

# “Planta Hortifuga” in Flora of the Continental Part of Croatia

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## Summary

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The term “planta hortifuga” refers to all cultivated plant species that have escaped from cultivation and grow spontaneously in different natural, semi-natural or man-made habitats. List of “planta hortifuga” (Tab.1) consists of 120 taxa. Traits are given for each species: Raunkiaer’s life-form groups, taxonomic rank (family and species), geographical origin, use value, invaded habitat, invasive behavior and harm impact, where it is evident. Only a few species of “planta hortifuga” have reached a high degree of the naturalization and realize up to now in places dramatically increasing in distribution and density. Such invasive species are the americanophytes: *Asclepias syriaca*, *Helianthus tuberosus*, *Solidago* spp., *Echinocystis lobata*, *Amorpha fruticosa* and *Robinia pseudacacia*; then Asiatic species: *Impatiens* spp., *Reynoutria japonica* and *Ailanthus altissima*. These are a threat to the survival of autochthonous plants and the stability of communities. From an agronomical point of view particularly dangerous species are: *Echinocystis lobata*, *Panicum capillare*, *P. miliaceum ssp. agricolum*, and *Abutilon theophrasti*. The species *Amorpha fruticosa* and *Robinia pseudacacia* have caused the harm in forestry while the species *Amorpha fruticosa* has caused harm in drainage systems. The species of plants that are harmful to human health are: *Rhus typhina*, *Asclepias syriaca*, *Solidago* spp., *Robinia pseudacacia*, *Wistaria sinensis*, *Ailanthus altissima* and *Artemisia absinthium*. Plant species *Asclepias syriaca*, *Robinia pseudacacia* and *Ailanthus altissima* may be harmful to animals. Results of this investigation may be used for assessing the risk of spreading cultivated plants out of their places of cultivation. These results illustrate why it is necessary to pay attention to appearance of cultivated species out of their place of the cultivation.

## Key words

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“planta hortifuga”, the continental part of Croatia, the list of planta hortifuga

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## Introduction

Many agricultural, horticultural or forestry species are intentionally introduced for cultivation. However, some of them have escaped from cultivation and grow spontaneously on different natural, semi-natural or man-made habitats. In scientific literature the term used for these plant species is “ergasiophytophyta” (Šugar, 1990; Hulina, 1998 a). Their spontaneous growth and appearance is often local, spotlike and ephemeral. Only some of them are able to make a dramatic increase in distribution and density and:

- a) to endanger the survival and regeneration of autochthonous plants and the stability of communities or
- b) to cause economic (as terrible segetal weeds) and environmental harm or harm to human or animal health.

When these species are naturalized i.e. when they are surmounted abiotic and biotic barriers to survival and when they overcome various barriers to their regular reproduction, (Richardson et al., 2000), they are named “agriophytes” (Kamysev, 1959, cit. Lohmeyer et Sukopp, 1992).

During the past few decades we have seen a rapid increase in the number of studies devoted to plant invasion of alien plants (archaeophytes and neophytes). A large number of these species are really the cultivated taxa escaping from cultivation. At the same time in literature exists a large number of terms mostly derived from Greek, whose clarity and consistency in use is questionable. This is the primary reason for the confusion in terminology (Ponert, 1977; Kowarik et al., 2000; Richardson et al., 2000; Pyšek et al., 2004; Mitić et al., 2000).

In this paper we propose the term “planta hortifuga” (Latin translation) because of its simple conceptualization in a broad sense. This term refers to all cultivated species that have escaped from cultivation and established themselves in different habitats. Accordingly to this term, the group “planta hortifuga” includes: “sua sponte” growing ornamental plants (trees, shrubs, lianes i.e. climbing-plants, herbaceous perennial and annuals), orchard or forest trees, cereals, vegetable, oil, fibre or industrial crops, forage, herbs, spices, plants as the bird’s food, weedy crops and melliferous plants.

