

# A CONTRIBUTION TO THE KNOWLEDGE OF VASCULAR FLORA OF KRKA NATIONAL PARK

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In this paper we analyse the composition of vascular flora of the Krka National Park after the changes of its boundaries in 1997 and on the basis of published data and results of our field research.

Along with 755 taxa previously registered within the new Park boundaries, 233 new taxa have been found, and total vascular flora now counts 988 taxa. The research is continuing.

**Key words:** vascular flora, new taxa, Krka National Park, Croatia

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Na temelju ranije objavljenih podataka i rezultata našeg terenskog istraživanja u radu se analizira sastav vaskularne flore Nacionalnog Parka »Krka« nakon promjene granica 1997. godine.

Uz 755 svojiti koje su prethodno bile zabilježene za područje Parka u današnjim granicama, pronađene su još 233 svojite, pa ukupna vaskularna flora sada broji 988 svojiti. Istraživanja se nastavljaju.

**Ključne riječi:** vaskularna flora, nove svojite, Nacionalni park »Krka«, Hrvatska

## INTRODUCTION

Krka National Park is situated on the line dividing north and central Dalmatia. It was proclaimed in 1985 within the borders that included area along the River Krka from the old fortifications Trošelj and Nečven in the north, to the bridge »Šibenik« in the south, including the lower canyon course of the Čikola tributary (Fig. 1).

In 1997 changes of the boundaries occurred because of the construction of the Zagreb-Split motorway with the route crossing the Park between Skradin and the

Prokljan Lake. The area between »Skradin« bridge and »Šibenik« bridge (Fig. 1) was excluded from the Park, while the area of the upper flow of River Krka to Knin was included. Total surface of the Park was reduced from the previous 142 km<sup>2</sup> to 109 km<sup>2</sup>.

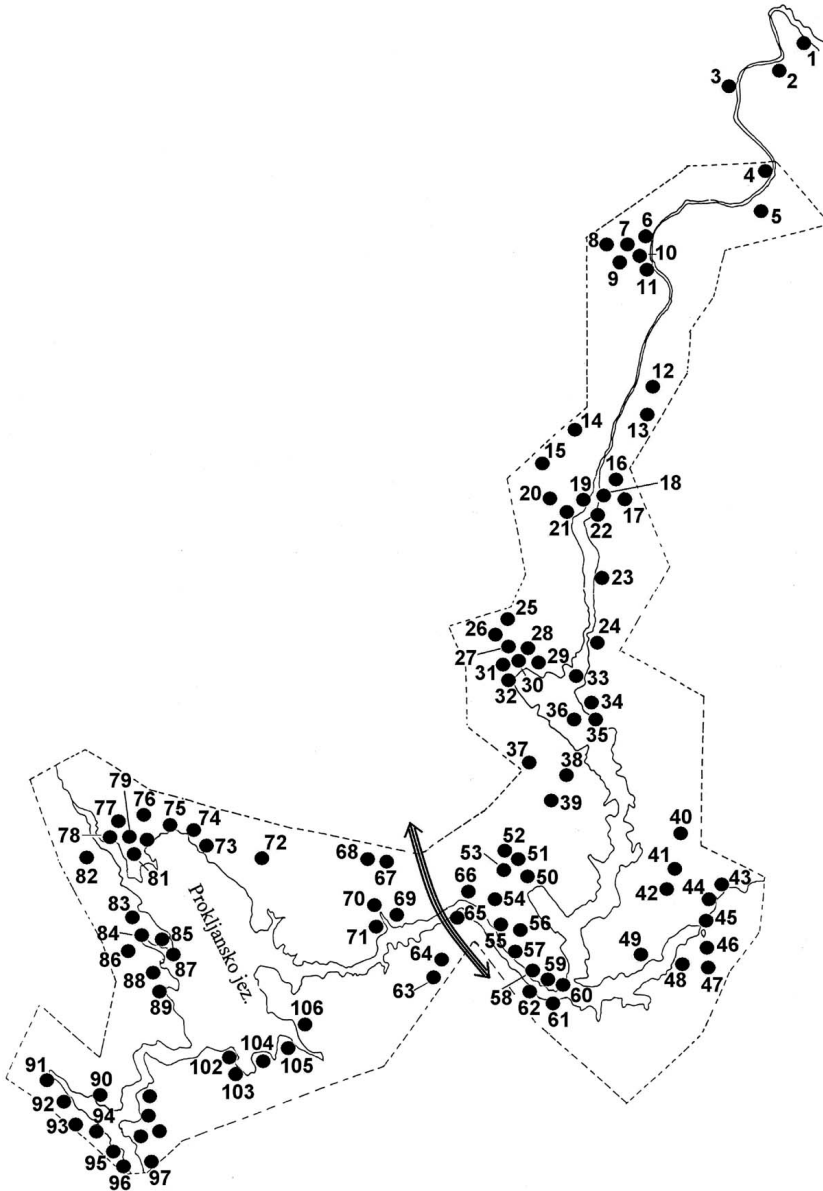


Fig. 1. The area of the Krka National Park within its old boundaries with the localities 1–106 researched by MARKOVIĆ *et al.* (1993). The new southern boundary of Park is pointed out by the arrow.

Regarding phytogeographical position, the area of the Krka National Park within the new boundaries completely belongs to the lower belt of the Submediterranean zone characterised by the zonal forest association *Quercus-Carpinetum orientalis*. In a large part of the Park the association *Quercus-Carpinetum orientalis* has developed in the form of bigger or smaller and thicker or thinner shrubs or bush. Due to degradation these forests have turned into specific anthropogenic forms – thorn scrublands of the order *Rhamno-Paliuretea* as well as dry grasslands and rocky pastures of the order *Scorzonero-Chrysopogonetalia* (MARKOVIĆ *et al.*, 1993; MARKOVIĆ, 2006).

