 1 (1.47) | 1 (2.08) |
| 2. Illyrian-Balkan | 1 (1.39) | . | . |
| 2.1. Illyrian-Balkan endemic plants (ILBE) | 1 (1.39) | . | . |
| 3. South European | 10 (13.89) | 9 (13.24) | 5 (10.41) |
| 3.1. South European-Mediterranean (SEME) | 9 (12.50) | 9 (13.24) | 4 (8.33) |
| 3.2. South European-Pontic (SEPO) | 1 (1.39) | . | 1 (2.08) |
| 4. East European-Pontic (EEUP) | 1 (1.39) | 1 (1.47) | . |
| 5. European (EURO) | 3 (4.16) | . | . |
| 6. Eurasian (EUAS) | 1 (1.39) | 5 (7.35) | 1 (2.08) |
| 7. Cosmopolitan (WISP) | 9 (12.50) | 9 (13.24) | 8 (16.67) |
| 8. Cultivated and adventive plants (CUAD) | 3 (4.16) | . | 1 (2.08) |
| No. of taxa (%) | 72 (100.00) | 68 (100.00) | 48 (100.00) |

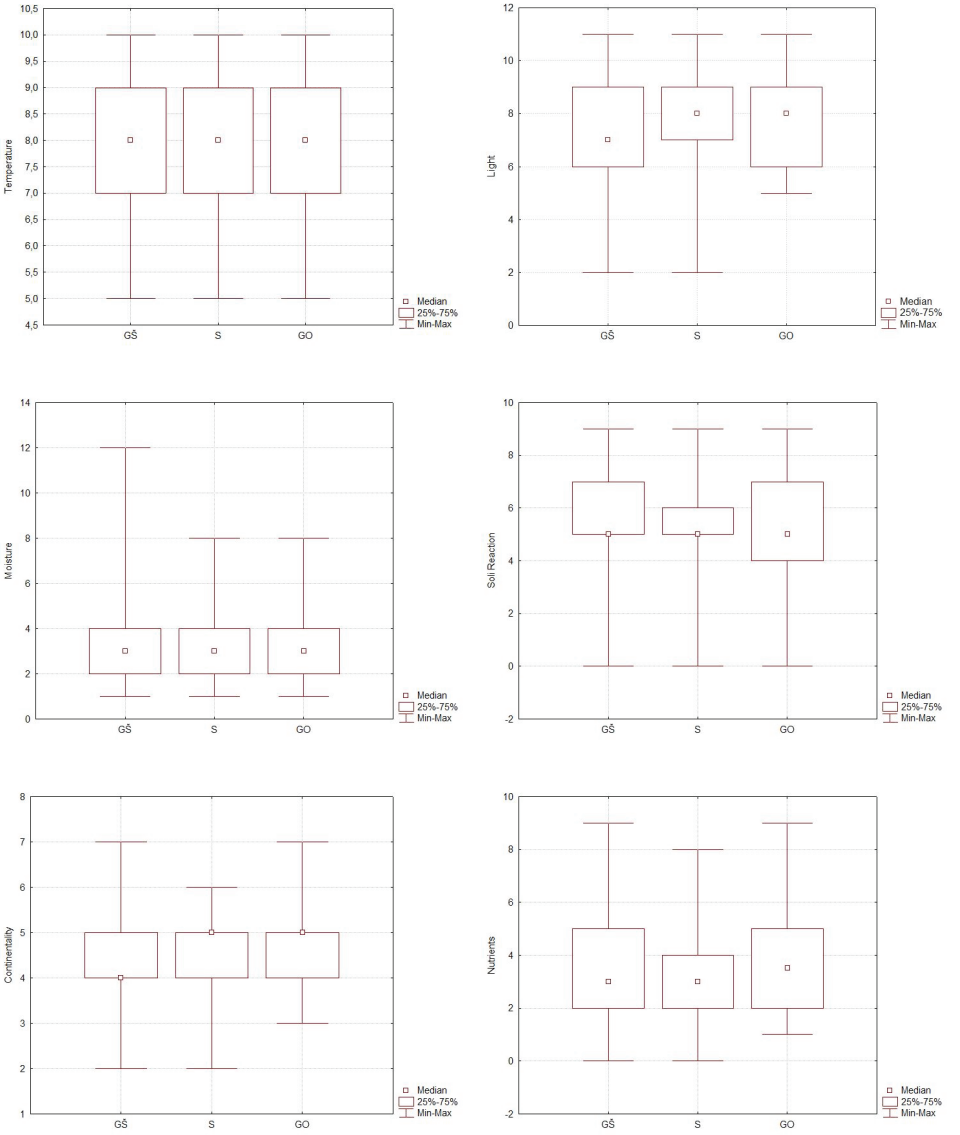


**Fig. 2**. Relationships of the studied islets to Pignatti indicator values (GŠ – Gospin Škoj, S – Srednjak, GO – Goljak).

The Red List categories Endangered (EN) and Vulnerable (VU) are assigned to one species in each: *Carex extensa* (EN) and *Desmazeria marina* (VU). In addition, three taxa (*Ephedra fragilis* ssp. *campylopoda*, *Limonium dictyophorum* and *Narcissus tazetta*) were considered as Near Threatened (NT) and two (*Vincetoxicum hirundinaria* ssp. *adriaticum* and *Vitis vinifera* ssp. *sylvestris*) were classified as of Least Concern (LC). Only two taxa (*Cymodocea nodosa* and *Posidonia oceanica*) have been classified as Data Deficient (DD).

In total, five taxa were Strictly Protected (SP) by Croatian Law: *Carduus micropterus* ssp. *micropterus*, *Carex extensa*, *Desmazeria marina*, *Limonium dictyophorum* and *Vincetoxicum hirundinaria* ssp. *adriaticum*.

Among the recorded taxa, only *Conyza canadensis* is considered to be invasive (IAS).

The analysis of plant life forms showed that GŠ and S were dominated by phanerophytes (32%) and therophytes (34%), respectively (Tab. 2). Phanerophytes and therophytes contributed equally (25%) on GO.

Mediterranean floral elements (61–69%), mostly circum-Mediterranean plants, followed by a considerable proportion of Cosmopolitans (13–17%) and South European plants (10–14%), dominated on all three islets (Tab. 3).

Pignatti's indicator values showed no differences among the islets (Fig. 2).