The appearance of “planta hortifuga” is particularly evident in fringe vegetation, as on the riparian habitats and banks, roadsides, along forestedge, then in urban environment, as on wasteyards, old walls, debris and also on arable fields.

The aim of the investigation was to establish:

1. how many species “planta hortifuga” consists of in flora of the continental part of Croatia and in which level of aggressivity they appear;
2. their impact on the overall environment i.e. to what extent they cause harm to economy and environment or harm to human and animal health.

## The study area and methods

The continental part of Croatia belongs to the Pannonic Plain and occupies the space between two rivers: Drava in the north and Sava in the south. This area is characterized by aluvial and diluvial valleys with different zonal and azonal soil types. The climate is classified as a moderate continental (type) with mod-

erately cold winters, warm summers and favourable annual distribution of precipitation. Orographic and soil properties and meteorological conditions are particularly favorable for agriculture and this area is mostly covered by arable fields with some meadows and pastures. Forest stands in this area belong mainly to ass. Salici-Populetum nigrae, Fraxino-Ulmetum, Genisto elatae-Quercetum roboris and Querco-Carpinetum croaticum (Rauš et al., 1985; Trinajstić, 2008).

Two sources of floristic data have been used in the work:

1. own observations gathered during the longtime floristic and phytosociological investigations,
2. data from the literature.

The survey of “planta hortifuga” in flora of the continental part of Croatia is listed in Tab.1. For each species some additional traits are given in columns: 1 - Raunkiaer’s life-form groups, 2 - taxonomic rank: family and species, 3 - geographical origin, 4 - use value, 5 - habitat invaded, 6 - invasive behavior and 7 - harm impact, where it is evident.

The nomenclature of taxa follows Ehrendorfer (1973). Other characteristics, such as life-forms and geographical origin, are used according to Garcke (1972) and Encke (1958, 1960).

## Results and discussion

The survey of “planta hortifuga” presented in Table 1. consists a total of 120 taxa belonging to 53 families.

Regarding Rankiaer’s life-forms, most of “planta hortifuga” are therophytes (54). The second most numerous group are phanerophytes (20), followed by hemicriptophytes (17), chamaephytes (13), geophytes (eight), lianes or climbing plants (seven) and hydrophytes (one).

The most numerous families are Asteraceae (17 species) and Poaceae (10 species). Both families are also recognized in Europe or at the world level as the most invasive families (Maillet et al., 2000). The family Fabaceae is represented with seven species and Balsaminaceae, Brassicaceae and Rosaceae with four species each. The most of families (47) are represented by a small number of species (one, two or three).

The largest group of “planta hortifuga” originates from North America (35), and only eight species came from South America. The plant species of the Asiatic origin (31) and the plant species from the Mediterranean region including the species from the Middle East and South Europe (26) are well represented. The other plant species come from other regions of the world: 10 from Euroasia, five from tropical / subtropical regions, three from Balkan, one from Africa and one of unknown origin.

The vast majority of taxa were initially cultivated as ornamental annuals (32), followed by herbaceous perennial plants (18), park trees (18) or shrubs, (12), lianes (seven), wild vegetable (seven) and crops (seven). Among “planta hortifuga” there are “sua sponte” growing melliferous plants (four), herbs (three), spices (two), forage (two), birds food plants (two), weedy crops (two) and manifold used (four).

“Planta hortifuga” establish themselves preferentially on sites and in plant communities where the saturation of overground and underground space is incomplete. These “open” ecosystems are: the roadsides, riverbanks, waste and ruderal places, forest