The major part of the excluded area of the Park belongs to the Eumediterranean zone characterised by the zonal evergreen forest association *Orno-Quercetum ilicis*. However, fragments of this association are still sporadically present within the new boundaries of Park, on the warmest slopes of southern exposition in the south part of the Krka River canyon (MARKOVIĆ, 2006).

Just after establishing the National Park, extensive research into cultural and historical as well as natural peculiarities were started, and also into the flora and vegetation of the area. The results were presented at two symposia and published in the Proceedings (KEROVEC, 1990; MARGUŠ, 2007). Several separate publications were published, too (MARGUŠ, 2006; FERİĆ, 2000).

In the classical floristic works from the 19<sup>th</sup> and the beginning of the 20<sup>th</sup> century (VISIANI, 1826, 1842–1852, 1872; HIRC, 1909) as well as in the papers published in the last two decades of the 20<sup>th</sup> century (GAŽI-BASKOVA, 1983; SEKULIĆ & LOVRIĆ, 1986; GARNWEIDNER, 1987; LOVRIĆ & BEDALOV, 1987; LOVRIĆ *et al.*, 1987; LOVRIĆ & RAC, 1989; TRINAJSTIĆ, 1993) mainly individual findings of plants from the area along the Krka River were registered. A detailed survey of research history into flora and vegetation of the area along the River Krka is reported by MARKOVIĆ *et al.* (1990, 1993), therefore it is not going to be dealt with in this paper.

The first systematic research into the flora of the Krka National Park was carried out from 1989 to 1991 by a group of botanists from the Department of Botany of the University of Zagreb. Preliminary results of this research with the list of vascular flora containing 583 taxa were published in 1990 (MARKOVIĆ *et al.*, 1990), and final results three years later (MARKOVIĆ *et al.*, 1993). The final list of flora contains 860 species and subspecies of Pteridophytes and Spermatophytes, found on 106 researched localities within former boundaries of the Park (Fig. 1). The authors presented the list of taxa as well as the qualitative analysis of flora and vegetation and suggestions for preventive measures for its conservation and improvement. As authors pointed out, investigations were not finished because of the onset of war in 1991 (MARKOVIĆ *et al.*, 1993). Thus it could be expected that the total number of 860 plant taxa registered by MARKOVIĆ *et al.* (1993) for the area of Krka National Park was not a complete inventory of its flora.

After the change of boundaries in 1997 no additional researches were carried out to revise and complete the inventory of vascular flora of the Park in new boundaries. In the most recent time findings of 18 neophytes within the new boundaries of Park were published by MILOVIĆ (2007).

The aim of our work was the revision of the inventory of vascular flora of the Krka National Park within its today's boundaries, according to the recent literature data (GAŽI-BASKOVA, 1983; GARNWEIDNER, 1987; MARKOVIĆ *et al.*, 1993; TRINAJSTIĆ, 1993; MILOVIĆ, 2007) and the results of our own fieldwork carried out from 2004 to 2008.

## METHODS

The starting point for revision of the composition of flora of the Krka National Park within its new boundaries was the list of flora of the Park within former boundaries published by MARKOVIĆ *et al.* (1993). All plant taxa registered by MARKOVIĆ *et al.* (1993) for localities marked by numbers 1–62 as well as 65 and 66 (Fig. 1) belong to the inventory of flora of the Park in today's boundaries. Previously registered plant findings for the Park area (GAŽI-BASKOVA, 1983; GARNWEIDNER, 1987) that were not included in the list by MARKOVIĆ *et al.* (1993) as well as the findings published in the most recent time by MILOVIĆ (2007) are added to the flora inventory of the Park in the today's boundaries.

Plant taxa registered by MARKOVIĆ *et al.* (1993) for the localities 63 and 64 as well as 67–106 (Fig. 1) were temporarily excluded from the list of flora of the Park and in our research we had to check whether they grew within the today's boundaries of the Park or not.

The field research was carried out in the period 2004–2008, including all vegetation seasons and different types of habitats on the total of 30 localities (Fig. 2) with particular interest on localities in the north-eastern area (Fig. 2, localities 1–9) that were included in the Park in 1997 and have not been investigated so far. The research along the southern boundaries of the Park (Fig. 2, localities 17–30) was intensified to affirm whether the plant taxa registered by MARKOVIĆ *et al.* (1993) for the area excluded from the Park are present within today's boundaries after all.

The list of flora in this paper contains plant taxa that have not been previously registered within today's boundaries of Park and those found during this research. Among cultivated plant taxa, only those that have the ability of spontaneous spreading out of cultivation were included in the list.

Determination of the plant taxa was done by standard floristic literature: Tutin *et al.* (1968–1980, 1993), PIGNATTI (1982), DOMAC (1994). The nomenclature in the flora list is arranged according to NIKOLIĆ (2008), except in the cases of *Ophrys flavicans* Vis. according to DELFORGE (2006). Plant families and genera with their appertaining species and subspecies are sorted alphabetically within the higher systematic taxa. Numerical marks (1–30, Fig. 2) are given for each species and subspecies for localities they were found on:

- 1 – Maćeševac (1962–244)
- 2 – Marjanovići (1962–244)
- 3 – Kasumi (1962–421)
- 4 – Zelići (1962–423)
- 5 – Marasovine, Liver (1962–433)
- 6 – Bilušića buk (1962–342)
- 7 – Brljansko jezero (1962–343)
- 8 – brunch road to hydroelectric power station »Manojlovac« (2062–343)
- 9 – Puljane (2062–114)
- 10 – Krka Monastery (2061–242)
- 11 – Roški slap, Marasovići (2061–443)
- 12 – Roški slap, entrance to the National Park (2061–444)

