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ECOLOGICAL-PHYTOGEOGRAPHICAL CHARACTERISTICS OF WEED AND RUDERAL FLORA OF GOLUBINCI (SERBIA)

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Summary: *Presence of 244 species of vascular plants, from 180 genera and 44 families, was determined in various types of weed and ruderal habitats of village Golubinci near Stara Pazova. This paper presents the taxonomic, ecological and phytogeographical analyses of weed and ruderal flora. By an analysis of the present life forms of the plants belonging to the investigated weed flora, its hemicryptophytic – therophytic character has been established (47.13%:38.11%). Phytogeographic analysis of the weed flora revealed the presence of 18 different floristic elements grouped into 7 main area types. The most numerous were the group which belongs to Eurasian areal type (34.02%).*

Key words: *weed flora, ruderal flora, ecological indices, phytogeographical analysis.*

INTRODUCTION

Weed and ruderal flora and vegetation is present in cities, villages, industrial zones and other areas under continuous or sporadic anthropogenic impact. Habitats of weed and ruderal flora and vegetation are situated on cultivated agricultural land, along the roads, alleys, railroads, in dilapidated buildings and at construction sites, on walls and roofs, various landfills, in hedges, along the moist and nitrified banks of streams and rivers in vicinity of settlements etc. As weed and ruderal flora and vegetation develop in closest vicinity of humans, it understandably besought considerable interest of researchers (Nestorović, 2002, 2003, 2005; Nestorović and Jovanović, 2002, 2003; Nestorović et al., 2005; Nestorović and Konstantinović, 2011a, 2011b; Jakovljević et al., 2008; Jovanović, 2004; Gavrilović et al., 2012; etc) for studies on taxonomic, phytogeographical and ecological analysis of weed and ruderal flora, monitoring of anthropogenous impact on changes in weed and ruderal flora and vegetation, and increased human activities influencing deliberate or accidental introduction of invasive plant species leading to disturbance of ecological equilibrium of weed and ruderal habitats (Jarić, 2009). The need for renewal and conservation of natural ecosystems in human environment also leads to need for research on urban flora and vegetation and impact of climatic and other conditions on vegetation cover of weed and ruderal habitats.

Research on weed and ruderal flora and vegetation was performed in area of village Golubinci, in Srem region of Vojvodina. Golubinci is a lowland area with poorly developed relief. Within this large complex there are various categories of weed and ruderal habitats with rich flora and vegetation.

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MATERIAL AND METHODS

The floristic research was performed in the territory within the cadaster limits of Golubinci (village near Stara Pazova). Collecting of plant material was performed in several weed and ruderal habitats from early April 2012 to late October 2013 (crops, orchards, vineyards, gardens, vegetable patches, road and path edges, hedges, trodden lawns, yards, landfills, levees, commons between fields etc.).

Following literature was used for determination of weed and ruderal flora of Golubinci: Takhtajan (2007); Tutin et al. (1999); etc.

Alignment of species to certain life forms was implemented according to the abridged Raunkier scheme presented by Ellenberg & Muller-Dambois, which was further developed and supplemented according to Stevanović (1992).

The phytogeographical placement of certain floristic elements was determined according to Gajić (1980).

The ecological (bioindication) indices for each species were determined for main ecological factors according to scheme devised by Kojić et al. (1994, 1997a).

RESULTS AND DISCUSSION

Presence of 244 species of vascular plants, from 180 genera and 44 families, was determined in various types of weed and ruderal habitats of village Golubinci near Stara Pazova (Table 1). The highest number of taxa within the weed and ruderal flora of Golubinci includes the same families that show the greatest richness in number of species and genera at the level of flora of whole Serbia. The best-represented families include *Asteraceae* (47), *Lamiaceae* (23), *Poaceae* (21) and *Fabaceae* (19). The high level of representation of families *Ranunculaceae* (12 species), *Scrophulariaceae* (11), *Boraginaceae* (10), *Brassicaceae* (10), *Polygonaceae* (9), *Rosaceae* (9) and *Apiaceae* (8) was expected due to the synanthropic character of many representatives of these families. This conclusion was supported by results of analysis of representation of certain genera in the weed and ruderal flora of village Golubinci. The dominance of typical weed and ruderal species from genera *Ranunculus*, *Chenopodium*, *Potentilla*, *Rumex*, *Trifolium* and *Veronica* shows a strong anthropogenous character of various weed and ruderal habitats, indicating that they are subjected to high level of nitrification, foot traffic, mowing and other anthropogenous impacts that define weed habitats as highly dynamic and unstable biotopes (Lososová et al., 2012).