Table 1. “Planta hortifuga” in flora of the continental part of Croatia

1	2	3	4	5	6	7
<b>I. Magnoliatae</b>						
Aceraceae (2):						
Ph	<i>Acer negundo</i> L.	NA	ot	hedge, forest	sa	-
Ph	<i>A.saccharinum</i> Marschal	NA	ot	hedge, forest	na	-
Amaranthaceae (2)						
T	<i>Amaranthus caudatus</i> L.	trop	oa	waste places	na	-
T	<i>Celosia argentea</i> L.	trop	oa	waste places	na	-
Anacardiaceae (1)						
Ph	<i>Rhus typhina</i> Torner	NA	ot	forest, banks, debris	a	en
Apiaceae (1)						
T	<i>Foeniculum vulgare</i> L.	Med	v, h, s	abandoned gardens	na	-
Apocinaceae (1)						
Ch	<i>Vinca major</i> L.	EurAs.	op	hedge, banks	sa	-
Asclepiadaceae (1)						
H	<i>Asclepias syriaca</i> L.	NA	op, m ind	roadsides, riverbanks, pastures	a	en, hh, ha
Asteraceae (17)						
T	<i>Ageratum mexicanum</i> Sims.	SA	oa	waste places	na	-
H	<i>Artemisia absinthium</i> L.	EurAs	h	abandoned gardens, roadsides	a	hh
H	<i>A. dracunculus</i> L.	NA	s	roadsides, waste places	sa	hh
H	<i>Aster lanceolatus</i> Willd.	NA	oa	waste places	na	-
H	<i>A. tradescantii</i> L.	NA	oa	waste places	na	-
T	<i>Callendula</i> off. L.	Med	oa	waste places	na	-
T	<i>Cosmos bipinatus</i> L.	trop	oa	waste places	na	-
T	<i>Coreopsis lanceolata</i> Nutt.	NA	oa	waste places, roadsides	na	-
T	<i>C. grandiflora</i> Nutt.	NA	oa	waste places, roadsides	na	-
T	<i>Guizotia abesinica</i> Negro	Af	bf	riverbanks	na	-
G	<i>Helianthus tuberosus</i> L.	NA	op, v, f	riverbanks, drainage system, forest edge	a	en
T	<i>Lactuca sativa</i> L.	Med	v	abandoned gardens	na	-
T	<i>Rudbeckia lanciniata</i> L.	NA	oa	roadsides, riverbanks	sa	-
H	<i>Solidago canadensis</i> L.	NA	op	roadsides, riverbanks, forestedge, abandoned fields	a	en
H	<i>S. gigantea</i> Ait.	NA	op	roadsides, riverbanks, forestedge, abandoned fields	a	en
T	<i>Tagetes patulus</i> L.	SA	oa	waste places	na	-
H	<i>Tanacetum parthenium</i> (L) Schultz	EurAs	oa	waste places	na	-
Balsaminaceae (4)						
T	<i>Impatiens balfourii</i> Hooker Fil.	As	oa	forestedge, waste places	a	en
T	<i>I. balsamina</i> L.	As	oa	waste places	na	en
T	<i>I. glandulifera</i> Royle	As	oa	riparian vegetation., roadsides, waste places	a	en
T	<i>I. parviflora</i> DC	As	oa	riparian vegetation, hedges	sa	-
Bignoniaceae (2)						
Ph	<i>Catalpa bignonioides</i> Walt.	NA	ot	roadsides, debris	sa	-
L	<i>Campsis radicans</i> (L.) Sem	NA	l	walls, roadsides	sa	-
Boraginaceae (1)						
T	<i>Borago officinalis</i> L.	Med	v	abandoned gardens, waste places	na	-
Brassicaceae (4)						
H	<i>Armoratia rusticana</i> Gaertn.	EurAs	v	abandoned gardens, ruderal places	sa	en
T	<i>Brassica napus</i> L. ssp.napus	Med	v, f	abandoned gardens, roadsides	sa	-
T	<i>B. rapa</i> L. var oleifera	Med	f	abandoned gardens, roadsides	sa	-
T	<i>B. nigra</i> (L) Koch	Med	s	abandoned gardens, roadsides	sa	-
Buddlejaceae (1)						
Ch	<i>Buddleja davidii</i> Franchet	As	os	roadsides	na	-
Caesalpiniaceae (1)						
Ph	<i>Cercis siliquastrum</i> L.	Med	ot	roadsides	sa	-
Cannabinaceae (1)						
T	<i>Cannabis sativa</i> L. ssp. spontanea	As	wc	roadsides, riparian vegetation	sa	ec
Caprifoliaceae (2)						
Ch	<i>Weigelia florida</i> Sieb.	As	os	roadsides	na	-
Ch	<i>Symphoricarpos albus</i> (L.) Blake	NA	os	waste places	na	-
Caryophyllaceae (3)						
H	<i>Dianthus barbatus</i> L.	EurAs	op	waste places	na	-
H	<i>Lychnis coronaria</i> (L) Desr.	Med	op	waste places	na	-
H	<i>Saponaria officinalis</i> L.	Med	op	waste places	na	-
Chenopodiaceae (3)						
T	<i>Atriplex hortensis</i> L.	NA	v	abandoned gardens, waste places	na	-
T	<i>Chenopodium ambrosioides</i> L.	SA	h	roadsides, waste places	na	-
T	<i>Kochia scoparia</i> (L) Schrad.	As	oa	roadsides, waste places	na	-
Cichoriaceae (1)						
T, H	<i>Cichorium endivia</i> L.	Med	v	abandoned gardens	sa	-