## Vegetation

A total of five plant associations, one subassociation and two stands within five vegetation classes have been identified on the three islets. Their syntaxonomic scheme is as follows:

*HALODULO WRIGTHII-THALASSIETEA TESTUDINUM* Rivas-Martínez, Fernández-González & Loidi 1998
+*Thalassio testudinum-Syringodietalia filiformis* Knapp in Borhidi, Muňiz & Del Risco 1983
**Syringodio filiformis-Thalassion testudinum* Borhidi in Borhidi, Muňiz & Del Risco 1983
***Cymodoceetum nodosae* Feldman 1937**

*POSIDONIETEA OCEANICAE* Hartog 1976 *ex* Géhu in Bardat, Bioret, Botineau, Boullet, Delpech, Géhu, Haury, Lacoste, Rameau, Royer, Roux & Touffet 2004
+*Posidonietalia oceanicae* Hartog 1976
**Posidonion oceanicae* Braun-Blanquet, Roussine & Nègre 1952
***Posidonietum oceanicae* (Funk 1927) Molinier 1958**

*ZOSTERETEA MARINAE* Pignatti 1953
+*Zosteretalia marinae* Béguinot *ex* Pignatti 1953
**Zosterion marinae* Christiansen 1934
***Nanozosteretum noltii* Harmsen 1936**

*CRITHMO MARITIMI-STATICETEA* Braun-Blanquet in Braun-Blanquet, Roussine & Nègre 1952 *em*. Biondi 2007
+*Crithmo maritimi-Staticetalia* Molinier 1934
**Crithmo maritimi-Staticion* Molinier 1934
***Limonietum anfracti* Ilijanić & S. Hećimović 1982 *helichrysetosum italici, subass. nova hoc loco* Jasprica 2015** (holotypus relevé no. 3, Tab. 4)

*QUERCETEA ILICIS* Braun-Blanquet in Braun-Blanquet, Roussine & Nègre 1952
+*Pistacio lentisci-Rhamnetalia alaterni* Rivas-Martínez 1975 [syntax. syn. *Quercetalia ilicis* Braun-Blanquet *ex* Molinier 1934 p.p.]
**Oleo sylvestris-Ceratonion siliquae* Braun-Blanquet *ex* Guinochet & Drouineau 1944
***Myrto communis-Pistacietum lentisci* (Molinier 1954) Rivas-Martínez 1975**
***Oleo sylvestris-Pistacietum lentisci* Braun-Blanquet 1931**
**macchia with *Erica arborea***
***Olea sylvestris-Narcissus tazetta* community**

**Tab. 4.** *Limonietum anfracti* Ilijanić & S. Hećimović 1982 *helichrysetosum italici subass. nova* hoc loco Jasprica 2015 (*holotypus rel. no. 3)

| No. of relevés | 1 | 2 | 3* | 4 | |
|---|---|---|---|---|---|
| No. of taxa | 13 | 5 | 7 | 11 | P |
| Altitude (m) | 1 | 1 | 1 | 1 | r |
| Slope (°) | 5 | 5 | 5 | 5 | e |
| Aspect | N | E | N | S | s. |
| Plot size ($m^2$) | 20 | 10 | 10 | 20 | |
| Vascular plant cover (%) | 30 | 30 | 30 | 50 | |
| Char. Ass., All., Ord., Class | | | | | |
| **Crithmo maritimi-Staticetea** | | | | | |
| *Limonium dictyophorum* | 3 | 3 | 3 | 3 | 4 |
| *Lotus cytisoides* | 1 | . | . | + | 2 |
| *Allium commutatum* | + | . | . | . | 1 |
| *Vincetoxicum hirundinaria* ssp. *adriaticum* | + | . | . | . | 1 |
| *Crithmum maritimum* | . | . | . | + | 1 |
| | | | | | |
| Diff. taxon of the *helichrysetosum italici* subass. | | | | | |
| *Helichrysum italicum* | + | 2 | 4 | 2 | 4 |
| | | | | | |
| Companions | | | | | |
| **Festuco valesiacae-Brometea erecti** | | | | | |
| *Hypericum perforatum* | . | + | + | + | 3 |
| *Muscari comosum* | 3 | . | . | . | 1 |
| *Carduus micropterus ssp. micropterus* | + | . | . | . | 1 |
| *Narcissus tazetta* | + | . | . | . | 1 |
| **Tuberarietea guttatae** | | | | | |
| *Romulea bulbocodium* | . | 1 | 2 | . | 2 |
| **Thero-Brachypodietea ramosi** | | | | | |
| *Centaurium erythraea* | . | . | + | + | 2 |
| *Valantia muralis* | + | . | . | . | 1 |
| *Orobanche minor* | + | . | . | . | 1 |
| *Brachypodium retusum* | + | . | . | . | 1 |
| *Allium subhirsutum* | . | . | . | + | 1 |
| **Quercetea ilicis** | | | | | |
| *Clematis flammula* | + | . | . | . | 1 |
| *Carex hallerana* | . | + | . | . | 1 |
| *Pistacia lentiscus* | . | . | + | . | 1 |
| **Stellarietea mediae** | | | | | |
| *Sonchus tenerrimus* | + | . | . | . | 1 |
| *Polycarpon tetraphyllum* | . | . | + | . | 1 |
| *Anagallis arvensis* | . | . | . | + | 1 |
| **Cakiletea maritimae** | | | | | |
| *Atriplex prostrata* | . | . | . | + | 1 |
| **Artemisietea vulgaris** | | | | | |
| *Dittrichia viscosa* | . | . | . | + | 1 |
| *Blackstonia perfoliata* ssp. *perfoliata* | . | . | . | + | 1 |

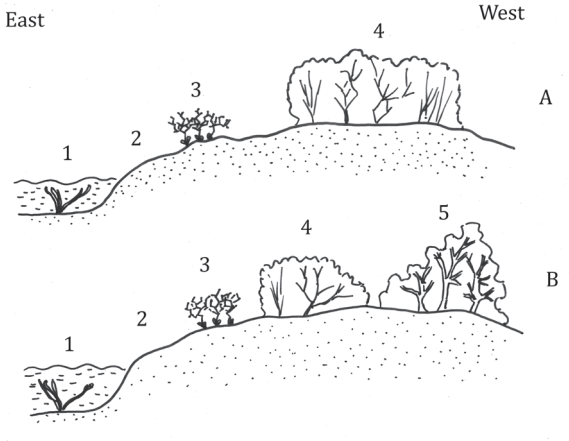


**Fig. 3**. Transect of the vegetation on the islets of Srednjak (A) and Goljak (B). 1. *Posidonietum oceanicae*, 2. Aphytic zone, 3. *Limonietum anfracti helichrysetosum italici*, 4. *Myrto communis-Pistacietum lentisci*, 5. Macchia with *Erica arborea*.

Submerged vegetation (Fig. 3)

The phanerogamic seagrasses are mainly composed of *Posidonia oceanica* (endemic to the Mediterranean), which has developed on the moving seabed in depths between 1 and 15(-20) m and determines the lower limit of the infralittoral zone (Bakran-Petricioli & Schultz, 2010). These seagrasses constitute an effective barrier to wave motion, and thus stabilise the sea bottom. Moreover, it constitutes the breeding site for many species and it is also one of the main sources of oxygenation of the environment. Other submerged phanerogamic seagrasses are *Cymodocea nodosa* and *Nanozostera noltii*, both of which form single uniform patches growing over gently mobile sandy or muddy-sand substrates between the Pelješac peninsula (village of Sreser) and the islet of GŠ. Thus, in the area the species occur from 0.5 to 5–8 (–10) m depths. The phytosociology of these seagrasses includes the *Posidonietum oceanicae*, *Cymodocetum nodosae* and *Nanozosteretum noltii* associations.