- 13 – Rupe, Bužinovac (2161–214)
- 14 – Rupe, by the Lake Visovac (2061–241)
- 15 – islet of Visovac (2161–243)
- 16 – the Lake Visovac, entrance to National Park (2161–342)
- 17 – Dubravice, Čulišić marshes (2161–423)

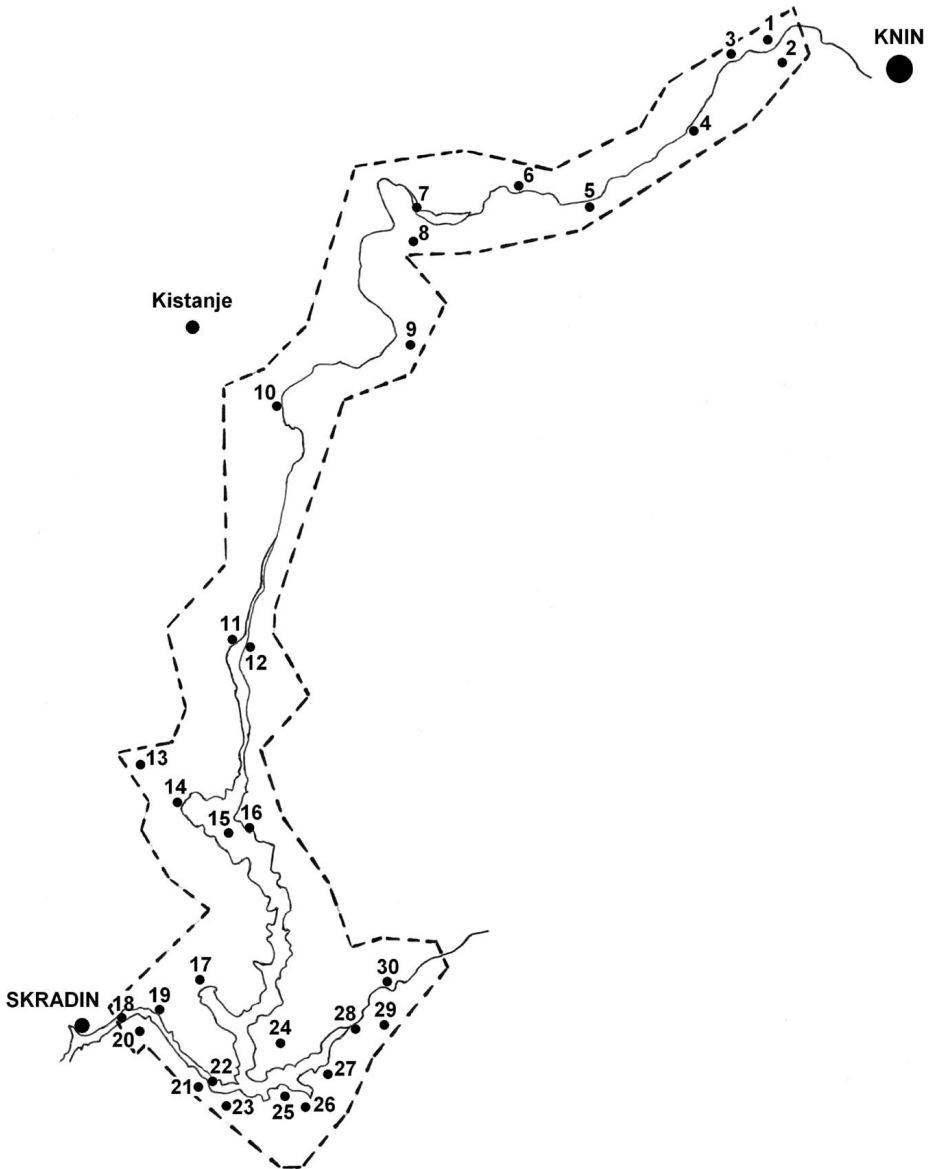


Fig. 2. The today's boundaries of the Krka National Park and position of the localities 1–30 researched in this work.

- 18 – Skradin bridge (2161–432)
- 19 – Žurić hill (2161–432)
- 20 – Lozovac, Erceg (2161–432)
- 21 – Lozovac, factory (2161–443)
- 22 – Skradin waterfall (2161–443)
- 23 – Lozovac, entrance to National Park (2261–221)
- 24 – Nos Kalik (2161–442)
- 25 – Konjevrate, Koštani (2261–222)
- 26 – Konjevrate, Krnići Gornji (2262–111)
- 27 – Goriš, Gligići (2162–333)
- 28 – Čikola, Torak (2162–331)
- 29 – the footway to Ključica, between Goriš and Brnjica (2162–332)
- 30 – Čikola, Ključica (2162–314)

The geocoding of all researched localities in corresponding MTB 1/64 unit was done and denotations are given in brackets.

Types of habitats are stated for all plant taxa and marked by letters in the following way:

- a – watery and marshy habitats
- b – brackish water shore
- c – floody woods and shrubs by the river
- d – damp meadows
- e – rocky ground pasturage
- f – deciduous forests and shrubs
- g – holm oak maquis
- h – cultivated fields
- i – abandoned fields
- j – hedges
- k – ruderal habitats
- l – path and road margins

In the flora list the plant taxa previously registered by MARKOVIĆ *et al.* (1993) for localities south of the Skradin bridge (Fig. 1, localities 63, 64, 67–106) but which were in our research found within the today's boundaries of the Park, are marked by an asterisk (\*) in front of a particular name. The names of these plant taxa are given in the brackets if they differ from the ones in the list of flora adjusted according to NIKOLIĆ (2008).