	Cucurbitaceae (2)					
L	<i>Echinocystis lobata</i> (Michx.) Torr & Gray	NA	l	riparian vegetation hedge, drainage system	a	en,ec
L	<i>Sycios angulatus</i> L.	NA	l	segetal weed, hedge	sa	ec
	Elaeagnaceae (1)					
Ch	<i>Elaeagnus angustifolia</i> L.	As	os	roadsides, waste places	na	-
	Euphorbiaceae (3)					
Ch	<i>Euphorbia latyris</i> L.	EurAs	op	waste places	sa	-
T	<i>E. marginata</i> Pursh.	NA	oa	waste places	sa	-
T	<i>Ricinus communis</i> L.	trop	oa	roadsides, waste places	sa	-
	Fabaceae (7)					
Ch	<i>Amorpha fruticosa</i> L.	NA	ot,os,m	riparian vegetation, roadsides, forestedge, drainage system	a	ec, en
Ph	<i>Gledichia triacanthos</i> L.	NA	ot	roadsides	na	-
T	<i>Medicago arabica</i> (L.) Huds.	As	oa	grass places, roadsides	na	-
T	<i>Medicago sativa</i> L.	unk.orig.	f	grass places	na	-
Ph	<i>Robinia pseudacacia</i> L.	NA	ot, m	forests, waste places	a	ec, en, hh, ha
Ph	<i>Sophora japonica</i> L.	As	ot	roadsides	na	-
L	<i>Wisteria sinensis</i> (Sins) Sweet	As	l	beyond gardens	a	en
	Fagaceae (1)					
Ph	<i>Quercus rubra</i> Du Roi	NA	ot	roadsides	na	-
	Hydrophilaceae (1)					
T	<i>Phacelia tanacetifolia</i> Benth.	NA	m,oa, f	roadsides, waste places	na	-
	Hyppocastanaceae (1)					
Ph	<i>Aesculus hippocastanum</i> L.	Balkan	ot	roadsides	na	-
	Hypericaceae (1)					
H	<i>Hypericum calycinum</i> L.	Med	op	beyond gardens	sa	-
	Juglandaceae (1)					
Ph	<i>Juglans regia</i> L.	Balkan	t	roadsides	na	-
	Lamiaceae (1)					
H	<i>Stachys lanata</i> Jacq.	As	op	waste places, debris	na	-
	Malvaceae (3)					
H	<i>Althea rosea</i> (L) Cav.	Med	op	roadsides, waste places	na	-
T	<i>Abutilon theophrasti</i> Med.	EurAs	h,fi,oil	fields, ruderal places	a	ec
Ch	<i>Hibiscus syriaca</i> L.	As	os	roadsides	na	-
	Moraceae (3)					
Ph	<i>Broussonetia papyrifera</i> (L)Vent.	As	ot	roadsides, at hences, walls	na	-
Ph	<i>Ficus carica</i> L.	Med	t	waste places, at fences	na	-
Ph	<i>Morus alba</i> L.	As	t	waste places, at fences	na	-
	Nictaginaceae (1)					
T	<i>Mirabilis jalapa</i> L.	trop	oa	beyond hences	na	-
	Oenotheraceae (1)					
T	<i>Oenothera biennis</i> L.	NA	oa	roadsides, riparian vegetation.	sa	-
	Oleaceae (2)					
Ch	<i>Forsythia suspensa</i> (Thunb.) Vahl.	As	os	waste places	na	-
Ch	<i>Syringa vulgaris</i> L.	EurAs	os	beyond fences	sa	-
	Oxalidaceae (1)					
T	<i>Oxalis corniculata</i> var.purpurea Vahl.	NA	oa	treated places	sa	-
	Phytolacaceae (1)					
H	<i>Phytolaca americana</i> L.	NA	op	hedge, forest edges	sa	-
	Polygonaceae (3)					
T	<i>Polygonum orientale</i> L.	As	oa	roadsides	na	-
L	<i>P.baldschuanicum</i> Regel	As	l	waste places, at fences	na	-
G	<i>Reynoutria japonica</i> Houtt.	As	op	roadsides, riparian vegetation	a	en
	Portulacaceae (1)					
T	<i>Portulaca grandiflora</i> Hook.	SA	oa	walls, beyond fences	na	-
	Ranunculaceae (3)					
T	<i>Consolida ajacis</i> (L) Schur	Med	oa	walls, roadsides	na	-
Ch	<i>Mahonia aquifolium</i> (Pursh) Nutt.	NA	os	at fences, waste places	sa	-
T	<i>Nigella damascena</i> L.	Med	oa	waste places	na	-
	Rosaceae (4)					
T	<i>Duchesnea indica</i> (Andrws) Focke	As	oa	grass and treated places	sa	en
Ch	<i>Cotoneaster tomentosa</i> (Ait) Lindl	EurAs	os	roadsides	na	-
Ch,Ph	<i>Prunus laurocerasus</i> L.	Balkan, Kaukas	os	waste places	sa	-
Ph	<i>Prunus serotina</i> Ehrh.	NA	ot	waste places	na	-
	Salicaceae (1)					
Ph	<i>Popus x canadensis</i>	NA	ot	riparian vegetation	sa	-
	Sapindaceae (1)					
Ph	<i>Koelreuteria paniculata</i> Laxm.	As	ot	roadsides	na	-
	Saxifragaceae (2)					
G	<i>Bergenia cordifolia</i> (Haw.) A.Br.	As	op	walls, roadsides	na	-
Ph	<i>Philadelphus coronarius</i> L.	Med	os	roadsides, beyond fences	na	-