The low rocky coast (Tab. 4, Fig. 3)

The rocky shores are home to the *Limonietum anfracti* plant association, characterised by *Limonium dictyophorum* (=*L. anfractum*), a species endemic to the southern coast of the eastern Adriatic, which forms dense low-spreading formations that colonise the cracks in the rocks. In our relevés, after *L. dictyophorum*, *Helichrysum italicum* had the highest cover and the greatest presence, and is considered as the differential taxon of the proposed new plant subassociation *helichrysetosum italici* Jasprica 2015 hoc loco (Tab. 4, holotypus relevé no. 3). The number of taxa in the relevés was between 5 and 13 (average 9). In total, 25 taxa have been recorded in the relevés sampled in the subassociation. Among them, 19 were companions, mostly from the *Thero-Brachypodietea ramosi* and *Festuco valesiacae-Brometea erecti* classes.

In our case, the rocks closest to the sea represent the aphytic zone (not colonised by vascular plants), which frequently has organic and waste material deposited by the sea. The organic matter can be composed of algae, floating wood, sponges, and fragments

**Fig. 4.** The *Limonietum anfracti helichrysetosum italici* subassociation on the islet of Goljak.

of *Posidonia* leaves and the rhizomes of other plants. After the aphytic zone and above the upper tidal line there follows a strip subject to the actions of the marine aerosol that is colonised by halo-chasmophytic vegetation of the *Limonietum anfracti helichrysetosum italici* subassociation. The rocky coasts are frequently exploited as beaches by holiday-makers.

Further inland from this strip, there follows macchia vegetation. These topographic contacts are indicated in the transect of Fig. 3.

## Macchia (Tab. 5, Fig. 3)

This type of vegetation includes the evergreen sclerophyllous shrublands belonging to the *Oleo sylvestris-Ceratonion siliquae* alliance, with the *Myrto communis-Pistacietum lentisci* and *Oleo sylvestris-Pistacietum lentisci* associations, and the macchia with *Erica arborea*.

The *Myrto communis-Pistacietum lentisci* (rels. 1-8) association mostly forms the strip between halophytic vegetation and the islets' central area. This association has developed as low (mostly between 1 and 1.5 m) and dense shrub formations. It occupies most of the surface area of the islet of Srednjak with a vegetation cover of 90-100%.

The *Oleo sylvestris-Pistacietum lentisci* association (rel.14) and ca 2.5 m high macchia with *Erica arborea* (rels. 9-12) covers most of the surface areas of both GŠ and GO. Due to the presence of a large population of European rabbit, the ground layer of dense impenetrable macchia with *Erica arborea* is extremely poor in species (4-8). In general, most of the companions of the macchia associations were treated as characteristic species of the *Thero-Brachypodietea ramosi* and *Festuco valesiacae-Brometea erecti* classes. Among companions, *Narcissus tazzeta* had the highest frequency.

**Tab. 5.** Macchia vegetation on three islets (for place and date of relevés see Appendix 1):
*Myrto communis-Pistacietum lentisci* (Molinier 1954) Rivas-Martínez 1975 (rels. 1-8).
Macchia with *Erica arborea* (rels. 9-12).
*Olea sylvestris* and *Narcissus tazetta* community (rel. 13).
*Oleo sylvestris-Pistacietum lentisci* Braun-Blanquet 1931 (rel. 14).

