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CONTRIBUTION TO THE URBAN FLORA OF ZAGREB (CROATIA)

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The process of urbanization is one of the most extreme forms of anthropogenic habitat modification. Negative trends and their effects on the one hand, and concern for the preservation of biodiversity and quality of city life on the other, are the initiators of urban flora research. The flora of urban areas in Croatia has not been the subject of sustained research and therefore floristic records for most of the larger cities are unknown. The research area is located in northwest Croatia in the city of Zagreb, on the right bank of the Sava River. In the area of Konopljenka and Piškorovo a total of 351 taxa of vascular plants belonging to 81 families were recorded. Seven of them (2%) were pteridophytes (Equisetidae), two of them (0.6%) gymnosperms (Pinidae), and others were angiosperms (Magnoliidae). Among angiosperms, 71 taxa (20.2%) belong to monocotyledons (superorder Lilianae) and the other 271 taxa (77.2%) from 65 families belong to other superorders of angiosperms. Families with the highest number of taxa are Poaceae (11.4%), Asteraceae (9.1%), Fabaceae (7.4%), Lamiaceae (5.7%) and Rosaceae (5.4%). Phytogeographical analysis showed that the Eurasian geoelement predominated (30.1%), followed by cosmopolites (27%). The most common life forms are hemicryptophytes (48.1%), therophytes (22.2%) and phanerophytes (11.4%). Among recorded taxa 22 are invasive alien species (6.3%), two taxa (0.57%) are threatened and 64 taxa (18.2%) are under legal protection. If we compare the number of species per unit area and proportion of protected and threatened species with the results of similar floristic researches in central and north Croatia we can conclude that it is a relatively rich floristic area.

Key words: urban flora, invasive species, Konopljenka, Piškorovo, Zagreb, Croatia

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Proces urbanizacije jedan je od ekstremnih oblika preinake staništa koju čovjek može poduzeti. Negativni trendovi i njihovi učinci s jedne strane, te briga za očuvanjem bioraznolikosti gradova i kvalitete života s druge, pokretači su istraživanja urbanih flora. U hrvatskim razmjerima urbane flore nisu bile predmetom osobito intenzivnih istraživanja te za većinu većih gradova nisu poznate. Proučavano područje smješteno je u sjeverozapadnom dijelu Hrvatske u gradu Zagrebu, na desnoj obali rijeke Save, desetak kilometara jugozapadno od centra grada. Na području Konopljenke i Piškorova zabilježena je 351 svojta vaskularnih biljaka iz 81 porodice. Od toga su sedam svojti (2%) papratnjače (Equisetidae), dvije svojte (0,6%) su golosjemenjače (Pinidae), a ostalo su kritosjemenjače (Magnoliidae). Među kritosjemenjačama 71 svojta (20,2%) pripada jednosupnicama (nadred Lilianae), a ostale 271 svojte (77,2%) iz 65 porodica su pripadnici ostalih nadredova kritosjemenjača. Vrstama najbogatije porodice su Poaceae (11,4%), Asteraceae (9,1%), Fabaceae (7,4%), Lamiaceae (5,7%) i

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Rosaceae (5,4%). Fitogeografska analiza pokazala je da su najzastupljenije svojte euroazijskog flornog elementa (30,1%) te široko rasprostranjene svojte (27%). Od životnih oblika najzastupljeniji su hemikriptofiti (48,1%), terofiti (22,2%) i fanerofiti (11,4%). Zabilježene su 22 invazivne svojte (6,3%), dvije svojte (0,57%) imaju status ugroženosti, a 64 svojte (18,2%) su pod zakonskom zaštitom. Usporedimo li broj vrsta po jedinici površine te udio zaštićenih i ugroženih svojti s rezultatima sličnih floristićkih istraživanja na području središnje i sjeverozapadne Hrvatske, možemo zaključiti da se radi o relativno bogatom području.

Ključne riječi: urbana flora, invazivne vrste, Konopljenka, Piškorovo, Zagreb, Hrvatska.

INTRODUCTION

The process of urbanization is one of the most extreme forms of anthropogenic habitat modification. A fairly large number of side effects, negative with respect to biodiversity, are related to this anthropogenic influence – alterations that make habitats completely uninhabitable, fragmentation, changes in ecological conditions, modifications of the qualitative and quantitative species composition etc. Modifications due to urbanization are more permanent then those caused by other anthropogenic activities, such as agriculture, because there is little or no possibility of restoring the original habitat type (THOMPSON & MCCARTHY, 2008).

The expected negative effects on flora such as loss of diversity and homogenization of flora are reported in many cities (MORACZEWSKI & SUDNIK-WOJCIKOWSKA, 2007; WITTIG & BECKER, 2010). Some authors like CHOCHOLOUŠKOVÁ & PYŠEK (2003), SUKOPP (2003), ZERBE *et al.* (2003), PYŠEK *et al.* (2004a) and VAN DER VEKEN *et al.* (2004) report reduction of species number in cities and increase of species number in the surroundings. At the same time, vegetation and related flora in urban surroundings provide some of the elementary functions of ecosystems – the effect on air quality, temperature, water content, filtration and soil drainage, and have an important social value (WILLIAMS *et al.*, 2009).

Negative trends and their effects on one hand, and concern for the preservation of biodiversity and quality of city life on the other, are the main reasons behind urban flora research. However, the amount of available data for the world, as well as for Europe, is very unequally distributed. In some cases urban areas are very well investigated and the data are systematically gathered virtually for centuries, which allows trend analysis (LANDOLT, 2000; PYŠEK *et al.*, 2004a; VAN DER VEKEN *et al.*, 2004). In other cases the floristic data for a vast number of cities are unknown and therefore research is necessary (WILLIAMS *et al.*, 2009).