	Scrophulariaceae (2)						
T	Antirrhinum maius L.	Med	oa	walls, waste places	na	-	
Ph	Paulownia tomentosa (Thunb.) Steud.	As	ot	roadsides	na	-	
	Simarubaceae (1)						
Ph	Ailanthus altissima (Mill.)Swingle	As	ot	roadsides, walls, debris	a	en, hh, ha	
	Solanaceae (3)						
T	Datura innoxia Mill.	SA	os	beyond fences	a	-	
T	Lycopersicum esculentum Mill.	SA	v	abandoned gardens	na	-	
T	Petunia x hybrida Vilm.	SA	oa	roadsides, walls	na	-	
	Tropaeolaceae (1)						
T	Tropaeolum majus L.	SA	oa	waste places	na	-	
	Valerianaceae (1)						
T	Valerianella olitoria L.var. oleracea	Med	v	vineyards, banks	na	-	
	Vitaceae (2)						
L	Parthenocissus tricuspidata (Sieb. et Zucc.) Planch.	NA	l	hedge, forestedges	na	-	
L	P. quinquefolia (L) Planch.	NA	l	hedge, forestedges	na	-	
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II. Liliatae							
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	Araceae (1)						
Hy	Acorus calamus L.	As	h	boggy vegetation	na	-	
	Commelinaceae (1)						
G	Commelina communis L.	As	op	roadsides, walls	na	-	
	Iridaceae (2)						
G	Iris germanica L.	Med	op	roadsides, waste places	sa	-	
H	Sisyrinchium bermudiana L.	NA	op	grass places	na	-	
	Liliaceae (2)						
G	Hemerocalis fulva L.	EurAs	op	roadsides	sa	-	
G	Muscari racemosum (L) Mill.	Med	op	grass places	na	-	
	Poaceae (10)						
T	Avena sativa L.	MidEast	c	roadsides	na	-	
T	Hordeum vulgare L.	MidEast	c	roadsides	na	-	
T	Panicum capillare L.	NA	oa	fields, ruderal places	a	ec	
T	P. milliaceum ssp. agricolum	As	wc	fields	a	ec	
T	Phalaris canariensis L.	Med	bf	roadsides	na	-	
T	Secale cereale L.	MidEast	c	roadsides	na	-	
T	Setaria italica (L.) PB.	trop,subtrop	c	roadsides	na	-	
G	Sorghum bicolor (L.) Moench	As	c	waste places	sa	-	
T	Triticum aestivum L.	MidEast	c	roadsides	na	-	
T	Zea mays L.	SA	c	waste places	na	-	