Table 1. Overview of weed and ruderal flora of village Golubinci.

Abutilon theophrasti Medik.
Achillea millefolium L.
Adonis aestivalis L.
Agrimonia eupatoria L.
Agrostemma githago L.
Ailanthus altissima (Mill.) Swingle
Ajuga chamaepitys (L.) Schreb.
Alcea rosea L.
Alliaria petiolata (M.Bieb.) Cavara & Grande
Alopecurus pratensis L.
Althaea officinalis L.
Althea cannabina L.
Alyssum alyssoides (L.) L.
Amaranthus retroflexus L.
Ambrosia artemisiifolia L.
Amorpha fruticosa L.
Anagallis arvensis L.
Anchusa arvensis (L.) M.Bieb.
Anchusa officinalis L.
Anthemis arvensis L.
Anthemis tinctoria L.
Antirrhinum majus L.
Arctium lappa L.
Aristolochia clematitis L.
Armoracia rusticana P.Gaertn., B.Mey. & Scherb.
Arrhenatherum elatius (L.) P.Beauv. ex J.Presl & C.Presl
Artemisia vulgaris L.
Asclepias syriaca L.
Aster lanceolatus Willd.
Aster salignus Willd.
Astragalus cicer L.
Avena fatua L.
Ballota nigra L.
Bassia scoparia (L.) A.J.Scott
Bellis perennis L.
Bidens tripartita L.
Bilderdykia convolvulus (L.) Dumort.
Bromus commutatus Schrad.
Bromus sterilis L.
Calamagrostis epigejos (L.) Roth
Calystegia sepium (L.) R.Br.
Campanula rapunculus L.
Capsella bursa-pastoris (L.) Medik.
Cardaria draba (L.) Desv.
Carduus acanthoides L.
Carthamus lanatsus L.
Caucalis platycarpos L.
Centaurea jacea L.
Centaurea pannonica (Heuff.) Simonk.
Centaurea scabiosa L.
Cerinthe minor L.
Chamaecytisus supinus (L.) Link
Chamomilla recutita (L.) Rauschert
Chelidonium majus L.
Chenopodium album L.
Chenopodium hybridum L.
Chenopodium murale L.
Chenopodium rubrum L.
Chondrilla juncea L.
Cichorium intybus L.
Cirsium arvense (L.) Scop.
Cirsium vulgare (Savi) Ten.
Clematis integrifolia L.
Clematis vitalba L.