The flora of the urban areas in Croatia has not been the subject of sustained research and therefore floristic records for most of the larger cities (>50.000 residents) are unknown. Floristic data for Split (RUŠČIĆ, 2003), Zadar (MILOVIĆ, 2008) and Omiš (TAFRA, 2009) are more an exception than the rule. Reports of the flora and vegetation of Zagreb and its surroundings are more numerous than of other cities in Croatia. On the other hand floristic data of the urban part of Zagreb are almost non-existing. Mapping of certain urban zones (Jarun, Maksimir, Savica) was conducted during 2006 within the project Countdown 2010 Zagreb (NIKOLIĆ *et al.*, 2007), when a new invasive species was recorded (ALEGRO *et al.*, 2010). TRINAJSTIĆ (2000) recorded another new taxon for the Croatian flora in the city of Zagreb. Furthermore the city of Zagreb is growing rapidly, both in size and population so the changes in urban flora are likely to be consistent with those observed in other European cities.

The area along the Sava River, which is the axis of the city plan, was partially investigated on several occasions. The first floristic data, however sparse, relating to the studied area date from the second half of the 19th (SCHLOSSER & VUKOTINOVIĆ, 1869), and the beginning of the 20th century (GJURAŠIN 1923, HORVATIĆ 1931). In the last fifty years contributions to the knowledge of the flora of this area were provided by GOSPODARIĆ (1958), HORVATIĆ & GOSPODARIĆ (1959–60), MARKOVIĆ-GOSPODARIĆ (1965), MARKOVIĆ (1970; 1973; 1975; 1978), TOPIĆ & ŠEGULJA (1978), LUKAČ (1988), ILIJANIĆ *et al.* (1989), SMITAL *et al.* (1998), NIKOLIĆ & FADLJEVIĆ (1999), HRŠAK (2002), MILOVIĆ (2004) and MITIĆ *et al.* (2007).

In order to make a contribution to the urban flora of Zagreb, in the context of the previous remarks, mapping of the flora in the area of Konopljenka and Piškorovo in the southwest part of the city on the right bank of the Sava River was conducted. This, an only partially built-up area, with elements of semi-natural habitats, greatly enriches the diversity of the flora of the City of Zagreb and represents a contribution to the overall knowledge of the urban flora.

MATERIAL AND METHODS

Study area

The investigated area of Piškorovo and Konopljenka (so-called area of »Sveučilišna bolnica«) is located in the city of Zagreb, on the right bank of the Sava River, approximately 10 kilometers southwest of downtown. It covers an area of about 8 km^2, which is in the northeast bordered by the Sava River embankment and in the southeast by Jadranska avenija [street]. The researched area is located in the MTB square units 0261.1 and 0261.2 (Fig. 1).

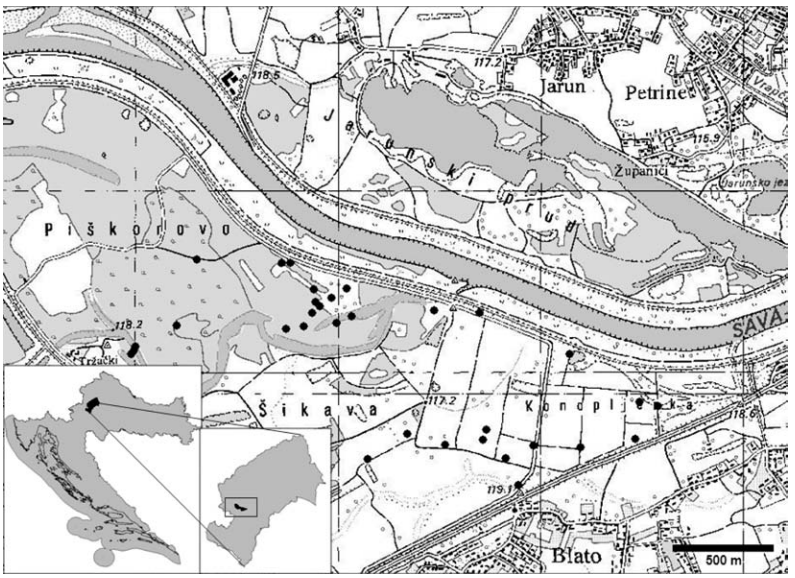

Fig. 1. Geographical position of the investigated area. On the 1:25.000 scale topographic map, the research sites are marked with black dots.

The climate is continental, typical of the northwest part of Croatia. Annual precipitation varies from 594.1 mm to 1026.1 mm (annual average is 838.8 mm). The average monthly precipitation varies from 36.9 mm (February) to 96.7 mm (September). The average annual temperature is 11.1°C, ranging from 9.6°C to 12.7°C (HUSNJAK, 2008).

The area lies on the Holocene sediments that are characteristic of the Sava River valley. The broad valley of the Sava River that dominates the city of Zagreb is part of an alluvial plain formed from gravel, sand, loam and clay sediments. The terrain is almost completely flat and lies at the altitude of about 120 m (HUSNJAK, 2008).

The area investigated phytogeographically belongs to the lowland area of the Central European province in the Euro-Siberian-North American region of the Holarctic (HORVAT, 1949). Potential natural vegetation in the study area is forest of pedunculate oak and dyer's broom (Ass. *Genisto elatae-Quercetum roboris* Horvat. 1938) (ANTONIĆ *et al.*, 2005). However, this area was first converted into arable land and then in recent years abandoned, now showing different stages of succession.