Legend: 1 - Life forms: Ph - Phanerophyt, Ch - Chamaephyt, H - Hemikryptophyt, T - Therophyt, G - Geophyt; Hy - Hydrophyt; L - lianes, climbing-plants; 2 - Familie/Species; 3 - Geographical origin: NA-North America, SA- South America, Med - Mediterranean, As-Asia, EurAs- Euroasia, Middle East- MidEast, Africa - Af, trop - tropical, subtrop - subtropical; unk. orig. - unknown origine 4 - Use's value: bf - bird's foot, c - crop, fi - fibre crop, ind - industrial crop, oil - oil crop, f - forage, h - herb, l - liane, climbing-plant; m - melliferous plant, oa - ornamental annual, op - ornamental herbaceous perennial, os - ornamental shrub, ot - ornamental tree, t - forest or orchard tree, v - vegetable, wc -weedy crop 5 - Habitat invaded; 6 - Invasive behaviour: a - aggressive, sa - slightly aggressive, na - no aggressive; 7 - Harms: ec - economic, en - environmental, hh - to human health, ha - to animal health.

clearings, abandoned gardens or fields, and borders of drainage systems.

Of the special interest are only invasive plant species because their aggressiveness that is very problematic increase in frequency and abundance (cover) or harm impact. They include:

a.) The plant species of the Northamerican origin: *Rhus typhina*, *Asclepias syriaca*, *Helianthus tuberosus*, *Solidago spp.*, *Echinocystis lobata*, *Amorpha fruticosa*, *Robinia pseudocacia* and *Panicum capillare*.

(1) The species *Rhus typhina*, staghorn sumac (Anacardiaceae) is an ornamental deciduous small (10-12 m) tree. It is very decorative, owing to umbrellaform crown, attractive autumn colour of leaves and auburn fruits, which persist on the tree through the winter. It prefers dry soil and open sunny exposition. In favourable conditions, once established it rapidly becomes invasive spreading predominantly root sprouts. It probably invades new areas via bird dispersed seeds. In the flora of Croatia it was noted as the planta “frequentissime culta .. et sepes quasi spontanea facta” (Schlosser et Vukotinović, 1869). Out of cultivation staghorn sumac is able to make a higher population

dynamic activity and has become a troublesome invader particularly on dry, rocky or gravelly soils, in old fields, clearings, roadside embankments and forestedges (Hulina, in the eastern part of Medvednica, unpublished data). Its control by cutting is very difficult. Some people may be allergic to its sap because it is very irritating.