Clinopodium vulgare L.
Conium maculatum L.
Consolida orientalis (J.Gay) Schrödinger
Consolida regalis Gray.
Convolvulus arvensis L.
Conyza canadensis (L.) Cronquist
Coronilla varia L.
Crepis biennis L.
Crepis foetida L.
Cynodon dactylon (L.) Pers.
Dactylis glomerata L.
Datura stramonium L.
Daucus carota L.
Digitalis lanata Ehrh.
Digitaria ciliaris (Retz.) Koeler
Digitaria sanguinalis (L.) Scop.
Diplotaxis muralis (L.) DC.
Dipsacus fullonum L.
Dipsacus laciniatus L.
Echinochloa crus-galli (L.) P. Beauv.
Echium vulgare L.
Elymus repens (L.) Gould
Equisetum arvense L.
Erigeron annuus (L.) Pers.
Erodium cicutarium (L.) L'Hér.
Eryngium campestre L.
Eupathorium cannabinum L.
Euphorbia cyparissias L.
Euphorbia esula L. subsp. *tommasiniana* (Bertol.) Nyman
Euphorbia helioscopia L.
Falcaria vulgaris Bernh.
Festuca arundinacea Schreb.
Fumaria officinalis L.
Galeopsis tetrahit L.
Galinsoga parviflora Cav.
Galium aparine L.
Galium mollugo L.
Galium verum L.
Geranium molle L.
Geum urbanum L.
Glechoma hederacea L.
Hedera helix L.
Helianthus annuus L.
Heliotropium europaeum L.
Helleborus odorus Waldst. & Kit.
Hibiscus trionum L.
Hieracium bauhini
Hordeum murinum L.
Humulus lupulus L.
Hyoscyamus niger L.
Hypericum perforatum L.
Inula britannica L.
Iva xanthifolia Nutt.
Knautia arvensis (L.) Coult.
Lactuca serriola L.
Lamium amplexicaule L.
Lamium purpureum L.
Lapsana communis L.
Lathyrus aphaca L.
Lathyrus tuberosus L.
Leonurus cardiaca L.
Ligustrum vulgare L.
Linaria genistifolia (L.) Mill.
Linaria vulgaris Mill.
Lithospermum arvense L.
Lolium perenne L.
Lotus corniculatus L.
Lycopus europaeus L.
Lysimachia vulgaris L.
Lythrum salicaria L.
Lythrum virgatum L.
Malva sylvestris L.
Matricaria perforata Mérat
Medicago lupulina L.
Medicago sativa L. subsp. *falcata* (L.) Arcang.
Melampyrum arvense L.
Melilotus officinalis (L.) Pall.
Melissa officinalis L.
Mentha arvensis L.
Mentha longifolia (L.) Huds.
Mentha piperita L.
Myosotis arvensis (L.) Hill
Myosotis sylvatica Hoffm.
Nigella arvensis L.
Nonnea pulla (L.) Lam. et D.C.
Oenothera biennis L.
Ononis spinosa L.
Orlaya grandiflora (L.) Hoffm.
Ornithogalum umbellatum L.
Oxalis stricta L.
Papaver rhoeas L.
Parietaria officinalis L.
Petasites hybridus (L.) P.Gaertn., B.Mey. & Scherb.
Phragmites australis (Cav.) Trin. ex Steud.
Picris echioides L.
Picris hieracioides L.
Pimpinella saxifraga L.
Plantago lanceolata L.
Plantago major L.
Plantago media L.
Poa annua L.
Poa pratensis L.
Polygonum aviculare L.
Polygonum lapathifolium L.
Polygonum persicaria L.
Portulaca oleracea L.
Potentilla anserina L.
Potentilla argentea L.
Potentilla cinerea Chaix ex Vill.
Potentilla reptans L.
Prunella vulgaris L.
Prunus spinosa L.
Ranunculus acris L.
Ranunculus arvensis L.
Ranunculus ficaria L.
Ranunculus repens L.
Ranunculus sardous Crantz
Raphanus raphanistrum L.
Reseda lutea L.
Robinia pseudoacacia L.
Rorippa sylvestris (L.) Besser
Rosa canina L.
Rubus caesius L.
Rumex acetosa L.
Rumex acetosella L.
Rumex crispus L.
Rumex sanguineus L.
Salvia nemorosa L.
Salvia pratensis L.
Salvia verticillata L.
Sambucus ebulus L.
Saponaria officinalis L.
Scutellaria hastifolia L.
Senecio erucifolius L.

Senecio vernalis Waldst. & Kit.
Senecio vulgaris L.
Setaria pumila (Poir.) Schult.
Setaria viridis (L.) P. Beauv.
Sideritis montana L.
Silene latifolia Poir. subsp. *alba* (Mill.) Greuter & Burdet
Silene vulgaris (Moench) Garcke
Sinapis arvensis L.
Solanum dulcamara L.
Solanum nigrum L.
Solidago virgaurea L.
Sonchus arvensis L.
Sonchus oleraceus L.
Sorghum halepense (L.) Pers.
Stachys annua (L.) L.
Stachys germanica L.
Stellaria media (L.) Vill.
Symphytum officinale L.
Tanacetum vulgare L.
Taraxacum officinale Weber
Teucrium chamaedrys L.
Thlaspi arvense L.
Thymus serpyllum L.
Torilis arvensis (Huds.) Link
Tragopogon dubius Scop.
Trifolium campestre Schreb.
Trifolium hybridum L.
Trifolium pretense L.
Trifolium repens L.
Tussilago farfara L.
Urtica dioica L.
Verbascum blattaria L.
Verbascum phlomoides L.
Verbena officinalis L.
Veronica austriaca L. subsp. *austriaca* Baumg.
Veronica chamaedrys L.
Veronica hederifolia L.
Veronica persica L.
Vicia cracca L.
Vicia sativa L.
Vicia villosa Roth.
Vinca minor L.
Viola arvensis Murray
Viola kitaibeliana Schult..
Viola odorata L.
Xanthium strumarium L.