Methods

Fieldwork was carried out in the period from April to September during 2010 and 2011. Within the researched area 32 localities were selected and geo-coded with GPS – a Garmin e-Trex receiver.

For the identification of plant material following iconographies, monographs and standard identification keys were used: TUTIN *et al.* (1964–1993), HORVATIĆ & TRINAJSTIĆ (1967–1981), PIGNATTI (1982), JAVORKA & CSAPODY (1991), DOMAC (1994), HAEUPLER & MUER (2000), ROTHMALER (2000), BLAMELY & GREY (2004), NIKOLIĆ & KOVAČIĆ (2008), SPOHN *et al.* (2008), STREETER (2010). The nomenclature is compatible with the Flora Croatica Database (NIKOLIĆ, 2012).

In the list of the recorded vascular plant taxa, each taxon is joined to adequate floral element and life form type. The floral element of each taxon was interpreted according to HORVATIĆ (1963), PIGNATTI *et al.* (2005), JASPRICA *et al.* (2006), MITIĆ *et al.* (2007) and PANDŽA (2010), and in the list is marked with following numbers: 1 – Mediterranean floral element, 2 – South European floral element, 3 – East European-Pontic floral element, 4 – Southeast European floral element, 5 – Central European floral element, 6 – European floral element, 7 – Eurasian floral element, 8 – Circum-Holarctic plants, 9 – Widespread plants, 10 – Cultivated & Adventive plants. Life forms were interpreted according to ELLENBERG *et al.* (1991), and marked with following abbreviations: P – phanerophyta, N – nanophanerophyta, Ch – chamaephyta, He – hemicryptophyta, G – geophyta, T – therophyta and Hy – hydrophyta. Invasive alien species are marked with abbreviation IAS.

Analysis of conservation status according to On-Line Red book of vascular flora of Croatia (NIKOLIĆ, 2012), legal protection (ANONYMOUS, 2009) and invasiveness (BORŠIĆ *et al.*, 2008; MITIĆ *et al.*, 2008) was made.

RESULTS

Within the urban area of Zagreb (the areas of Konopljenka and Piškorovo), a total of 351 taxa of vascular plants from 81 families were found. Seven of them (2%) are pteridophytes (Equisetidae), two of them (0.6%) gymnosperms (Pinidae), and

others are angiosperms (Magnoliidae). Among angiosperms, 71 taxa (20.2%) belong to monocotyledons (superorder Lilianae) and the remaining 271 taxa (77.2%) from 65 families belong to other superorders of angiosperms.

List of vascular plant taxa

* plants protected by law

PTERIDOPHYTA

Subclass Equisetidae

EQUISETACEAE
Equisetum arvense L.; 8; G
Equisetum hyemale L.; 8; He; *
Equisetum pratense L.; 8; G
Equisetum ramosissimum Desf.; 8; G
Equisetum sylvaticum L.; 8; G
Equisetum telmateia Ehrh.; 8; G
Equisetum variegatum Schleich.; 8; G; *

SPERMATOPHYTA

Subclass Pinidae

CUPRESSACEAE
Juniperus communis L.; 8; P

PINACEAE
Picea abies (L.) Karsten; 10; P

Subclass Magnoliidae

ACERACEAE
Acer campestre L.; 6; P
Acer negundo L.; 10; P; IAS
Acer platanoides L.; 6; P
Acer pseudoplatanus L.; 6; P

AMARANTHACEAE
Amaranthus retroflexus L.; 9; T; IAS

ANACARDIACEAE
Rhus typhina L.; 10; P

APIACEAE
Aegopodium podagraria L.; 7; He
Daucus carota L.; 7; He
Oenanthe aquatica (L.) Poir.; 7; Hy; *
Pastinaca sativa L.; 9; He
Peucedanum oreoselinum (L.) Moench; 6; He

ARALIACEAE
Hedera helix L.; 6; P

ARISTOLOCHIACEAE
Aristolochia clematitis L.; 2; He

ASCLEPIADACEAE
Asclepias syriaca L.; 10; He; IAS
Vincetoxicum hirundinaria Medik.; 7; He; *

ASTERACEAE
Achillea millefolium L.; 9; He
Ambrosia artemisiifolia L.; 10; T; IAS
Arctium lappa L.; 7; He
Arctium minus Bernh.; 6; He
Artemisia alba Turra; 1; Ch
Artemisia verlotiorum Lamotte; 10; He; IAS
Artemisia vulgaris L.; 9; He
Carlina vulgaris L.; 7; He
Centaurea jacea L.; 7; He
Centaurea nigrescens Willd.; 2; He
Centaurea rhenana Boreau; 6; He
Centaurea scabiosa L.; 7; He
Chamomilla suaveolens (Pursh) Rydb.; 10; T; IAS
Cirsium arvense (L.) Scop.; 7; G
Cirsium palustre (L.) Scop.; 7; He
Cirsium vulgare (Savi) Ten.; 7; He
Conyza canadensis (L.) Cronquist; 10; He; IAS
Erigeron annuus (L.) Pers.; 10; He; IAS
Eupatorium cannabinum L.; 7; He
Helianthus tuberosus L.; 10; G; IAS
Inula britannica L.; 7; He
Inula salicina L.; 7; He
Leucanthemum ircutianum DC.; 2; He
Leucanthemum vulgare Lam.; 8; He
Matricaria perforata Mérat; 9; T
Petasites albus (L.) Gaertn.; 5; G
Pulicaria dysenterica (L.) Bernh.; 2; He; *
Senecio vernalis Waldst. et Kit.; 4; He
Senecio vulgaris L.; 9; T
Solidago gigantea Aiton; 10; He; IAS
Tanacetum vulgare L.; 7; He; *
Tussilago farfara L.; 7; G