| No. of relevés | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. of taxa | 13 | 17 | 23 | 11 | 7 | 6 | 5 | 10 | 6 | 4 | 8 | 7 | 12 | 13 |
| Altitude (m) | 0-2 | 3 | 1-2 | 2 | 2 | 2 | 2 | 1 | 3 | 3 | 4 | 3 | 2 | 1 |
| Slope (°) | 30 | 5 | 5-10 | 5 | 5 | 5 | 5 | 5 | 5 | - | 5-10 | - | 5 | 5 |
| Aspect | E | NW | E | N | E | N | NW | W | E | N | NW | W | SE | W |
| Plot size ($m^2$) | 20 | 100 | 100 | 100 | 50 | 50 | 50 | 50 | 100 | 100 | 100 | 100 | 100 | 100 |
| Vascular plant cover (%) | 100 | 90 | 90 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 80 | 60 |
| **Char. Ass.** | | | | | | | | | | | | | | |
| *Myrtus communis* | 2 | 2 | + | 1 | 1 | 1 | 3 | 2 | 1 | 1 | 3 | 2 | . | + |
| *Erica arborea* | . | . | . | . | 2 | + | . | + | 4 | 5 | 1 | 3 | . | . |
| *Pistacia lentiscus* | 2 | 2 | 4 | 5 | 4 | 3 | 4 | 4 | 2 | + | 2 | 1 | + | 3 |
| *Olea europaea* var. *sylvestris* | 1 | + | . | . | . | . | . | . | . | . | 2 | . | 3 | 4 |
| | | | | | | | | | | | | | | |
| **Quercetea ilicis** | | | | | | | | | | | | | | |
| **Fraxino orni-Quercion ilicis** | | | | | | | | | | | | | | |
| *Smilax aspera* | + | + | . | . | + | . | . | + | 1 | . | + | 1 | . | + |
| *Asparagus acutifolius* | . | + | . | . | . | . | + | + | . | . | . | . | . | . |
| *Arum italicum* | . | . | 1 | . | . | . | . | . | . | . | . | . | . | + |
| *Clematis flammula* | . | + | . | + | . | . | . | . | . | . | . | . | . | . |
| *Phillyrea latifolia* | . | . | . | . | . | . | . | . | . | . | 1 | . | + | . |
| *Olea europaea* var. *europaea* | . | + | . | . | . | . | . | . | . | . | . | . | . | . |
| *Quercus ilex* | . | + | . | . | . | . | . | . | . | . | . | . | . | . |
| *Pistacia terebinthus* | . | + | . | . | . | . | . | . | . | . | . | . | . | . |
| *Viburnum tinus* | . | + | . | . | . | . | . | . | . | . | . | . | . | . |
| *Laurus nobilis* | . | . | . | + | . | . | . | . | . | . | . | . | . | . |
| *Rosa sempervirens* | . | . | . | . | . | . | . | + | . | . | . | . | . | . |
| **Oleo sylvestris-Ceratonion siliquae** | | | | | | | | | | | | | | |
| *Arisarum vulgare* | + | . | + | . | . | . | + | . | . | . | . | + | . | . |
| *Pinus halepensis* | . | . | . | . | . | . | . | . | . | . | . | 1 | . | . |
| *Ephedra fragilis* ssp. *campylopoda* | . | . | . | . | . | . | . | . | . | . | . | . | . | + |
| | | | | | | | | | | | | | | |
| Companions | | | | | | | | | | | | | | |
| **Festuco valesiacae–Brometea erecti** | | | | | | | | | | | | | | |
| *Narcissus tazetta* | 1 | + | . | . | . | 2 | + | + | . | + | + | + | 4 | 2 |
| *Helichrysum italicum* | . | . | + | . | 1 | + | . | + | . | . | . | . | . | . |
| *Muscari comosum* | . | . | + | + | . | . | . | . | . | . | . | . | . | . |
| *Teucrium polium* | . | . | + | . | . | . | . | . | . | . | . | . | . | . |
| *Carduus micropterus* ssp. *micropterus* | . | . | + | . | . | . | . | . | . | . | . | . | . | . |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Hypericum perforatum* | . | . | . | . | + | . | . | . | + | . | . | . | . | . |
| *Lotus corniculatus* ssp. *hirsutus* | . | . | . | . | . | . | . | . | . | . | . | . | + | . |
| **Thero-Brachypodietea ramosi** | | | | | | | | | | | | | | |
| *Centaurium erythraea* | . | . | + | + | . | . | . | . | . | . | . | . | + | 1 |
| *Opopanax chironium* | + | . | . | . | . | . | . | . | . | . | . | . | 1 | + |
| *Valantia muralis* | . | . | + | + | . | . | . | . | . | . | . | . | . | . |
| *Allium subhirsutum* | . | . | + | . | . | . | . | . | . | . | . | . | . | + |
| *Sideritis romana* | + | . | . | . | . | . | . | . | . | . | . | . | . | . |
| *Valerianella muricata* | + | . | . | . | . | . | . | . | . | . | . | . | . | . |
| *Brachypodium retusum* | . | . | + | . | . | . | . | . | . | . | . | . | . | . |
| *Dactylis glomerata* ssp. *hispanica* | . | . | + | . | . | . | . | . | . | . | . | . | . | . |
| *Reichardia picroides* | . | . | + | . | . | . | . | . | . | . | . | . | . | . |
| *Anchusella cretica* | . | . | . | . | . | . | . | . | . | . | . | . | + | . |
| **Querco roboris-Fagetea sylvaticae** | | | | | | | | | | | | | | |
| *Ulmus minor* | 1 | + | . | . | . | . | . | . | . | . | . | . | . | . |
| *Tamus communis* | . | . | 2 | 2 | . | . | . | . | . | . | . | . | . | . |
| *Vitis vinifera* ssp. *sylvestris* | . | + | . | . | . | . | . | . | . | . | . | . | . | . |
| *Clematis vitalba* | . | . | . | . | . | . | . | . | . | . | . | . | . | + |
| **Stellarietea mediae** | | | | | | | | | | | | | | |
| *Anagallis arvensis* | + | . | . | . | . | . | . | . | . | . | . | . | + | . |
| *Vicia peregrina* | . | . | 2 | + | . | . | . | . | . | . | . | . | . | . |
| *Vicia villosa* ssp. *varia* | . | . | . | . | . | . | . | . | . | . | . | . | + | + |
| *Fumaria capreolata* | . | . | + | . | . | . | . | . | . | . | . | . | . | . |
| *Crepis sancta* | . | . | . | + | . | . | . | . | . | . | . | . | . | . |
| **Artemisietea vulgaris** | | | | | | | | | | | | | | |
| *Dittrichia viscosa* | . | + | . | . | . | . | . | + | . | . | . | . | . | . |
| *Sonchus asper* ssp. *glaucescens* | . | . | + | + | . | . | . | . | . | . | . | . | . | . |
| *Daucus carota* | . | . | + | . | . | . | . | . | . | . | . | . | . | . |
| *Conyza canadensis* | . | . | . | . | . | . | . | . | . | . | . | . | + | . |
| **Rhamno catharticae-Prunetea spinosae** | | | | | | | | | | | | | | |
| *Paliurus spina-christi* | + | 1 | . | . | . | . | . | . | . | . | . | . | . | . |
| *Rubus ulmifolius* | . | + | . | . | . | . | . | . | . | . | + | . | . | . |
| **Tuberarietea guttatae** | | | | | | | | | | | | | | |
| *Romulea bulbocodium* | . | . | . | . | 1 | 1 | . | . | . | . | . | . | . | . |
| *Linaria pelisseriana* | . | . | . | . | . | . | . | . | . | . | . | . | + | + |
| **Asplenietea trichomanis** | | | | | | | | | | | | | | |
| *Umbilicus horizontalis* | + | . | . | . | . | . | . | . | . | . | . | . | . | . |
| **Parietarietea judaicae** | | | | | | | | | | | | | | |
| *Geranium purpureum* | . | . | + | . | . | . | . | . | . | . | . | . | . | . |
| **Saginetea maritimae** | | | | | | | | | | | | | | |
| *Sagina maritima* | . | . | + | . | . | . | . | . | . | . | . | . | . | . |
| **Crithmo maritimi-Staticetea** | | | | | | | | | | | | | | |
| *Allium commutatum* | . | . | + | . | . | . | . | . | . | . | . | . | . | . |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Vincetoxicum hirundinaria* ssp. *adriaticum* | . | . | + | . | . | . | . | . | . | . | . | . | . | . |
| | | | | | | | | | | | | | | |
| **Other companions** | | | | | | | | | | | | | | |
| *Cladonia* spp. | . | . | . | . | . | . | . | . | 1 | . | . | . | . | . |
| *Pittosporum tobira* | . | + | . | . | . | . | . | . | . | . | . | . | . | . |
| *Opuntia vulgaris* | . | . | . | . | . | . | . | + | . | . | . | . | . | . |

This study revealed the presence of a stand with *Olea sylvestris* and *Narcissus tazetta* (rel. 13) on the islet of GŠ. The highly level of anthropogenic disturbance within the study area does not permit the provision of a precise syntaxonomical reference in terms of association.

## DISCUSSION

Generally, in comparison with the table (Tab. 2) made by Pandža & Milović (2015) for some uninhabited Dalmatian islets with surface areas less than one km$^2$, the islets investigated showed a relatively low variety of vascular plant taxa. These differences are very difficult to evaluate due to variations in the topography (e.g. flat areas, rocky cliffs, level or steep shores, etc.) and the degree of human presence of the Adriatic islets (e.g. Jasprica *et al*., 2014b, Pandža & Milović, 2015, and references therein). This was also found for the islets in the W Mediterranean (e.g. Pasta *et al*., 2014). The differences in floristic diversity among similar sized islets are still unexplained, but this is not a rare pattern on such small islets, which often represent 'unbalanced biota'. However, further investigations on the diversity of vascular flora for more than 400 islets (0.01 – 1 km$^2$) and 600 skerries (<0.01 km$^2$) which have not yet been studied on the eastern Adriatic remain to be carried out.

In our case, the number of taxa on an islet decreases with distance from the peninsula. The richest islet is GŠ with the highest contribution of phanerophytes; this islet is the closest (ca 50 m) to the peninsula of Pelješac and has vegetation similar to that of the peninsula. Our results suggest that the chorological spectrum highlights a clear dominance of the steno-Mediterranean element on all islets. Similarly, Pignatti indicator values did not show differences among the islets. These data confirm the peculiarity of the surveyed area from the phytogeographic point of view.