## RESULTS AND DISCUSSION

Because of the changes of boundaries of Krka National Park, the revision of the list of vascular flora of the Park in the former boundaries stated by MARKOVIĆ *et al.* (1993) was done. Among the total of 860 plant taxa, 732 were found on localities situated within the present boundaries of the Park (Fig 1, localities 1–62, 65, 66) while 128 taxa were registered on localities out of the today's boundaries of the Park (Fig. 1, localities 63, 64, 67–106).

GAŽI-BASKOVA (1983) noted the findings of two species – *Scorzonera humilis* L. (as *S. parviflora* Jacq. ssp. *candollei* Vis.) and *Tetragonolobus maritimus* (L.) Roth for the area between Skradin and Skradin waterfall that were not included in the list of flora of the Park published by MARKOVIĆ *et al.* (1993).

Among the 74 plant taxa that were noted for the area of Skradin waterfall by GARNWEIDNER (1987) there are three species that were not found by MARKOVIĆ *et al.* (1993): *Orobanche hederæ* Duby, *Poa nemoralis* L. and *Rumex sanguineus* L.

In the last survey of the neophytic flora of the area along the River Krka, MILOVIĆ (2007) recorded new findings of 18 neophytes for the area within today's boundaries of the National Park. Among them, there are five taxa previously registered by MARKOVIĆ *et al.* (1993) but for the area excluded from today's boundaries of the Park: *Amaranthus albus* L., *A. deflexus* L., *Ambrosia artemisifolia* L., *Diplotaxis erucoides* (L.) DC. and *Opuntia vulgaris* Miller.

According to the literature data published so far, 755 taxa of vascular plants have been recorded for the area of the Krka National Park within its new boundaries: 732 by MARKOVIĆ *et al.* (1993), two by GAŽI-BASKOVA (1983), three by GARNWEIDNER (1987) and 18 by MILOVIĆ (2007).

During our fieldwork carried out from 2004 to 2008, 233 new taxa of vascular flora were found on the area of Krka National Park.

## THE LIST OF NEW REGISTERED PLANT TAXA

### PTERYDOPHYTA

#### SPHENOPSIDA

##### *Equisetaceae*

\**Equisetum ramosissimum* Desf.; 16; d

### SPERMATOPHYTA

#### GYMNOSPERMAE: CONIFEROPSIDA

##### *Pinaceae*

*Pinus nigra* Arnold ssp. *nigra*; 1, 4, 16, 20; e, f

#### GYMNOSPERMAE: GNETOPSIDA

##### *Ephedraceae*

*Ephedra major* Host; 20; f

#### ANGIOSPERMAE: MAGNOLIOPSIDA

##### *Apiaceae*

*Bunium alpinum* Waldst. et Kit. ssp. *montanum* (Koch) P.W. Ball; 20, 21, 25, 26; e

*Bupleurum praealtum* L.; 10, 17; j

\**Chaerophyllum coloratum* L.; 9, 7, 29, 30, 25, 26; h, i, j

\**Crithmum maritimum* L.; 18; b

*Ferulago campestris* (Besser) Grec.; 9; j

*Peucedanum cervaria* (L.) Lapeyr.; 1; f

*Scandix australis* L.; 3; e

\**Scandix pecten veneris* L. ssp. *pecten-veneris*; 19, 23, 25; h, i, k

\**Seseli pallasii* Besser; 11; g, j

\**Seseli tomentosum* Vis.; 4, 26, 18; e

*Seseli tortuosum* L.; 16, 28, 30; i

*Smyrniium perfoliatum* L.; 4; f, i

*Tordylium maximum* L.; 7, 30; j, k

*Torilis arvensis* (Huds.) Link ssp. *purpurea* (Ten.) Hayek; 7, 10, 19, 16, 26, 27, 29, 30; i, j

#### **Asteraceae**

*Achillea collina* Becker ex Rchb.; 5, 10, 28, 29, 30; e, i, l

*Achillea nobilis* L.; 1; d

\**Anthemis segetalis* Ten.; 7, 28, 30; l, h

*Arctium lappa* L.; 7; k

\**Bellis sylvestris* Cirillo; 12; i

\**Bidens subalternans* DC. (as *B. bipinnata* L.); 12, 13, 15, 16, 17, 18, 22, 24, 16; k, l

\**Calendula arvensis* L.; 17; h, k

*Carlina vulgaris* L.; 29, 30; f, l

*Centaurea rupestris* L.; 26; e

*Cirsium creticum* (Lam.) d'Urv.; 14, d

*Crupina crupinastrum* (Moris) Vis.; 19, 21, 25, 26, 29, 30; e, i

*Inula spiraeifolia* L.; 5, 7; e, i

*Jurinea mollis* (L.) Rchb.; 30; e, f

*Matricaria perforata* Mérat; 5, 28, 30; h, l

*Onopordum acanthium* L.; 10; k

*Senecio bicolor* (Willd.) Tod. ssp. *cineraria* (DC.) Chater; 21; e

\**Senecio vulgaris* L.; 4, 10, 15, 26; h, k, l

*Tussilago farfara* L.; 4; d

*Tyrimnus leucographus* (L.) Cass.; 28, 30; e, i, l

#### **Boraginaceae**

\**Echium plantagineum* L.; 16, 19, 20, 21, 22, 24, 30; e, i, l

*Lithospermum officinale* L.; 16; f

*Lithospermum incrassatum* Guss.; 5, 6, 21, 25; e, f, g

*Neatostemma apulum* (L.) I.M.Johnst.; 20, 21, 26; e, i

#### **Brassicaceae**

*Arabis glabra* (L.) Bernhardt; 3, 5; f, i

*Arabis verna* (L.) R.Br.; 23; f

*Biscutella cichoriifolia* Loisel.; 26; e, l

*Clypeola jonthlaspi* L.; 5, 25; e

\**Erophila verna* (L.) Chevall. ssp. *praecox* (Steven) Walters; 1, 2, 3, 5, 6, 20, 21, 25; e, i, l