The analysis of representation of plant life forms in the weed and ruderal flora of village Golubinci indicates pronounced dominance of hemicryptophytes (47.13%), matching the representation of this life form in the overall flora of Serbia (Table 2). The perennial scapose hemicryptophytes, along with biennial forms, are best represented with a total of 95 species. Regarding the phenological dynamics of this life form, there is a dominance of aestival-flowering species (135), while regarding the height categories the tall plants are particularly pronounced. All this characteristics match the perennial character of hemicryptophyte life form and the general ecological-climatic characteristics of the study area.

The annual herbaceous plants (therophytes) are represented with 93 species (38.11%), placing them at the second place within the biological spectrum of weed and ruderal flora of village Golubinci (Table 2). Besides the fact that structure of this life form is also dominated by stem (scapose) forms, in contrast to hemicryptophytes there is a significant increase in number of vernal species as well as shorter plants, which is explained by their annual character and need to complete their life cycle (from seed to seed) within a single vegetation season.

The life form of geophytes is represented in the weed and ruderal flora of village Golubinci by 14 species (5.74%). At the same time, most present geophytes belong to the rhizome-bearing type, which is one of most adaptable life forms among the polycarpous perennials in such unstable anthropogenized habitats. This is contrasted with insignificant presence of bulb and root geophytes, which are more characteristic of stable or less degraded forest, steppe or meadow habitats. The life forms of chamaephytes and phanerophytes show the same tendencies, as they are primarily characteristic of stable habitats with primary vegetation and insignificant zooanthropogenous impact.

Table 2. Overview and representation of life forms in weed and ruderal flora of Golubinci.

Life forms	n	%	Life forms	n	%
Hemicryptophytes (H)			Geophytes (G)		
H scap	76	31.15	G rhiz	2	0.82
H scap-bienn	19	7.79	G rhiz scap	3	1.23
H caesp	7	2.87	G rhiz caesp	2	0.82
H rept-ros	4	1.64	G rhiz rept-caesp	1	0.41
H rept-scap	1	0.41	G tub rept	1	0.41
H ros	4	1.64	G rad scap	4	1.64
H ros bienn	1	0.41	G bulb scap	1	0.41
H ros-rept	1	0.41	Total	14	5.74
H semiros	2	0.82			
Total	115	47.13	Hydrophytes (Hyd)		
			Hyd G rhiz	2	0.82
Therophytes (T)			Total	2	0.82
T scap	76	31.15			
T scap-semiros	3	1.23	Chamaephytes(Ch)		
T caesp	6	2.46	Ch suff caesp	4	1.64
T caesp-rept	2	0.82	Ch herb rept	2	0.82
T rept	3	1.23	Total	6	2.46
T semiros	1	0.41			
T semiros-scap	1	0.41	Phanerophytes (P)		
T ros	1	0.41	NP caesp	3	1.23
Total	93	38.11	NP rept	1	0.41
			Mi caesp	1	0.41
Scandentophytes (S)			P scap	2	0.82
S herb	4	1.64	Total	7	2.87
S lig	3	1.23			
Total	7	2.87			

The analysis of ecological indices for five main ecological factors (humidity, acidity, amount of nitrogen, light and temperature) has shown dominance of plants preferring submesophytic and subxerophytic habitats, with mostly

neutral to weekly alkaline reaction, mostly of semiopen to open character, medium rich or rich in mineral materials, and mesothermic to thermophilous regarding the temperature regime (Table 3).

Table 3. Representation of species with certain values of ecological indices.