BALSAMINACEAE
Impatiens parviflora DC.; 7; T; IAS

BETULACEAE
Betula pendula Roth; 7; P

BORAGINACEAE
Echium vulgare L.; 6; He

Lithospermum arvense L.; 7; T
Myosotis arvensis (L.) Hill; 7; T
Myosotis sylvatica Hoffm.; 7; He
Symphytum officinale L.; 6; He

BRASSICACEAE
Alliaria petiolata (M. Bieb.) Cavara et Grande; 7; He; *
Arabidopsis thaliana (L.) Heynh.; 9; T
Barbarea vulgaris R. Br.; 9; He
Brassica nigra (L.) Koch; 10; T; *
Capsella bursa-pastoris (L.) Medik.; 9; He
Cardamine hirsuta L.; 9; T
Cardamine impatiens L.; 7; T
Cardaria draba (L.) Desv.; 9; He
Diplotaxis tenuifolia (L.) DC.; 9; He
Erophila verna (L.) Chevall.; 9; T
Lepidium virginicum L.; 9; T; IAS
Rorippa sylvestris (L.) Besser; 7; He
Sinapis arvensis L.; 9; T

BUDDLEJACEAE
Buddleja davidii Franch.; 10; P

CAMPANULACEAE
Campanula patula L.; 7; He
Legousia speculum-veneris (L.) Chaix; 2; T

CANNABACEAE
Humulus lupulus L.; 7; He

CAPRIFOLIACEAE
Sambucus ebulus L.; 6; N
Sambucus nigra L.; 6; N
Viburnum lantana L.; 2; N; *
Viburnum opulus L.; 7; N

CARYOPHYLLACEAE
Arenaria leptoclados (Reichenb.) Guss.; 7; T
Cucubalus baccifer L.; 7; He
Myosoton aquaticum (L.) Moench; 7; He
Petrorhagia saxifraga (L.) Link; 2; He
Saponaria officinalis L.; 9; He; *
Silene latifolia Poir. ssp. *alba* (Mill.) Greuter et Bourdet; 7; He
Silene vulgaris (Moench) Garcke; 7; He
Stellaria media (L.) Vill.; 9; T

CELASTRACEAE
Euonymus europaeus L.; 7; N; *

CHENOPODIACEAE
Chenopodium album L.; 9; T
Chenopodium polyspermum L.; 9; T

CICHORIACEAE
Chondrilla juncea L.; 7; He
Cichorium intybus L.; 9; He
Crepis biennis L.; 5; He
Crepis foetida L.; 2; T
Lactuca serriola L.; 9; He
Lapsana communis L.; 7; T
Leontodon hispidus L. ssp. *danubialis* (Jacq.) Simonk.; 5; He
Picris hieracioides L.; 7; He
Sonchus asper (L.) Hill; 7; T
Taraxacum officinale Weber; 9; He
Tragopogon pratensis L. ssp. *orientalis* (L.) Čelak.; 7; He

CLUSIACEAE
Hypericum perforatum L.; 9; He; *

CONVOLVULACEAE
Calystegia sepium (L.) R. Br.; 9; He
Convolvulus arvensis L.; 9; G

CORNACEAE
Cornus sanguinea L.; 6; P

CORYLACEAE
Corylus avellana L.; 6; N

CRASSULACEAE
Sedum acre L.; 7; Ch; *
Sedum ochroleucum Chaix; 2; Ch
Sedum sexangulare L.; 5; Ch

CUCURBITACEAE
Bryonia alba L.; 3; G; *

CUSCUTACEAE
Cuscuta europaea L.; 7; T

DIPSACACEAE
Dipsacus fullonum L.; 2; He
Knautia arvensis (L.) Coult.; 7; He
Knautia drymeia Heuff. ssp. *intermedia* (Pernh. et Wettst.) Ehrend.; 2; He
Scabiosa columbaria L.; 2; He
Scabiosa triandra L.; 2; He

EUPHORBIACEAE
Euphorbia cyparissias L.; 7; He
Euphorbia esula L.; 7; He
Euphorbia helioscopia L.; 9; T
Euphorbia platyphyllos L.; 2; T

FABACEAE
Anthyllis vulneraria L.; 5; He; *
Astragalus glycyphyllos L.; 7; He

Coronilla varia L.; 6; He
Dorycnium germanicum (Gremli) Rikli; 2; He
Dorycnium herbaceum Vill.; 2; He
Galega officinalis L.; 3; He; *
Genista tinctoria L.; 7; Ch; *
Lathyrus hirsutus L.; 2; T
Lathyrus latifolius L.; 2; He
Lathyrus tuberosus L.; 7; He
Lathyrus pratensis L.; 7; He
Lotus corniculatus L.; 9; He
Medicago lupulina L.; 9; T
Medicago minima (L.) Bartal.; 9; T
Medicago sativa L.; 10; He
Melilotus albus Medik.; 7; T
Melilotus altissimus Thuill.; 7; G; *
Melilotus officinalis (L.) Lam.; 7; He
Robinia pseudoacacia L.; 10; P; IAS
Securigera cretica (L.) Lassen; 4; T
Trifolium campestre Schreber; 9; T
Trifolium pratense L.; 7; He
Trifolium repens L.; 9; He
Vicia cracca L.; 7; He
Vicia sativa L.; 9; T
Vicia villosa Roth; 3; T

GERANIACEAE
Geranium columbinum L.; 7; T
Geranium dissectum L.; 9; T
Geranium pusillum Burm. f.; 7; T
Geranium robertianum L.; 9; T; *
Geranium rotundifolium L.; 7; T