\**Lepidium graminifolium* L. ssp. *suffruticosum* (L.) P.Monts.; 13, 17, 24; i, l



*Rorippa lippizensis* (Wulfen) Rchb.; 5; d

\**Sisymbrium orientale* L.; 21, 29, 30; k, l

#### **Campanulaceae**

*Campanula bononiensis* L.; 7, 8; e, f

\**Legousia hybrida* (L.) Delarbre; 5, 7, 21, 25, 26, 27; e, h, l

#### **Caprifoliaceae**

\**Lonicera implexa* Aiton; 18, 19; e, g

#### **Caryophyllaceae**

*Cerastium brachypetalum* Pers. ssp. *roeseri* (Boiss. et Heldr.) Nyman; 5; i

*Cerastium glomeratum* Thuill.; 5; h

*Cerastium ligusticum* Viv. ssp. *trichogynum* (Moschl.) P.D. Sell et Whitehead; 2, 3, 4, 6, 21, 23, 25; e, f

*Cerastium semidecandrum* L.; 6, 25; e, l, h

\**Dianthus ciliatus* Guss. ssp. *ciliatus*; 30; e, f

*Holosteum umbellatum* L.; 2, 3, 5, 25; e, f, l

*Minuartia globulosa* (Labill.) Schinz. et Thell.; 7, 10, 30; e, f

*Minuartia hybrida* (Vill.) Schischkin in Komarov; 6, 20; e, i, l

*Minuartia mediterranea* (Link.) K. Maly; 10, 16, 26, 27; i, l

*Saponaria officinalis* L.; 1, 5; c

*Silene italica* (L.) Pers.; 6, 29; f

*Silene otites* (L.) Wibel; 4, 7, 8, 20, 29, 30; e, f

\**Silene paradoxa* L.; 10, 20, 29; f

*Stellaria pallida* (Dumort) Piré; 6, 25; h, l

#### **Ceratophyllaceae**

*Ceratophyllum submersum* L.; 28; a

#### **Chenopodiaceae**

\**Chenopodium ambrosioides* L.; 5; k

\**Chenopodium murale* L.; 10; k

*Polycnemum majus* A. Braun; 7; l

#### **Cichoriaceae**

*Cichorium endivia* L. ssp. *endivia*; 28; l

*Crepis vesicaria* L. ssp. *vesicaria*; 5, 6, 25; d, i, e, l

\**Crepis zacintha* (L.) Babç.; 26, 29, 30; e, l

*Hieracium hoppeanum* Schult. ssp. *testimoniale* Nägeli et Peter; 6; e

*Hypochoeris cretensis* (L.) Bory et Chaub.; 22; l

*Picris hieracioides* L. ssp. *spinulosa* (Bertol. ex Guss.) Arcang.;

*Sonchus arvensis* L.; 5; h

*Sonchus tenerrimus* L.; 14; h

*Taraxacum hoppeanum* Griseb.; 6; e

*Taraxacum megalorrhizon* (Forssk.) Hand.-Mazz.; 24; l

*Tragopogon tommasinii* Sch.Bip.; 16; i

**Cistaceae**

*Fumana thymifolia* (L.) Spach ex Webb; 16; e

**Convolvulaceae**

*Calystegia sylvatica* (Kit.) Griseb.; 6, 7, 10, 14, 18; c

**Crassulaceae**

*Sedum dasyphyllum* L.; 27, 29, 30; e

*Sedum rubens* L.; 7; e

**Cuscutaceae**

*Cuscuta europaea* L.; 26; h

**Dipsacaceae**

*Sixalix atropurpurea* (Forrsk.) Greuter et Burdet ssp. *maritima* (L.) Greuter et Burdet; 18; l