No real islet specialists have been detected on any of the three considered islets. In addition, it should be emphasised that only one invasive alien taxon, i.e. *Conyza canadensis*, whose presence has been recorded only on GŠ, is common in the circum eastern Adriatic islets (Pandža, 2003; Jasprica *et al*., 2006; Jasprica & Ruščić, 2013). In our case, its cover value at the plot level was low. Although a high level of invasion was predicted for the Mediterranean coastline (Chytrý *et al*., 2009) and islands (Lloret *et al*., 2005; Podda *et al*., 2010; Cardona Pons *et al*., 2013; Brundu, 2014), the currently low number of alien species to be found in the islets may be related to the low level of human activity. Risk of invasion may increase if more species are directly introduced to the islets, and if anthropogenic disturbance and a changing climate make conditions more favourable for alien species (Caujapé-Castells *et al*., 2010; Kueffer *et al*., 2010; Nastos *et al*., 2013). In addition, the incoming of alien species depends on birds so that

diffusion of species having fleshy fruits eaten by birds is facilitated (Lockwood *et al*., 2007).

Regarding the vegetation, the islets also show a relatively low variety of terrestrial plant associations. The relevés of *Limonietum anfracti* (*sensu* Ilijanić & Hećimović, 1982; Hećimović, 1984), identify a new subassociation with the name of *Limonietum anfracti helichrysetosum italici* which is characteristic mostly of flat areas and it is always linked to macchia or forest vegetation. *Helichrysum italicum* always reaches cover values higher than those of the other subassociations under these ecological conditions, as already documented by previous studies (Jasprica, 1983; Trinajstić, 1995; Jasprica & Ruščić, 2013).

Regarding the shrubland vegetation, macchia with *Erica arborea* shows some similarities with that reported for the western Italian coast (Tuscan Archipelago) by Viciani *et al.* (2011). However, in Italy the stands prefer acidic and nutrient-poor soils. In our study, the floristic composition and physiognomy of macchia with *Erica arborea* differ from the *Erico arboreae-Arbutetum unedonis* association reported from the south Adriatic and elswhere (cf. Di Pietro *et al*., 2010; Jasprica *et al*., 2015), despite its many physiognomic and/or ecological variations. Our results show, as is the case in the Iberian Peninsula and southern France, that site colonization by the European rabbit has a negative influence on vegetation through the complete absence or much reduced proportion of both the shrub and herb layers (cf. Lombardi *et al*., 2003; Monzón *et al*., 2004; Sarmento *et al*., 2012; Narce *et al*., 2012).

The *Myrto communis-Pistacietum lentisci* is a community occurring along the Mediterranean coasts from Spain to Croatia. On the eastern Adriatic coast and in Italy, this low macchia is widespread in coastal environments and affected by marine aerosols, and is usually associated with salt-tolerant communities of *Crithmo maritimi-Staticetalia* (Stanisci *et al*., 2005; Brullo *et al*., 2008; Pandža & Krpina, 2010; Viciani *et al*., 2011; Jasprica & Ruščić, 2013). On the Croatian islands, it occupies the hottest and driest sites mostly on slopes under the influence of strong southern winds (Rac & Lovrić, 1998, 2002, 2003). In fact, the association is ecologically and physiognomically closely related to the *Oleo sylvestris-Pistacietum lentisci* association which it also often borders (Jasprica & Dolina, 2012; Vukelić, 2012).

In sum, the study emphasizes the importance of continuous floristic and phytocoenological investigations on the Croatian islands and islets, as has been done by local and foreign authors for other sites in the Adriatic Basin and in some other Mediterranean countries (Jeričević *et al*., 2014, and references therein). The islets are highly vulnerable ecosystems on which intense environmental fluctuations (storms, wave-action) or human interference, even of a low intensity, can considerably affect the flora and vegetation (Vidal *et al*., 1998; Panitsa & Tzanoudakis, 2010). They provide a heritage of biodiversity that must be bequeathed to future generations, as a 'reservoir' at the disposal of the processes of biological evolution and for the ecological value, and as witness to the extraordinary natural history of our country.

## AUTHOR CONTRIBUTIONS

N.J. planned the research; N.J., K.D. conducted the field sampling; M.M., K.D. performed the analyses of flora; N.J. analysed the vegetation data, N.J. and M.M. led the writing, while all authors critically revised the manuscript.

## ACKNOWLEDGEMENTS

The authors thank Croatian Meteorological and Hydrological Service for providing the meteorological data from the Ploče station and Mr. Željko Nožica whos supported us by boat transport to the islets. Thanks are also extended to Drs Rade Garić and Vanja Stamenković for drawing Figures 1 and 3, Steve Latham (UK) for improving the English, and two anonymous reviewers whose observations improved the quality of the final version of the manuscript.

*Received July 31, 2015*

## REFERENCES

Anonymous, 2007: Croatian Programme of protection and use of small, sometimes inhabited and uninhabited islands and surrounding sea. Croatian Goverment.

Anonymous, 2013a: Zakon o zaštiti prirode [The Nature Protection Act]. Narodne novine 80/2013.

Anonymous, 2013b: Pravilnik o strogo zaštićenim vrstama [The Regulation on strictly protected species]. Narodne novine 144/2013.

APO, 2014: Report on the state of the environment of Dubrovnik-Neretva County for the period from 2007 to 2010.

Arrigoni, P.V., Baldini, R.M., Foggi, B. & Signorini, M.A., 2003: Analysis of the floristic diversity of the Tuscan Archipelago for conservation purposes. Bocconea **16**(1), 245-259.

Bakran-Petricioli, T. & Schultz, S., 2010: Biometry and leaf lepidochronology of the seagrass *Posidonia oceanica* in the Croatian Adriatic. In: Proceedings of the 4th Mediterranean Symposium on Marine Vegetation. El Asmi, S.. Langar, H. & Belgacem, W. (eds.). UNEP-MAP- RAC/SPA, Tunis, 28-31.

Bašić, F., 2013: The soils of Croatia. World Soils Book Series. Springer, Dordrecht.

Biel, B., 2002: Contributions to the flora of the Aegean islands of Lesvos and Limnos, Greece. Willdenowia **32**, 209-219.

Biondi, E., Blasi, C., Allegrezza, M., Anzellotti, I., Azzella, M. M., Carli, E. *et al*., 2014: Plant communities of Italy: The Vegetation Prodrome. Plant Biosystems **148**, 728-814.

Boechieri, E., 1992: Flora of the small islands of the archipelago of Maddalena (north-eastern Sardinia) and floristic contribution regarding some of the main islands of the Archipclago. Flora Mediterranea **2**, 33-64.

Bogdanović, S. & Mitić, B., 2003: The flora of the volcanic island of Brusnik (central Dalmatia, Croatia) Acta Botanica Croatica **62**, 103-113.

Bonnier, G., 1911–1935: Flore compléte illustrée en couleurs de France, Suisse et Belgiqe [Complete flora illustrated in colour of France, Switzerland and Belgium]. Neuchatel, Paris et Bruxelles.

Braun-Blanquet, J., 1964: Pflanzensoziologie. Grundzüge der Vegetationskunde [Plant sociology. Basic course of Vegetation Science]. 3. Springer-Verlag, New York.