HIPPOCASTANACEAE
Aesculus hippocastanum L.; 10; P

HIPPURIDACEAE
Hippuris vulgaris L.; 8; Hy; *

JUGLANDACEAE
Juglans regia L.; 10; P

LAMIACEAE
Ajuga genevensis L.; 7; He
Ajuga reptans L.; 7; He
Ballota nigra L.; 6; He; *
Clinopodium vulgare L.; 9; He
Galeopsis speciosa Mill.; 6; T
Glechoma hederacea L.; 8; He
Glechoma hirsuta Waldst. et Kit.; 2; He
Lamium maculatum L.; 7; He
Lamium purpureum L.; 7; T
Lycopus europaeus L.; 7; He; *
Mentha aquatica L.; 9; He; *
Mentha longifolia (L.) Huds.; 9; He; *
Prunella vulgaris L.; 9; He
Salvia pratensis L.; 6; He
Stachys palustris L.; 8; He
Stachys recta L.; 2; He
Stachys sylvatica L.; 7; He
Teucrium chamaedrys L.; 2; Ch; *
Thymus praecox agg.; 5; Ch
Thymus pulegioides L.; 7; Ch

LINACEAE
Linum catharticum L.; 9; T; *

LYTHRACEAE
Lythrum salicaria L.; 9; He; *

MALVACEAE
Abutilon theophrasti Medik.; 9; T; IAS
Malva sylvestris L.; 9; He

MORACEAE
Morus nigra L.; 10; P

OLEACEAE
Forsythia suspensa (Thunb.) Vahl; 10; N
Fraxinus ornus L.; 2; P
Ligustrum vulgare L.; 5; N

ONAGRACEAE
Epilobium dodonaei Vill.; 2; Ch
Epilobium tetragonum L. ssp. *lamyi* (F. W. Schultz) Nyman; 6; He

OXALIDACEAE
Oxalis corniculata L.; 9; Ch
Oxalis fontana Bunge; 10; He

PAPAVERACEAE
Chelidonium majus L.; 9; He
Papaver dubium L.; 9; T
Papaver rhoeas L.; 9; T; *

PLANTAGINACEAE
Plantago lanceolata L.; 9; He
Plantago major L.; 9; He
Plantago media L.; 7; He

PLATANACEAE
Platanus acerifolia (Aiton) Willd.; 10; P

POLYGALACEAE
Polygala vulgaris L.; 7; He

POLYGONACEAE
Fagopyrum esculentum Moench; 7; T
Fallopia convolvulus (L.) Á. Löve; 9; T
Polygonum aviculare L.; 9; T
Polygonum lapathifolium L. ssp. *lapathifolium*; 5; T

Polygonum persicaria L.; 9; T
Reynoutria japonica Houtt.; 10; G; IAS
Rumex acetosa L.; 9; He
Rumex crispus L.; 9; He
Rumex patientia L.; 3; He
Rumex pulcher L.; 2; He

PORTULACACEAE
Portulaca oleracea L.; 9; T

PRIMULACEAE
Anagallis arvensis L.; 9; T
Lysimachia nummularia L.; 6; He
Lysimachia vulgaris L.; 7; He
Primula vulgaris Huds.; 2; He

RANUNCULACEAE
Clematis vitalba L.; 6; P
Ranunculus acris L.; 9; He; *
Ranunculus ficaria L.; 6; G; *
Ranunculus repens L.; 9; He; *
Thalictrum flavum L.; 7; He; *
Thalictrum lucidum L.; 6; He; *
Thalictrum minus L.; 9; He; *

RESEDACEAE
Reseda lutea L.; 9; He; *

ROSACEAE
Agrimonia eupatoria L.; 8; He; *
Crataegus monogyna Jacq.; 7; P; *
Fragaria viridis Duchesne; 7; He
Geum urbanum L.; 9; He; *
Malus domestica Borkh.; 10; P
Potentilla erecta (L.) Raeuschel; 7; He; *
Potentilla heptaphylla L.; 5; He
Potentilla recta L.; 7; He
Potentilla reptans L.; 1; He
Prunus avium L.; 7; P; *
Prunus cerasifera Ehrh.; 10; P
Prunus domestica L. ssp. *insititia* (L.) C. K. Schneid.; 10; P
Prunus persica (L.) Batsch; 10; P
Prunus spinosa L.; 7; P
Pyrus communis L.; 10; P; *
Rosa canina L.; 9; N; *
Rubus caesius L.; 7; N
Rubus discolor Weihe et Ness; 5; N
Sanguisorba minor Scop. ssp. *muricata* Briq.; 9; He; *

RUBIACEAE
Cruciata laevipes Opiz; 7; He
Galium aparine L.; 9; T
Galium lucidum All.; 2; He
Galium mollugo L.; 7; He
Galium palustre L.; 7; He
Galium verum L.; 9; He; *

SALICACEAE
Populus alba L.; 7; P
Populus nigra L.; 9; P
Populus tremula L.; 7; P; *
Salix alba L.; 7; P
Salix caprea L.; 7; P
Salix cinerea L.; 7; P
Salix eleagnos Scop.; 2; P
Salix purpurea L.; 7; P

SAXIFRAGACEAE
Saxifraga tridactylites L.; 9; T

SCROPHULARIACEAE
Antirrhinum majus L.; 1; Ch
Linaria vulgaris Mill.; 7; He; *
Odontites vulgaris Moench; 6; T
Scrophularia canina L.; 2; He
Scrophularia nodosa L.; 8; He; *
Scrophularia umbrosa Dumort.; 7; He
Verbascum nigrum L.; 6; He; *
Verbascum thapsus L.; 6; He; *
Veronica arvensis L.; 7; T
Veronica chamaedrys L.; 7; He
Veronica persica Poir.; 9; T; IAS
Veronica polita Fr.; 7; T