Ecological indices	Values of ecological indices										Mean of ecological indices
	1		2		3		4		5		
	No. of spacies	%	No. of spacies	%	No. of spacies	%	No. of spacies	%	No. of spacies	%	
V	6	2.46	107	43.85	112	45.9	17	6.97	2	0.82	2.59
K	1	0.41	7	2.87	157	64.34	79	32.38	0	0	3.29
N	2	0.82	30	12.3	119	48.77	86	35.25	7	2.87	3.27
S	0	0	4	1.64	95	38.93	141	57.79	4	1.64	3.59
T	0	0	1	0.41	117	47.95	106	43.44	20	8.2	3.59

The phytogeographical analysis of weed and ruderal flora of village Golubinci shows high diversity of floristic elements, with 18 recorded floristic elements (Table 4). The spectrum of floristic elements is dominated by elements with extensive distribution, matching the findings of most authors studying this issue in various weed habitats (Gavrilović et al. 2012; Nestorović, 2005; Nestorović and Konstantinović, 2011).

The spectrum of range types (Table 4) indicates that the most numerous group is Eurasian with 83 species (34.02%), followed by Pontic-Central Asian with 43 species (17.62%), Central European with 40 species (16.39%) and circumpolar-cosmopolitan with 30 species (12.3%). Far lower percentage was recorded for plant species from Atlantic group (2.46%), while no endemic or relict species were recorded. The total number of 244 recorded weed and ruderal species and dominant participation of species with extensive ranges is matching the ecological characteristics of weeds growing in immediate vicinity of human settlements and under strong anthropogenous and zoogenous influences.

The most prominent characteristic of weed and ruderal flora overall is significant participation of adventive (9.02%) and cosmopolitan species (8.2%). The increased abundance of adventive and cosmopolitan species indicates instability of weed habitats.

Table 4. Spectrum of range types.

Group	No. of species	%	Floristic element	No. of species	%
Euroasian	83	34.02	Euroasian	41	16.8
			Subeuroasian	35	14.34
			Subsouthsiberian	7	2.87
Middle-European	40	16.39	Submiddle European	40	16.39
Circumpolar-cosmopolitan	30	12.3	Circumpolare	5	2.05
			Subcircumpolar	5	2.05
			Cosmopolitan	20	8.2
Pontic-Central-Asian	43	17.62	Pontic-Panonian	1	0.41
			Subpontic	10	4.1
			Subpontic-Centralasian	8	3.28
			Subpontic-Submediterranean	12	4.92
			Pontic-Centralasian	3	1.23
			Pontic-Centralasian-Submediterranean	7	2.87
			Subpontic-Subcentralasian- Submediterranean	2	0.82
Submediterranean	20	8.2	Submediterranean	13	5.33
			Pontic- Submediterranean	7	2.87
Adventive	22	9.02	Adventive	22	9.02
Atlantic	6	2.46	Subatlantic- Submediterranean	6	2.46
Total				244	100

The analysis of adventive flora of Golubinci has shown presence of 22 plant species (9.02% of total flora). This percentage is lower than in studies of some other urban floras (Pyšek et al., 2009a, 2009b; Yavorska and Mosyakin, 2001). Comparison of percentage of adventive plants in total weed and ruderal flora of Golubinci with data in 4 other urban areas in Serbia: Smederevska Palanka (13.76%) (Jakovljević and Jovanović, 2005), Kragujevac (12.4%) (Marinković, 2002), Mladenovac (12.3%) (Anđelković, 2002), Loznica (10.49%) (Jovanović and Mitrović, 1998) indicates that representation of this plant group is the greatest at Smederevska Palanka, which was expected due to the larger size of this urban area.

Number of species shared by all study areas was high, but according to available data some of the species recorded in other studied urban areas are absent in subspontaneous form at Golubinci. Species recorded at Smederevska Palanka (Jakovljević and Jovanović, 2005) include: *Amaranthus crispus* (Lesp. & Thévenau) N.Terracc., *Callistephus chinensis* (L.) Nees, *Ipomoea purpurea* Roth. Species recorded at Mladenovac (Anđelković, 2002) include: *Callistephus chinensis* (L.) Nees, *Catalpa bignonioides* Walt., *Tecoma radicans* (L.) Juss., *Symphoricarpus racemosus* Mill., *Convolvulus tricolor* L., *Ipomoea purpurea* Roth, *Parthenocissus inserta* (A.Kern.) Fritsch. Species recorded at Kragujevac (Marinković, 2002) include: *Cosmos bipinnatus* Cav., *Cosmos sulphureus* Cav., *Rudbeckia laciniata* L., *Euphorbia lathyris* L., *Pyracantha coccinea* M. Roem., *Sorghum technicum* (Körn.) Batt. & Trab., *Sorghum bicolor* (L.) Moench. Species recorded at Loznica (Jovanović and Mitrović, 1998) include: *Catalpa bignonioides* Walt., *Ipomoea purpurea* Roth, *Philadelphus coronarius* L. These species belong to the group of decorative plants and they obviously managed to escape from cultivation and appear subspontaneously, but only as ephemerophytes. It may be assumed that all this species are also present at the territory of Golubinci but as cultivated plants, and it is only a matter of time before they are recorded in escaped state in this area. It is however still insufficiently explained if records of all the listed adventive species in other towns in Serbia satisfy the criteria of adventive character presented by Rejmánek et al. (2002).