Brullo, S., Gianguzzi, L., La Mantia, A. & Siracusa, G., 2008: La classe *Quercetea ilicis* in Sicilia [The *Quercetea ilicis* class in Sicily]. Bollettino dell' Accademia Gioenia di Catania **41**, 1-80.

Brundu, G., 2014: Chapter 18: Invasive alien plants in protected areas in Mediterranean islands: knowledge gaps and main threats. In: Plant invasions in protected areas: patterns, problems and challenges. Foxcroft, L.C., Pyšek, P., Richardson, D.M & Genovesi, P. (eds). Springer, Dordrecht, 395-422.

Cardona Pons, E., Estaún, I., Fraga, P. & Comas, M. (eds.), 2013: The Second Botanical Conference in Menorca. Proceedings and abstracts. Islands and plants: preservation and understanding of flora on Mediterranean islands. Colleció Recerca, 20. Institut Menorquí d'Estudis i Consell Insular de Menorca, Maó.

Carta, A., Bedini, G., Guidi, T. & Foggi, B., 2013: Tuscan Archipelago flora: from genesis to conservation. In: Proceedings and abstracts of the 2nd Botanical Conference: Islands and plants: preservation and understanding of flora on Mediterranean. Cardona Pons, E., Estaún, I., Fraga, P. & Comas, M. (eds.): Maó : Institut Menorquí d'Estudis: Consell Insular de Menorca, 157-175.

Caujapé-Castells, J., Tye, A., Crawford, D.J., Santos-Guerra, A., Sakai, A., Beaver, K., Lobin, W., Florens, F.B.V., Moura, M., Jardim, R., Gómes, I. & Kueffer, C., 2010: Conservation of oceanic island

floras: present and future global challenges. Perspectives in Plant Ecology Evolution and Systematics **12**, 107-130.

Chytrý, M., Pyšek, P., Wild, J., Pino, J., Maskell, L.C. & Vilà, M., 2009: European map of alien plant invasions, based on the quantitative assessment across habitats. Diversity and Distributions **15**, 98-107.

Delfroge, P. (ed.), 2006: Orchids of Europe, North Africa and the Middle East (3rd ed.), English translation. A. & C. Black, London.

Delfroge, P., 1995: Orchids of Britain & Europe. Harper Collins Publishers, London.

Dengler, J., Chytry, M. & Ewald, J., 2008: Phytosociology. In: Encyclopedia of Ecology. Jørgensen, S.E. & Fath, B.D. (eds). Elsevier, Oxford, 2767-2779.

Di Pietro, R., Azzella, M. M. & Facioni, L., 2010: The forest vegetati on of the Tolfa-Ceriti mountains (northern Latium – central Italy). Hacquetia **9**(1), 91-150.

Domac, R., 1994: Flora Hrvatske [Flora of Croatia]. Priručnik za određivanje bilja. Zagreb.

Fiori, A., 1923–1929: La Nuova Flora Analitica d'Italia [New analytical flora of Italy]. I–II. Firenze.

Greuter, W., 1994: Extinctions in Mediterranean areas. Philosophical Transactions of the Royal Society, B 344, 41-46.

Greuter, W., 1995: Origin and peculiarities of Mediterranean island floras. Ecologia Méditerranea **21**, 1-10.

Greuter, W., 2001: Diversity of Mediterranean island floras. Bocconea **13**, 55-64.

Hayek, A., 1924-1933: Prodromus florae Peninsulae Balcanicae. I–III. Dahlem bei Berlin.

Hećimović, S., 1984: Vegetation der Inseln Bobara und Mrkan [Vegetation of the islets of Bobara and Mrkan]. The Eighteenth Symposium of the Eastern Alpine and Dinaric Society for Vegetation Ecology. Acta Botanica Croatica **43**, 109-118.

Hegi, G., 1936-1987: Illustrierte Flora von Mittel-Europa [Illustrated flora of Central Europe] (2nd ed.), München.

Horvat, I., Glavač, V. & Ellenberg, H., 1974: Vegetation Südosteuropas [Vegetation of south-eastern Europe]. Gustav Fischer Verlag, Stuttgart.

Horvatić, S. & Trinajstić, I. (eds.), 1967-1981: Analitička flora Jugoslavije 1 [Analytical flora of Yugoslavia 1]. Šumarski fakultet, Sveučilišna naklada Liber. Zagreb.

Ilijanić, Lj. & Hećimović, S., 1982: Das *Limonietum anfracti*, eine neue Assoziation des Verbandes *Crithmo-Limonion* Molinier 1934 [The *Limonietum anfracti*, a new association of the *Crithmo-Limonion* Molinier 1934 alliance]. Acta Botanica Croatica **41**, 87-92.

IUCN, 2014. Guidelines for Using the IUCN Red List Categories and Criteria. Version 11. Prepared by the Standards and Petitions Subcommittee.

Downloadable from http://www.iucnredlist.org/documents/RedListGuidelines.pdf

Jasprica, N., 1983: Struktura i dinamika ekosistema u pukotinama vapnenačkih stijena i u zoni prskanja mora u okolici Janjine (Pelješac). [Structure and dynamic of the vegetation of the rock crevices and rocky seacliffs splashed by salt spray, the peninsula of Pelješac]. Diplomski rad, Prirodno-matematički fakultet, Univerzitet u Sarajevu, Bosna i Hercegovina.

Jasprica, N., 2011: Vegetation outline and NATURA 2000 habitats of the Pelješac peninsula, South Croatia. In: Proceedings of the Conference""Nature Protection in XXI Centur"", Bulić, Z. (ed.). Podgorica : Zavod za zaštitu prirode Crne Gore, Žabljak, Montenegro, September 20-23, 2011, 443-450.

Jasprica, N. & Kovačić, S., 1997: Vascular flora of the central part of Pelješac peninsula. Natura Croatica **6**, 349-456.

Jasprica, N., Hafner, D., Batistić, M. & Kapetanović, T., 2005: Phytoplankton in three freshwater lakes in the Neretva River delta (Eastern Adriatic, NE Mediterranean). Nova Hedwigia **81**, 37-54.

Jasprica, N., Kovačić, S. & Ruščić, M., 2006: Flora and vegetation of Sveti Andrija Island, southern Croatia. Natura Croatica **15**, 27-42.

Jasprica, N. & Kovačić, S. 2010: Pelješac. In: Botanički važna područja Hrvatske [Important Plant Areas in Croatia]. Nikolić, T., Topić J. & Vuković, N. (eds.). Prirodoslovno-matematički fakultet Sveučilišta u Zagrebu i Školska knjiga d.o.o, Zagreb, 335-340.

Jasprica, N. & Kovačić, S., 2011: Raznolikost vegetacije na Pelješcu [The vegetation diversity on the Pelješac peninsula]. In: Zbornik radova u čast Ivice Žile. Lupis, V.B. (ed.). Matica hrvatska – ogranak Dubrovnik, Dubrovnik, 263-282.