SIMAROUBACEAE
Ailanthus altissima (Mill.) Swingle; 10; P; IAS

SOLANACEAE
Datura stramonium L.; 9; T; IAS
Solanum nigrum L.; 9; T

TILIACEAE
Tilia cordata Mill.; 6; P
Tilia platyphyllos Scop.; 6; P

ULMACEAE
Ulmus minor Miller; 6; P

URTICACEAE
Urtica dioica L.; 9; He

VALERIANACEAE
Valeriana officinalis L.; 7; He; *

VERBENACEAE
Verbena officinalis L.; 9; He

VIOLACEAE
Viola hirta L.; 7; He

VITACEAE
Parthenocissus quinquefolia (L.) Planchon; 10; P; IAS
Vitis vinifera L.; 10; P

Superorder Lilianae

ALISMATACEAE
Alisma plantago-aquatica L.; 9; Hy

AMARYLLIDACEAE
Allium carinatum L.; 6; G
Allium ursinum L.; 7; G
Allium vineale L.; 9; G
Leucojum aestivum L.; 6; G; *

ASPARAGACEAE
Asparagus officinalis L.; 10; G; *

COLCHICACEAE
Colchicum autumnale L.; 5; G; *

CYPERACEAE
Carex caryophyllea Latourr.; 7; He
Carex flacca Schreb.; 9; G
Carex flacca Schreb. ssp. *serrulata* (Biv.) Greuter; 1; G
Carex hirta L.; 7; G
Carex otrubae Podp.; 7; He
Carex pendula Huds.; 7; He
Carex pseudocyperus L.; 8; He
Carex spicata Huds.; 9; He
Carex sylvatica Huds.; 6; He
Carex tomentosa L.; 7; G
Carex vulpina L.; 9; He
Eleocharis palustris (L.) Roem. et Schult.; 9; G

DIOSCOREACEAE
Tamus communis L.; 2; G; *

IRIDACEAE
Iris pseudacorus L.; 7; G; *

JUNCACEAE
Juncus articulatus L.; 8; He
Juncus inflexus L.; 7; He
Juncus tenuis Willd.; 9; He; IAS

LILIACEAE
Muscari comosum (L.) Mill.; 2; G
Ornithogalum umbellatum L.; 2; G; *

ORCHIDACEAE
Anacamptis pyramidalis (L.) Rich.; 6; G; *
Orchis morio L.; 7; G; *

POACEAE
Agrostis stolonifera L.; 8; He
Alopecurus pratensis L.; 7; He
Apera spica-venti (L.) P. Beauv.; 7; T
Arrhenatherum elatius (L.) P. Beauv. ex J. Presl et C. Presl; 6; He
Avena sativa L.; 10; T
Briza media L.; 7; He
Bromus commutatus Schrad.; 6; T; *
Bromus erectus Huds.; 9; He
Bromus hordeaceus L.; 9; T
Bromus racemosus L.; 6; T
Bromus sterilis L.; 9; T
Calamagrostis epigejos (L.) Roth; 6; He
Cynodon dactylon (L.) Pers.; 9; G
Dactylis glomerata L.; 7; He
Echinochloa crus-galli (L.) P. Beauv.; 9; T
Elymus repens (L.) Gould; 9; G
Eragrostis minor Host; 9; T
Festuca arundinacea Schreb.; 6; He
Festuca pratensis Huds.; 9; He
Holcus lanatus L.; 7; He
Hordeum murinum L.; 8; T
Hordeum vulgare L.; 10; T
Koeleria pyramidata (Lam.) P. Beauv.; 6; He
Lolium multiflorum Lam.; 1; T
Lolium perenne L.; 6; He
Panicum capillare L.; 10; T; IAS
Phalaris arundinacea L.; 8; He
Phleum pratense L.; 8; He
Phragmites australis (Cav.) Trin. ex Steud.; 9; G
Poa angustifolia L.; 9; He
Poa annua L.; 9; T
Poa compressa L.; 9; He
Poa nemoralis L.; 8; He
Poa pratensis L.; 9; He
Poa trivialis L.; 7; He
Setaria pumila (Poir.) Schult.; 9; T
Setaria viridis (L.) P. Beauv.; 7; T
Sorghum halepense (L.) Pers.; 9; G; IAS
Triticum aestivum L.; 10; T
Vulpia ciliata Dumort.; 2; T
Zea mays L.; 10; T