**Euphorbiaceae**

\**Chrozophora tinctoria* (L.) A. Juss.; 14; h

*Euphorbia cyparissias* L.; 1, 2, 3; f, l

*Euphorbia peplus* L.; 10, 15; h, k, l

**Fabaceae**

*Cercis siliquastrum* L. ssp. *siliquastrum*; 15, 18, 28; k, l

*Hippocrepis biflora* Spreng.; 16, 20, 25, 29; e, l

*Hippocrepis ciliata* Willd.; 16, 29, 30, 26; e

*Lathyrus cicera* L.; 1, 5, 6, 25; e, i

*Lathyrus pannonicus* (Jacq.) Garcke; 1; f

*Lathyrus saxatilis* (Vent.) Vis.; 19; e

*Lathyrus sphaericus* Retz.; 16, 26; e

*Medicago coronata* (L.) Bartal.; 20, 29, 30; e, i

*Medicago falcata* L.; 17, 27, 29, 30; i, l

*Medicago littoralis* Rohde ex Loisel.; 18; b, l

*Medicago polymorpha* L.; 17, 18; e, l

*Melilotus albus* Medik.; 5, 7; d, l, l

*Ononis ornithopodioides* L.; 18; e

*Ononis reclinata* L.; 16, 20, 22, 26; e, i

*Scorpiurus muricatus* L.; 16; l

*Trifolium echinatum* M.Bieb.; 28, 30; d

*Trifolium incarnatum* L.; 6; i

*Trifolium lappaceum* L.; 16; e

*Trifolium repens* L. ssp. *prostratum* Nyman; 6, 7; d

*Trifolium tomentosum* L.; 20; l

*Trigonella gladiata* M. Bieb.; 16, 21; e

*Vicia angustifolia* L.; 5, 6, 7, 10, 16, 19, 23, 25, 26, 29, 30; e, i, j, l

*Vicia grandiflora* Scop.; 6, 18; f, i

*Vicia melanops* Sm.; 3, 5, 25; i, j

**Fumariaceae**

*Fumaria capreolata* L.; 20; e

**Geraniaceae**

\**Erodium ciconium* (L.) L'Her; 7, 22, 24, 25; h, k, l

\**Geranium dissectum* L.; 10; d

*Geranium molle* L. ssp. *brutium* (Gasparr.) Graebn.; 1, 2, 3, 5, 6, 10, 12, 19, 20, 22, 23, 25, 28, 30; h, i, l

**Juglandaceae**

*Juglans regia* L.; 5, 6, 7, 10, 11, 12, 13, 14, 15, 17, 22, 24; h, i

**Lamiaceae**

*Calamintha grandiflora* (L.) Moench; 16, 17; f

*Hyssopus officinalis* L.; 3; e, f

*Leonurus cardiaca* L.; 4; k

*Melissa officinalis* L.; 5, 10; f, i

*Salvia verbenaca* L.; 5, 7, 16, 17; i, l

*Satureja montana* L. ssp. *variegata* (Host) P.W. Ball; 1-7, 12-16, 18, 21-27, 29, 30; e, f, g, i

*Scutellaria altissima* L.; 10; d

*Stachys subcrenata* Vis.; 26; e

**Linaceae**

*Linum strictum* L. ssp. *corymbulosum* (Rchb.) Riony; 16, 26; e, i

\**Linum strictum* L. ssp. *strictum* (as *L. strictum* L.); 19, 20, 27; e, i

**Malvaceae**

*Alcea biennis* Winterl; 30; l

*Alcea setosa* (Boiss.) Alef.; 30; l

\**Hibiscus trionum* L.; 5, 16; h

**Moraceae**

*Morus alba* L.; 10, 15, 16, 22, 24; c, l

**Onagraceae**

*Epilobium dodonaei* Vill.; 16; l

*Epilobium tetragonum* L. ssp. *tetragonum*; 13; c

*Ludwigia palustris* (L.) Elliott; 10; a

**Orobanchaceae**

*Orobanche minor* Sm.; 7, 30, 26; e, f

**Papaveraceae**

*Papaver apulum* Ten.; h

**Plantaginaceae**

*Plantago major* L. ssp. *major*; 5; h

**Polygonaceae**

\**Rumex pulcher* L. ssp. *pulcher*; 24; l

**Portulacaceae**

\**Portulaca oleracea* L. ssp. *oleracea*; 13, 15, 24, 30; h, l

**Primulaceae**

\**Samolus valerandi* L.; 10; a

**Ranunculaceae**

*Ranunculus illyricus* L.; 5, 6; e

*Thalictrum minus* L.; 26, 29, 30; e

**Resedaceae**

\**Reseda phyteuma* L.; 10, 16, 17, 21; e, h, l

**Rosaceae**

*Potentilla detommasii* Ten.; 26; e

*Potentilla recta* L.; 26, 27; e

*Prunus cerasifera* Ehrh.; 5, 10, 22; j, l

*Prunus dulcis* (Mill.) D.A. Webb; 6, 16, 20, 25, 26; i, k, l

*Prunus persica* (L.) Batsch; 1, 5, 15, 22; k, l

*Pyracantha coccinea* M.J. Roemer; 16; j

\**Sorbus domestica* L.; 5, 17; f, i

**Rubiaceae**

*Galium verum* L.; 10, 28, 30; d, j

**Rutaceae**

*Dictamnus albus* L.; 6; f

*Haplophyllum patavinum* (L.) G. Don; 25; e

\**Ruta graveolens* L.; 7, 25, 26, 29, 30; e, f

**Santalaceae**

\**Thesium divaricatum* Jan. ex Mert. et Koch; 4, 6, 21, 26; e, f, i

**Saxifragaceae**

*Saxifraga tridactylites* L.; 1, 2, 5, 6, 20, 21, 22, 23, 25, 27; e, f, l

**Scrophulariaceae**

*Chaenorhinum minus* (L.) Lange ssp. *litorale* (Willd.) Hayek; 17, 29; l

\**Cymbalaria muralis* P. Gaertn., B.Mey et Scherb.; 22; k

*Digitalis laevigata* Waldst. et Kit.; 4; f

*Kickxia commutata* (Bernh. ex Rchb.) Fritsch; 14; h

*Kickxia spuria* (L.) Dumort.; 14, 17; h, k

\**Linaria angustissima* (Loisel.) Borbás; 17, 27; i, k, l

\**Linaria simplex* (Willd.) DC.; 16, 21, 25, 26, 29, 30; e, f

\**Odontites lutea* (L.) Clairv.; 4, 16; e, i

*Odontites vulgaris* Moench; 16; l

*Verbascum blattaria* L.; 10, 17, 28, 30; d, i

*Verbascum phoeniceum* L.; 3, 6; i

**Valerianaceae**

*Valeriana officinalis* L. ssp. *collina* (Wallr.) Nyman; 6; c

*Valeriana tuberosa* L.; 1, 3, 2, 4, 5, 21, 23, 25, 27; e, f

\**Valerianella discoidea* (L.) Loisel.; 25; i

*Valerianella echinata* (L.) DC.; 25; h, i

*Valerianella muricata* (Stiven ex M. Bieb.) J.W. Loudon; 16, 19, 21, 27; h, i, l