Jasprica, N. & Dolina, K., 2012: Ecological characteristics of the *Oleo sylvestris-Ceratonion siliquae* Braun-Blanquet *ex* Guinochet et Drouineau 1944 alliance in Croatia. In: Book of Abstract of ClimMani Workshop 2012. Alebić-Juretić, A. (ed). Medical School, Rijeka, Croatia, Dubrovnik, June 5-8, 2012.

Jasprica, N. & Ruščić, M., 2013: Flora i vegetacija otočića Supetra (Cavtat, južna Hrvatska) [Flora and vegetation of the small islet of Supetar (Cavtat Archipelago, south Croatia]. Hrvatska misao (Sarajevo) **46**, 111-134.

Jasprica, N., Bogdanović, S., Dolina, K., Ruščić, M., Pandža, M. & Kovačić, S., 2014a: Syntaxonomy of *Arundo* stands along the eastern Adriatic coast. Plant Biosystems DOI: 10.1080/11263504.2014.990942.

Jasprica, N., Kovačić, S. & Dolina, K., 2014b: Vegetation of the islands of the Pelješac peninsula archipelago (South Croatia, eastern Adriatic). In: Book of Abstract of 23rd International Workshop of the European Vegetation Survey. Čarni, A., Juvan, N. & Ribeiro, D. (eds.). Ljubljana: Jovan Hadži Institute of Biology ZRC SAZU, Anton Melik Geographical Institute ZRC SAZU, Ljubljana, Slovenia, May 8-12, 2014.

Jasprica, N., Škvorc, Ž., Dolina, K., Ruščić, M., Kovačić, S. & Franjić, J., 2015: Composition and ecology of the *Quercus coccifera* L. along the eastern Adriatic coast (NE Mediterranean). Plant Biosystems DOI: 10.1080/11263504.2014.1001461.

Javorka, S. & Csapody, V., 1975: Iconographia florae partis Austro-orientalis Europae centralis. Akadémiai Kiadó, Budapest.

Jeričević, M., Jeričević, N. & Jasprica, N., 2014: Floristic novelties from the island of Korčula and peninsula of Pelješac (South Croatia). Natura Croatica **23**, 241-253.

Kueffer, C., Daehler, C., Torres-Santana, C. W., Lavergne, C., Meyer, J-Y., Otto, R. & Silva, L., 2010: A global comparison of plant invasions on oceanic islands. Perspectives in Plant Ecology, Evolution and Systematics **12**, 145-161.

Lloret F., Medail, F., Brundu, G., Camarda, I., Moragues, E., Rita, J., Lambdon, P. & Hulme, P.E., 2005: Species attributes and invasion success by alien plants on Mediterranean islands. Journal of Ecology **93**, 512-520.

Lockwood, J., Hoopes, M. & Marchetti, M., 2007: Invasion ecology. Blackwell Publishing Ltd, Oxford, UK.

Lombardi, L., Fernandez, N., Villafuerte, R. & Moreno, S., 2003: Habitat related change in rabbit abundance, distribution and activity. Journal of Mammalogy **84**, 26-36.

Long, J.L., 2003: Introduced mammals of the World: Their history, distribution and influence. CSIRO Publishing, Colling wood, Australia.

Médail, F. & Quézel, P., 1997: Hot-spots analysis for conservation of palnt biodiversity in the Mediterranean Basin. Annals of the Missouri Botanical Garden **84**, 112-127.

Milović, M., Vukelja, N., Pandža, M. & Mitić, B., 2013: The vascular flora of Tribunj and nearby islets of Logorun and Lukovnik (Dalmatia, Croatia). Natura Croatica **22**, 45–71.

Monzón, A., Fernandes, P. & Rodrigues, N., 2004: Vegetation structure descriptors regulating the presence of wild rabbit in the National Park of Peneda-Gerês, Portugal. European Journal of Wildlife Research **50**, 1-6.

Narce, M., Meloni, R., Beroud, T., Pléney, A. & Ricci, J.C., 2012: Landscape ecology and wild rabbit (*Oryctolagus cuniculus*) habitat modeling in the Mediterranean region. Animal Biodiversity and Conservation **35**(2), 277–283.

Nastos, P.T., Politi, N. & Kapsomenakis, J., 2013: Spatial and temporal variability of aridity index in Greece. Atmospheric Research **119**, 140–152.

Nikolić, T., 2006: Flora: priručnik za inventarizaciju i praćenje stanja [Flora: Handbook for inventory and monitoring]. Državni zavod za zaštitu prirode, Zagreb.

Nikolić, T. (ed.), 2015: Flora Croatica baza podataka [Flora Croatica database] (online). Available: http://hirc.botanic.hr/fcd. Botanički zavod, Prirodoslovno-matematički fakultet, Sveučilište u Zagrebu. [last accessed on June 25, 2015].

Nikolić, T., Bukovec, D., Šopf, J. & Jelaska, S. D., 1998: Kartiranje flore Hrvatske – mogućnosti i standardi [The mapping of Croatian flora – opportunities and standards]. Natura Croatica **7** (Suppl. 1), 1-62.

Nikolić, T. & Topić, J. (eds.), 2005: Crvena knjiga vaskularne flore Hrvatske. [Red Book of Vascular Flora of Croatia]. Ministarstvo kulture. Državni zavod za zaštitu prirode. Republika Hrvatska. Zagreb.

Nikolić, T., Antonić, O., Alegro, A., Dobrović, I., Bogdanović, S., Liber, Z. & Rešetnik, I., 2008: Plant species diversity of Adriatic islands: An introductory survey. Plant Biosystems **142**, 435-445.

Nikolić, T., Mitić, B. & Boršić, I., 2014: Flora Hrvatske Invazivne biljke [Flora of Croatia Invasive plants]. Alfa d.d., Zagreb.

Nikolić, T., Milović, M., Bogdanović, S. & Jasprica, N., 2015: Endemi u hrvatskoj flori [Endemics in flora of Croatia]. Alfa d.d., Zagreb.

Pandža, M., 2003: Flora of the island of Žirje and small islands around it (eastern Adriatic coast, Croatia). Acta Botanica Croatica **62**, 115-139.

Pandža, M. & Krpina, V., 2010: Šumska vegetacija Vrgadskih otočića i Vrgade (Dalmacija, Hrvatska) [The forest vegetation of the island of Vrgada and the surrounding islets, Dalmatia, Croatia]. Šumarski list **9-10**, 134, 447-459.

Pandža, M. & Milović, M., 2015: Flora of the islets near Pakoštane (Dalmatia, Croatia). Natura Croatica **24**, 19-35.

Panitsa, M. & Tzanoudakis, D., 2010: Floristic diversity on small islands and islets: Leros islets' group (East Aegean area, Greece). Phytologia Balcanica **16**, 271-284.

Pasta, S., Sciberras, A., Sciberras, J. & Scuderi, L, 2014: Analysis of the vascular flora of four satellite islets of the Egadi Archipelago (W Sicily), with some notes on their vegetation and fauna. Biodiversity Journal **5**, 39-54.

Pignatti, S., 1982: Flora d'Italia [Flora of Italy]. 1-3. Edagricole, Bologna.