CONCLUSION

Presence of 244 species of vascular plants, from 180 genera and 44 families, was determined in various types of weed and ruderal habitats of village Golubinci near Stara Pazova.

The best-represented families were *Asteraceae, Lamiaceae, Poaceae* and *Fabaceae*, which are also characterized by the greatest richness in number of species and genera in flora of the whole territory of Serbia. However, the pronouncedly high participation of species from families *Ranunculaceae*, *Scrophulariaceae*, *Boraginaceae*, *Brassicaceae*, *Polygonaceae*, *Rosaceae* and *Apiaceae*, as well as species from genera *Ranunculus*, *Chenpodium*, *Potentilla*, *Rumex, Trifolium* and *Veronica*, indicate pronounced anthropogenous character, dynamic and unstable conditions in weed habitats.

The analysis of representation of life forms in weed and ruderal flora of village Golubinci has shown its hemicryptophyte-therophyte character, where aestival, mostly tall and scapose hemicryptophytes are represented much more (47.13%) that therophytes (38.11%). On the other hand, among the therophytes there is a more significant increase in number of vernal species and shorter plants, which is explained by their annual character and need to complete their life cycle (from seed to seed) within a single vegetation season. The greater percentage representation of hemicryptophytes and lower participation of annual weed plants in area of Golubinci was explained by greater stability and lower openness of weed and ruderal habitats in a typical non-urban area with much less pronounced anthropogenous impact.

The analysis of ecological indices for five main ecological factors has shown dominance of plants preferring submesophytic and subxerophytic habitats, of mostly neutral to weekly alkaline reaction, medium rich to rich in mineral materials, mostly of semi-open to open character, and mesothermic to thermophilous regarding the temperature regime.

The phytogeographical analysis of weed and ruderal flora has shown presence of 18 recorded floristic elements, grouped in seven main range types. The analysis of floristic elements and their representation indicate dominant participation of species with extensive ranges. The most numerous group is Eurasian with 83 species (34.02%), followed by Pontic-Central Asian with 43 species (17.62%), Central European with 40 species (16.39%) and circumpolar-cosmopolitan with 30 species (12.3%). Far lower percentage was recorded for plant species from the adventive group, submediterranean and Atlantic species. This type of phytogeographical structure matches the ecological characteristics of weeds growing in immediate vicinity of human settlements and under strong anthropogenous and zoogenous influences.

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EKOLOŠKO-FITOGEOGRAFSKE KARAKTERISTIKE KOROVSKE I RUDERALNE FLORE GOLUBINACA (SRBIJA)

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Izvod: Na različitim tipovima korovskih i ruderalnih staništa sela Golubinci kod Stare Pazove utvrđeno je prisustvo 244 vrste vaskularnih biljaka, iz 180 rodova i 44 familije. U radu je predstavljena taksonomska, ekološka i fitogeografska analiza korovske i ruderalne flore. Analizom zastupljenosti životnih formi biljaka u ispitivanoj korovskoj flori ustanovljen je hemikriptofitsko-terofitski karakter (47,13%:38,11%). Fitogeografskom analizom utvrđeno je prisustvo 18 različitih flornih elemenata, grupisanih u 7 osnovnih areal tipova. Najbrojnija je grupa koja pripada evroazijskom aeral tipu (34,02%).

Ključne reči: korovska flora, ruderalna flora, ekološki indeksi, fitogeografska analiza, Golubinci, Stara Pazova.

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