(2) The species *Asclepias syriaca* (Asclepiadaceae), known in America as the common milkweed or silkweed is perennial milky-juiced herb, erect and 150 cm tall. Its flowers are dull purple in large, more or less nodding umbels and rich with pollen and nectar. Common milkweed produces fruits with many silk hair-covered seeds. It is in cultivation since the 1629. In the flora of Croatia it was known by Schlosser et Vukotinović (1869) as the plant “ex hortis auffuga”. Escaping from gardens, it becomes an exceptionally aggressive plant, growing very frequently on sandy soils along rivers and roads, on pastures, waste places and similar (Hulina, 1984, 1989; Marković, 1990; Panjković, 1990; Vrbek, 2000; Rešetnik et al., 2007). It spreads by seeds and underground root sprouts and it is able to successfully compete with autochthonous plants, rapidly invading native communities. Its

milky sap contains cardiac glycosides and it is toxic to humans and many animals. The common milkweed is not palatable to any kind of livestock and only under emergency conditions will animals consume them. When the livestock consumes the leaves in large amounts they may cause the poisoning (Bartels et Cramer, 1966; Roth et al., 1994). Milky sap from leaves may cause also a skin allergy.

(3) The species *Helianthus tuberosus* (Asteraceae) known as “Jerusalem artichoke” is ornamental plant, up to 2-2.5 m tall, with an abundance of sunflower-like heads on the tips of stems in late autumn. It is also cultivated extensively for its edible tubers, which consist an inulin (for medical use by diabetics), or as a stock feed. Garden escaped, it forms the fringes along temporarily flooded woodlands on the river banks of Sava, Sutla and Krapina (Marković, 1979; Marković et Lukač, 1994), Drava (Kranjčev, 1995), in Turopolje (Hulina, 1989, 1998 b).

(4, 5) The species of the genus *Solidago* (Asteraceae, *S. gigantea* and *S. canadensis*, goldenrods) are perennial garden ornamental and melliferous plants, tall cca 150 cm, native of North America. They are growing in Europe since late 17th century. With a gigantic output of pappus-fying fruits and vigorous vegetative reproduction they can travel quickly and escaping from gardens form pure dense stands on waste ground, along the streams, roadsides, railways and borders of forests (Marković, 1977, 1979, 1990; Šegulja, 1977; Rauš et al., 1985; Hulina, 1989; Panjković, 1990; Skender et al., 1995). From point of view of naturalness, goldenrods definitely represent a major threat to natural communities. Also, *Solidago* spp. have caused the pollinosis in late summer and autumn (Tlustak et Ptačkova, 1995; Hulina, 2000 a; Staffolani et Hruska, 2008). After the war (1990-1995) they have started to spread rapidly on abandoned fields and minefields in the continental part of Croatia.

(6) The climbing plant *Echynocystis lobata* or wild cucumber (Cucurbitaceae) has become naturalized in the region of Central and South-Eastern Europe (Tutin, 1968). Since 1949 (Devidé, 1956, cit. Dubravec, 1994) *E. lobata*, as the hydrohor and zoohor plant, has been rapidly wide-spreading in the continental part of Croatia in different habitats (Marković, 1979; Hulina, 1989, 1998 b; Panjković, 1990; Trinajstić et al., 1991; Dubravec, 1994; Tomašević, 1998). This plant is the dangerous for agriculture, particularly as a weed in orchards and nursery gardens, in riparian habitats of lowland rivers and drainage systems. It is a very aggressive member of the riparian vegetation (Cuscuta-Convolutum). In its original range wild cucumber is planted for arbors, but it has also weed status (Muencher, 1955).