#### **Verbenaceae**

\**Vitex agnus-castus* L.; 26; l

#### **Violaceae**

\**Viola arvensis* Murray; 10, 16, 23, 25; e, h, i

*Viola kitaibeliana* Schultes; 5, 25; e

### **ANGIOSPERMAE: LILIOPSIDA**

#### **Araceae**

\**Biarum tenuifolium* (L.) Schott; 25; e

#### **Cyperaceae**

\**Carex extensa* Gooden.; 18; b

*Carex flacca* Schreb. ssp. *serrulata* (Biv.) Greuter; 6, 29, 30; e, f

*Carex vulpina* L.; 29, 30; a, d

\**Schoenus nigricans* L.; 19; b

#### **Iridaceae**

*Crocus biflorus* Mill. (incl. *C. weldenii* Hoppe et Füm. nom. nud.); 4; e

*Crocus thomasi* Ten.; 4, 5; e

*Gladiolus illyricus* W.D.J. Koch; 25, 27; i

*Iris adriatica* Trinajstić ex Mitic; 2, 25; e, f

*Iris germanica* L.; 4, 24; i, l

#### **Juncaceae**

*Juncus acutiflorus* Ehrh. ex Hoffm.; 10; a

\**Juncus gerardi* Loisel.; 28, 30; a, d

#### **Liliaceae**

\**Allium ampeloprasum* L.; 18, 20; l

*Allium vineale* L.; 10; i

*Anthericum liliago* L.; 22; e

*Asphodeline liburnica* (Scop.) Rchb.; 7; e

*Colchicum hungaricum* Janka; 1, 2, 3, 4; e, i

\**Colchicum visianii* Parl.; 6, 17; e, i

*Fritillaria orientalis* Adams; 2; f

*Muscari botryoides* (L.) Mill.; 1, 2; e, f

*Ornithogalum comosum* L.; 3, 6, 20, 21, 23, 26, 27; e, f

*Tulipa sylvestris* L.; 26, 29; e, f

#### **Orchidaceae**

*Cephalanthera damasonium* (Mill.) Druce; 25; f

*Epipactis microphylla* (Ehrh.) Sw.; 6, 16; f

*Ophrys bertolonii* Moretti; 25, 26; e, i

*Ophrys dinarica* Kranjcev et P. Delforge; 12; f  
*Ophrys incantata* Devillers et Devillers-Tersch.; 5, 22, 25; e, i  
*Ophrys scolopax* Cav. ssp. *cornuta* (Steven) E.G. Camus; 25, 26; e, i  
*Ophrys sphegodes* Mill.; 22; e  
*Ophrys flavicans* Vis.; 16, 23, 25; e, i  
*Orchis morio* L.; 5; e  
*Orchis quadripunctata* Cirillo ex Ten.; 5, 25; e, i

#### Poaceae

\**Aegilops neglecta* Req. ex Bertol.; 10, 19, 20, 21, 26, 29, 30; e, i, l  
*Agrostis castellana* Boiss. et Reut.; 10; d  
*Alopecurus myosuroides* Huds.; 30; d  
*Brachypodium pinnatum* (L.) P. Beauv. ssp. *rupestre* (Host) Schübl. et M. Martens; 16, 20; e, f, i  
*Bromus arvensis* L.; 29, 30; d; h  
*Bromus intermedius* Guss.; 21; h, l  
*Bromus rigidus* Roth; 7, 18, 22, 27;  
*Bromus secalinus* L.; 29, 30; d  
*Calamagrostis epigejos* (L.) Roth; 5; d  
\**Cleistogenes serotina* (L.) Keng; 7, 16, 24; e, l (as *C. serotina* (L.) Keng ssp. *serotina*)  
\**Elymus pycnanthus* (Godr.) Melderis; 18; b  
*Eragrostis cilianensis* (All.) F.T. Hubb.; 5; l  
*Eragrostis minor* Host; 16, 4, 7; h, l  
*Festuca illyrica* Marikgr.-Dann.; 2, 3, 4, 6, 20, 21, 25, 26, 27; e  
*Hordeum secalinum* Schreb.; 5; d  
*Lagurus ovatus* L.; 22; l  
*Lolium multiflorum* Lam.; 27; l  
*Lolium rigidum* Gaudin ssp. *lepturoides* (Boiss.) Sennen et Mauricio; 16; h  
\**Lolium rigidum* Gaudin ssp. *rigidum*; 7, 16, 29, 29, 30; h, l  
*Molinia caerulea* (L.) Moench ssp. *caerulea*; 16; d  
*Piptatherum virescens* (Trin.) Boiss.; 22; c  
*Psilurus incurvus* (Gouan) Schinz et Thell.; 10, 16, 29, 30; e, f  
\**Puccinellia festuciformis* (Host) Parl.; 22; b  
*Sorghum bicolor* (L.) Moench; 5; h  
*Tragus racemosus* (L.) All.; 24; l

The list contains 233 taxa new for the area of Krka National Park, and together with 755 previously noted taxa vascular flora of the Park within the new boundaries counts 988 taxa. Among 233 new taxa there are 52 (in the list of flora marked by an asterisk) previously registered by MARKOVIĆ *et al.* (1993) for the area outside today's boundaries of the Park.