Pignatti, S., 2005: Valori di bioindicazione delle piante vascolari della flora d'Italia [Indicator values for vascular plants in the flora of Italy]. Braun-Blanquetia **39**, 3-97.

Podda, L., Fraga, I., Arguimbau, P., Mayoral Garcia-Berlanga, O., Mascia, F. & Bacchetta, G., 2010: Comparación de la flora exótica vascular en sistemas de islas continentales: Cerdeña (Italia) y Baleares (España) [Comparison of the vascular exotic flora in continental islands: Sardinia (Italy) and Balearic Islands (Spain)]. Anales Jardín Botánico de Madrid **67**, 157-176.

Rac, M. & Lovrić, A.Ž., 1998: Halofilna i morska vegetacija u široj okolini Trogira [Halophilous and marine vegetation in the town of Trogir and its surroundings]. In: Zbornik radova Simpozija Kaštela – kolijevka Hrvatske. Hodžić, M. (ed). Matica Hrvatska, Kaštela-Split. Kaštel Stari, September 30-October 3, 1998, 543-547.

Rac, M. & Lovrić, A.Ž., 2002: Benthic and xeric vegetation of remote islands Sušac and Kopišće, and of adjacent seafloors in southern Adriatic. Periodicum biologorum **104**, 139-148.

Rac, M. & Lovrić, A.Ž., 2003: Vegetation and phytonyms in Dugi island, Telašćica islets and surrounding benthos in the north-eastern Adriatic. Periodicum biologorum **105**, 439-451.

Raunkiaer, C., 1934: The life forms of plants and statistical plant geography. Clarendon Press, Oxford.

Rivas-Martínez, S., Sánchez-Mata, D. & Costa, M., 1999: North American boreal and western temperate vegetation (Syntaxonomical synopsis of the potential natural plant communities of North America,II). Itinera Geobotanica **12**, 5-316.

Rivas-Martínez, S., Penas, A. & Díaz, T.E., 2004: Biogeographic Map of Europe. Cartographic Service, Bioclimates, Thermoclimatic Belts. University of León, Spain http://www.globalbioclimatics.org/form/maps.htm [last accessed on July 5, 2015].

Sarmento, P., Cruz, J., Anabela, P., Catarina, E., Capinha, M., Ambrósio, I., Ferreira, C. & Fonseca, C., 2012: Occupancy, colonization and extinction patterns of rabbit populations: implications for Iberian lynx conservation. European Journal of Wildlife Research **58**, 523-533.

Stanisci, A., Feola, S. & Blasi, C., 2005: Map of vegetation series of Ponza island (central Italy). Lazaroa **26**, 93-113.

STATSOFT, 2005: STATISTICA (data analysis software system), version 7.1. Available: http://www.statsoft.com Tulsa: StatSoft Inc.

Trinajstić, I. (ed.), 1975-1986: Analitička flora Jugoslavije 2(1-4) [Analytical flora of Yugoslavia 2(1-4)]. Institut za botaniku Sveučilišta u Zagrebu, Zagreb.

Trinajstić, I., 1995: Vegetacijske značajke otoka Mljeta [Vegetation characteristics of the island of Mljet]. In: Mljet, Priopćenja sa simpozija "Prirodne značajke i društvena valorizacija otoka Mljeta". Durbešić, P. & Benović, A. (eds). Ekološke monografije 6. Hrvatsko ekološko društvo, Pomena, the island of Mljet, September 4-10, 1995, 247-269.

Troia, A., Raimondo, F.M. & Mazzola P., 2012: Mediterranean island biogeography: Analysis of fern species distribution in the system of islets around Sicily. Plant Biosystems **146**, 576-585.

Tutin, T.G., Burges, N.A., Chater, A.O., Edmondson, J.R.E., Heywood, V.H., Moore, D.M., Valentine, D.H., Walters, S.M. & Webb, D.A. (eds.), 1993: Flora Europaea 1 (2nd ed.), Cambridge University Press, Cambridge.

Tutin, T.G., Heywood, V H., Burges, N.A., Moore, D.M., Valentine, D.H., Walters, S.M. & Webb, D.A. (eds.), 1968–1980: Flora Europaea 2–5. Cambridge University Press. Cambridge.

Viciani, D., Albanesi, D., Dell'Olmo, L. & Foggi, B., 2011: Contributo alla conoscenza della vegetazione dell'Isola di Gorgona (Arcipelago Toscano) (con carta in scala 1:5.000) [Contribution to the knowledge of the vegetation of the island of Gorgona (Tuscan Archipelago) (with a map scale of 1:5,000)]. Fitosociologia **48**, 45-64.

Vidal, E., Medail, F. Tatoni, T., Vidal, P. & Roche, P., 1998: Functional analysis of the newly established plants induced by nesting gulls on Riou Archipelago (Marseille, France). Acta Oecologica **19**, 241-250.

Vukelić, J., 2012: Šumska vegetacija Hrvatske [Forest vegetation in Croatia]. Šumarski fakultet, Državni zavod za zaštitu prirode, Zagreb.

Weber, H.E., Moravec, J. & Theurillat, J.P., 2000: International code of phytosociological nomenclature. Journal of Vegetation Science **11**, 739-768.

## APPENDIX 1

Place and date of relevés (phytocoenological tables 4 and 5):

**Table 4**. *Limonietum anfracti helichrysetosum italici*: Rel. 1. Srednjak, 27.4.2014, X=5700332, Y=4759244; Rel. 2. Goljak, 10.3.2015, X=5700949, Y=4759528; Rel. 3*. Goljak, 10.3.2015, X=5700920, Y=4759633 (**holotypus*); Rel. 4. Goljak, 20.5.2015, X=5700799, Y=4759500; **Table 5.** Macchia vegetation: Rels. 1-8. *Myrto communis-Pistacietum lentisci*: Rel. 1. Gospin Škoj, 27.4.2014, X=5700185, Y=4758761; Rel. 2. Gospin Škoj, 27.4.2014, X=5700180, Y=4758805; Rel. 3. Srednjak, 27.4.2014, X=5700342, Y=4759185; Rel. 4. Srednjak, 27.4.2014, X=5700332, Y=4759244; Rel. 5. Goljak, 10.3.2015, X=5700949, Y=4759528; Rel. 6. Goljak, 10.3.2015, X=5700895, Y=4759635; Rel. 7. Goljak, 10.3.2015, X=5700800, Y=4759643; Rel. 8. Goljak, 10.3.2015, X=5700794, Y=4759627; Rels. 9-12. Macchia with *Erica arborea*: Rel. 9. Goljak, 10.3. 2015, X=5700912, Y=4759533; Rel. 10. Goljak, 10.3.2015, X=5700885, Y=4759651; Rel. 11. Goljak, 10.3. 2015, X=5700858, Y=4759662; Rel. 12. Goljak, 10.3.2015, X=5700794, Y=4759627; Rel. 13. *Olea sylvestris-Narcissus tazetta* community, Gospin Škoj, 27.4.2014, X=5700169, Y=4758702; Rel. 14. *Oleo sylvestris-Pistacietum lentisci*: Gospin Škoj, 27.4.2014, X=5700110, Y=4758696.