POTAMOGETONACEAE
Potamogeton natans L.; 9; Hy

TYPHACEAE
Typha angustifolia L.; 8; G; *
Typha latifolia L.; 9; G; *

DISCUSSION

In the area of Konopljenka and Piškorovo a total of 351 taxa of vascular plants belonging to 81 families were found. Seven of them (2%) were pteridophytes (subclass Equisetidae) while 344 taxa (98%) are spermatophytes. Gymnosperms (subclass Pinidae) are represented with two taxa (0.6%) from families Cuppresaceae and Pinaceae. Other taxa belong to the subclass Magnoliidae among which 71 taxa (20.2%) from 13 families are monocotyledons (superorder Lilianae) and the remaining 271 taxa (77.2%) from 65 families are members of other superorders of angiosperms. The families with the highest number of taxa are Poaceae, Asteraceae, Fabaceae, Lamiaceae and Rosaceae (Fig. 2). This order of families with the highest number of taxa is almost identical to the order for the entire national flora according to NIKOLIĆ (2012), with the exception of the families Rosaceae and Lamiaceae, which are represented with a slightly larger number of taxa than the national average. On average there are ca 44 taxa per square kilometer. Although the number of taxa per unit area recorded in other parts of Zagreb is very diverse, it seems that Piškorovo and Konopljenka have relatively low floristic diversity. For example area of Savica has approximately 618 taxa per square kilometer, Maksimir has approximately 121 taxa per square kilometer and Jarun has approximately 43 taxa per square kilometer (NIKOLIĆ, 2012). These areas are under the different types of management, hence the difference between them is present. Namely, the area of Savica, with the highest diversity is a semi-natural area with a high degree of conservation and large habitat heterogeneity, Maksimir is a Forest Park, a more homogeneous habitat under management, while Jarun is sporting and recreational area with the highest proportion of surfaces under anthropogenic influence. Even though, it is necessary to stress, that none of these areas has complete list of flora and that these figures are still relative. Maksimir and Jarun, uniform habitat areas, are more species-poor than heterogeneous parts.

The recorded taxa belong to a total of 10 floral elements (Fig. 3). The proportions of floral elements are consistent with other areas of the continental part of Croatia (ALEGRO *et al.*, 2006; MITIĆ *et al.*, 2007). Eurasian floral element is predominant, with 30.1%, followed by cosmopolites with 27%. Furthermore, the large influence of the European floral element is evident, and together with the Eurasian floral element it dominates with over 55%. This is as expected considering the geographical position

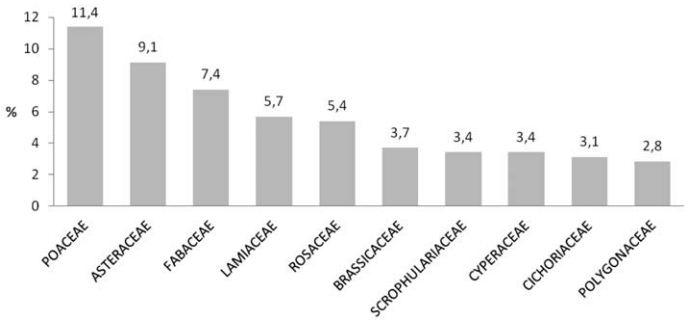

Fig. 2. Families with the highest number of taxa in the area of Konopljenka and Piškorovo.

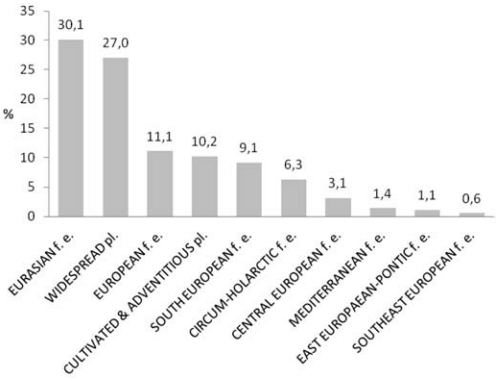

Fig. 3. Phytogeographical analysis of the area of Konopljenka and Piškorovo (pl. – plants; f.e. – floral element).

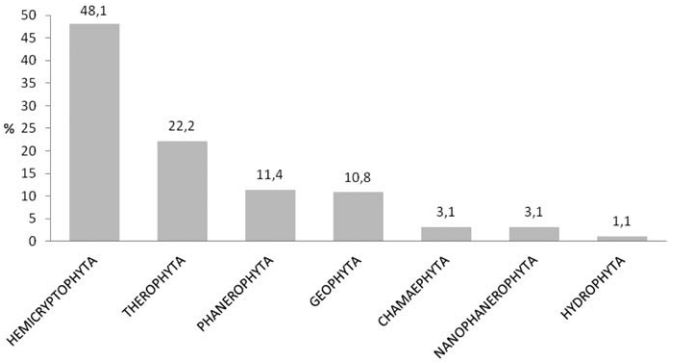

Fig. 4. Life form spectrum of the area of Konopljenka and Piškorovo.

of the researched area. A certain difference is observed due to the absence of plants that belong to the Illyrian-Balkan and Atlantic floral element that usually appear in the surrounding area (MITIĆ *et al.*, 2007), though even there with small number of taxa.

As expected, life forms (Fig. 4) are represented with typical proportions characteristic of the continental part of Croatia (MARKOVIĆ, 1970; 1975; 1978; MITIĆ *et al.*, 2007; PANDŽA, 2010). According to HORVAT (1949), that corresponds to areas with temperate climates where hemicryptophytes dominate, with 48.1%. The percentage of therophytes (22.2%) is slightly higher than expected for this type of climate. This indicates a higher presence of taxa directly related to anthropogenic-influence habitats (MITIĆ *et al.* 2007, MILOVIĆ, 2008).

In this area we report 22 invasive alien species (IAS), 6.3% of the total number of reported taxa. According to BORŠIĆ *et al.* (2008) and MITIĆ *et al.* (2008) these are: *Abutilon theophrasti*, *Acer negundo*, *Ailanthus altissima*, *Amaranthus retroflexus*, *Ambrosia artemisiifolia*, *Artemisia verlotiorum*, *Asclepias syriaca*, *Chamomilla suaveolens*, *Conyza canadensis*, *Datura stramonium*, *Erigeron annuus*, *Helianthus tuberosus*, *Impatiens parviflora*, *Juncus tenuis*, *Lepidium virginicum*, *Panicum capillare*, *Parthenocissus quinquefolia*, *Reynoutria japonica*, *Robinia pseudoacacia*, *Solidago gigantea*, *Sorghum halepense* and *Ve-*

ronica persica. This high percentage of IAS is not surprising because this area is ruderal and abandoned and has a few illegal construction waste disposal sites suitable for neophytes. So far several authors investigated invasive flora in this area, so LUKAČ (1988) reported *Solidago gigantea* and *Helianthus tuberosus*, and MILOVIĆ (2004) *Conyza canadensis*. A considerable contribution to the knowledge of neophytes and ruderal vegetation along the Sava River banks was made by MARKOVIĆ (1970; 1973; 1975; 1978) and GOSPODARIĆ (1958), MARKOVIĆ-GOSPODARIĆ (1965), newcomers for the Croatian flora being reported.