From the total of 128 taxa noted by MARKOVIĆ *et al.* (1993) for the area excluded from the Park, 57 taxa were additionally found within the new boundaries of the Park – 5 taxa by MILOVIĆ (2007) and 52 in this research. Some taxa among the remaining 71 can be expected to be found in future investigations, while part of the taxa might not be growing within today's boundaries of the Park, for example some typical halophytic species: *Inula crithmoides*, *Limonium cancellatum*, *L. narbonense*, *Salicornia europaea*, *Halimione portulacoides*, *Artemisia coerulescens* etc. However some halophytic species (*Crithmum maritimum*, *Elymus pycnanthus*, *Puccinellia festucaiformis*) that are usual in the lower flow of the River Krka (MARKOVIĆ *et al.*, 1993) were found within today's boundaries of the Park (localities of Skradin Bridge and Skradin waterfall) which confirms a slight influence of saltwater even to the Skradin waterfall. Among the new taxa registered during this research, particularly interesting are findings of taxa from *Orchidaceae* family, all of them protected by National Law, and the majority listed as threatened taxa (NIKOLIĆ & TOPIĆ, 2005): *Cephalanthera damasonium*, *Epipactis microphylla*, *Ophrys bertolonii*, *O. dinarica*, *O. incantata*, *O. scolopax* ssp. *cornuta*, *O. sphegodes*, *Orchis morio* and *O. quadripunctata*.

There are interesting findings of relatively rare species *Crocus thomasi* and *Tulipa sylvestris*, and findings of endemic species *Iris adriatica* which were found in the vicinity of villages Marjanovići and Koštani (Fig. 2; localities 2 and 25).

During their research into the flora and vegetation in the canyons of Croatian karst rivers some authors reported individual taxa findings for Krka and Čikola (SEKULIĆ & LOVRIĆ, 1986; LOVRIĆ & BEDALOV, 1987; LOVRIĆ & RAC, 1989). Among them there is the finding of endemic species *Moltkia petraea* (Tratt.) Griseb. The authors state this species grows in the canyon of the River Krka (without a precise site) as well as on the locality at the entrance to the canyon of Čikola River near Drniš (LOVRIĆ *et al.*, 1987) which is not in the boundaries of the Park. During the research carried out by MARKOVIĆ *et al.* (1993) as well as during this research, the species *Moltkia petraea* was not found within the boundaries of the Park. Therefore this species has not been included in the list of flora of the Krka National Park.

Diversity of the vegetation was reduced along with the change of the boundaries of the Park in 1997 because the area which belongs to the Eumediterranean zone of the holm oak (*Quercus ilex*) woods was excluded from the Park, as well as the vegetation of muddy habitats by the shores of the Prokljan Lake. The fragments of the evergreen vegetation are found sporadically within today's boundaries of the National Park, on the slopes along the canyon of the River Krka with the southern exposition.

After this research the vascular flora of the Krka National Park within its new boundaries contains the total of 988 taxa, in relation to 860 taxa of the Park within its former boundaries stated by MARKOVIĆ *et al.* (1993) thus in spite of the significant reduction of the Park surface (from 142 km<sup>2</sup> to 109 km<sup>2</sup>), the total number of taxa has not decreased, but increased. That is surely the result of better exploration of the Park flora. As the research go on, the total flora of the Park is expected to be counting about 1000 species and subspecies. The great richness of the Park flora is the result of its phytogeographic position near the boundary of the Eumediterranean and Submediterranean vegetation zones, as well as of the great diversity of habitats and longlasting and powerful anthropogenic influences on flora and vegetation of this area.

## CONCLUSION

The first systematic research of the Krka National Park flora within its former boundaries were carried out from 1989–1991 and 860 vascular plant taxa were registered (MARKOVIĆ *et al.*, 1993). After the change of boundaries in 1997 the revision of the literature data was necessary as well as the additional exploring of the flora of Krka National Park.

Before this research 755 species and subspecies of Pteridophytes and Spermatophytes were registered for the Park area within the new boundaries (GAŽI-BASKOVA, 1983; GARNWEIDNER, 1987; MARKOVIĆ *et al.*, 1993; MILOVIĆ, 2007). It could be supposed that this number was not definitive and that was confirmed in our research when 233 new plant taxa for the area of the Park were registered. Thus Krka National Park vascular flora inventory now contains 988 taxa within its new boundaries.

Among cultivated taxa that grow in the area of Krka National Park, only those that have the ability of subsponaneous spreading outside the cultivation are included in the inventory of the flora of Park.

The research into the vascular flora is continuing with the accent on taxa findings that have not been registered so far, as well as on the research into the distribution of the registered taxa in different parts of the National Park and inventarization of the cultivated plants.

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## SAŽETAK

### Prilog poznavanju vaskularne flore Nacionalnog Parka »Krka«

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Nakon promjene granica Nacionalnog parka »Krka« 1997. godine bilo je neophodno uskladiti postojeće podatke o vaskularnoj flori s novonastalim stanjem. Uz analizu dosad objavljenih podataka, obavili smo i dopunska terenska istraživanja u razdoblju 2004.–2008. godine.

Kao polazište za analizu poslužio je popis vaskularne flore Parka u starim granicama (MARKOVIĆ *et al.*, 1993) u kojem se navodi ukupno 860 svojti te noviji radovi

u kojima su objavljeni pojedinačni nalazi svojti s ovog područja. Prema obrađenoj literaturi, za područje Nacionalnog parka »Krka« u novim granicama, prije terenskog dijela ovog istraživanja, bilo je zabilježeno ukupno 755 svojti.

Tijekom ovog istraživanja zabilježene su 233 nove svojte, pa sada vaskularna flora Nacionalnog parka »Krka« sadrži ukupno 988 svojti. Istraživanja se nastavljaju s ciljem utvrđivanja rasprostranjenosti pojedinih svojti u različitim dijelovima Parka te inventarizacije kultiviranih svojti.