The problem of IAS in urban areas is increasing along with expansion of such areas. Therefore indigenous flora is being suppressed and biodiversity decreased (PYŠEK, 2004b). Our findings suggest that the city of Zagreb is no exception in this trend. Changes in the investigated area after the beginning of urbanization were the cause for the desertion of the former agricultural production. Abandoned arable land was ideal ground for IAS. In the course of research it was noticed that some of the arable land was completely overgrown with *Solidago gigantea.* Likewise some of the IAS, e.g. *Acer negundo*, *Ailanthus altissima* and *Reynoutria japonica* are expanding rapidly in habitats that were exposed to devastation during construction works. The presence of the species *Ambrosia artemisiifolia*, probably because agricultural production has been almost totally abandoned, is just occasional and although it has very allergenic pollen (PETERNEL *et al*. 2005) its presence is not a problem.

From a total of 351 recorded taxa, two of them are threatened according to NIKOLIĆ (2012): *Hippuris vulgaris* is endangered (EN) and *Equisetum hyemale* is vulnerable (VU). According to the Ordinance on the proclamation of protected and strictly protected wild taxa (ANONYMUS, 2009), 57 taxa found (16.2%) are protected and seven of them (2%) strictly protected.

The urban flora in Zagreb has been insufficiently researched. This is illustrated by the fact that we found 88 new plant taxa for MTB 0261 where the area of Konopljenka and Piškorovo are located. There are 610 taxa previously reported for this MTB square (NIKOLIĆ, 2012), but we have not confirmed the presence of 349 of them, mainly because our study area was 32 times smaller than total area of MTB field, which contains more different habitat types.

The condition found *in situ* proves that the area is not appropriately managed. The dominance of IAS, which have a tendency to increase in numbers and occupy greater areas, is evident. Process of rebalancing and natural vegetation restoration is visible in different stages of succession, which is, though slowly, in progress. In order to prevent further spreading of IAS, as well as of newcomers, it is essential to create a management plan for this area with a recommendation for further monitoring. The gathered data may indicate the need for coordination of the development plans with the need for biodiversity preservation.

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SAŽETAK

Prilog poznavanju urbane flore Zagreba (Hrvatska)

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Jedan od najekstremnijih oblika preinake staništa koju čovjek može poduzeti je proces urbanizacije. Preinake nastale urbanizacijom trajnije su od onih uzrokovanih drugim antropogenim djelovanjima, npr. poljoprivredom, jer su mogućnosti obnavljanja primarnih tipova staništa male ili ih uopće nema. Negativni trendovi i njihovi učinci s jedne strane, te briga za očuvanjem bioraznolikosti gradova i kvalitete života s druge, pokretači su istraživanja urbanih flora. U hrvatskim razmjerima urbane flore nisu bile predmetom osobito intenzivnih istraživanja te za većinu većih gradova nisu poznate. U svrhu davanja priloga poznavanju urbane flore grada Zagreba, a u kontekstu rečenog, provedeno je kartiranje flore na području Konopljenke i Piškorova. Ovo, samo djelomice izgrađeno područje s elementima poluprirodnih staništa u velikoj mjeri obogaćuje raznolikost flore Zagreba. Na području Konopljenke i Piškorova zabilježena je 351 svojta vaskularnih biljaka iz 81 porodice. Od toga su sedam svojti (2%) papratnjače (Equisetidae), dvije svojte (0,6%) su golosjemenjače (Pinidae), a ostalo su kritosjemenjače (Magnoliidae). Među kritosjemenjačama 71 svojta (20,2%) pripada jednosupnicama (nadred Lilianae) a 271 svojta (77,2%) iz 65 porodica pripada ostalim nadredovima kritosjemenjača. Vrstama najbogatije porodice su Poaceae (11,4%), Asteraceae (9,1%), Fabaceae (7,4%), Lamiaceae (5,7%) i Rosaceae (5,4%), što gotovo u potpunosti odgovara slijedu zastupljenosti porodica za cijelu nacionalnu floru. Izuzetak su samo porodice Rosaceae i Lamiaceae koje su ovdje zastupljene s nešto većim brojem vrsta od nacionalnog prosjeka. Najzastupljeniji florni element je euroazijski (30,1%), a za njim slijede široko rasprostranjene biljke (27%). Biljke euroazijskog i europskih flornih elemenata dominiraju s više od 55%

što je i očekivano s obzirom na geografski položaj područja. Od životnih oblika najzastupljeniji su hemikriptofiti (48,1%), terofiti (22,2%) i fanerofiti (11,4%). Na istraživanom području zabilježene su 22 invazivne svojte (6,3%). Od ugroženih svojti zabilježene su *Hippuris vulgaris* i *Equisetum hyemale*, a 64 svojte (18,2%) je pod zakonskom zaštitom. U istraživanju je zabilježeno i 88 novih svojti za ovo MTB polje. Broj vrsta po jedinici površine te udio zaštićenih i ugroženih svojti ukazuje da se radi o floristički relativno bogatom području.