(7) The species *Amorpha fruticosa* (Fabaceae), commonly known as “river locust” or “false indigo” is the shrub up to 4 m tall. It was introduced in Europe in the 18th century and in Croatia in the 20th century in order to bind the soil in railway embankments and as the melliferous plant. It is also the ornamental shrub, remarkable for the unusual color of its dark violet-purplish flowers. Successful propagation, by seed and vegetative reproduction, is the reason that this species has become, in course of time, the very invasive weed, particularly in the lowland area of Croatia, where mainly inhabiting along railways, on riverbanks, drainage systems, forestedges and roadsides (Marković, 1977; Rauš et al., 1985; Hulina, 1989, 1998b; Panjković, 1990). It forms large and dense populations and it is highly destructive

for banks, very competitive regarding autochthonous species and difficult to control. It has become one of the most harmful weeds in the drainage systems (Hulina, 1998).

(8) It is interesting that the tree *Robinia pseudacacia* (Fabaceae) extinct in Europe during the ice age was reimported as an ornamental tree in the 17th century from North America. It soon spread over the warmer parts of Central Europe, not only in disturbed habitats but also in seminatural and natural vegetation. This tree has harmful effects in the forest communities (Hruska, 1991) and it is the worst forest weed (Holzner, 1982; Hulina, 1998). Seeds, root and bark are very toxic to animals and pollen has allergizing effect on man’s respiratory organs (Roth et al., 1994; Tlustak et Ptačkova, 1995; Staffolani et Hruska, 2008).

(9) The species *Panicum capillare* (Poaceae) was introduced from North America in Europe as ornamental plant. At present it is widespread and often locally abundant segetal and ruderal weed in the continental part of Croatia (Šegulja, 1977; Rauš et al., 1985; Hulina, 1989, 1995; Panjković, 1990; Topić, 1998; Vrbek, 2000). This grass has been known as segetal and ruderal weed in its original range (Muencher, 1955) and in the world (Häfliger et Scholz, 1980).

(10) The species *Datura innoxia* (Solanaceae), originally from Central and South America was introduced and cultivated worldwide as an ornamental very beautiful plant with attractive flowers. But, in the process of time, it has established itself beyond garden fences (Pavletić et Trinajstić, 1990; Franjić, 1993; Hulina, 1998 a; Panda et al., 2001) and spread rapidly.

b.) The plant species of the Asiatic origin (31), of great interest in the continental part of Croatia:

(11, 12) the species of genus *Impatiens* (Balsaminaceae). During the several last decades the touch-me-nots (*Impatiens balfourii*, *I. glandulifera*) spread from gardens and have become plant invaders of wet areas, especially in riparian vegetation. The attractive nature of flowers and the curious mode of seed dispersal (explosive dehiscence of seed pods) of *Impatiens* species have ensured that their occurrences and distributions have been well recorded by botanists at a national level (Marković, 1970, 1979, 1984; Trinajstić, 1974; Rauš et al., 1985; Lukač, 1989; Pavletić, 1993; Ilijanić et al., 1994; Panda et al., 2001; Cigić et al., 2003).

A significant pest status of *Impatiens* spp. have been noted in the British Isles (Trewick et Wade, 1986) and their distribution in other parts of Europe (Moore, 1968; Jehlik, 1984) etc.

(13) The species *Wisteria sinensis* (*Glycine sinensis*, Fabaceae) is native of China. It is an attractive large climbing-plant with numerous blue, lilac or white fragrant flowers in long drooping racemes. It is planted for covering walls, porches, arbors and buildings. It grows in any soil. Their lower vines touching the soil will be rooted. This plant also produces underground runners that shoot up all over the garden. Its aggressive invasive spreading quickly go beyond the place where has been planted. It is very difficult to control. Its response to cutting is shoot regeneration and sprouts emergence from root (Hulina, in the eastern part of Medvednica, unpublished data). Roots, shoots, bark, leaves, pots and especially seeds are very toxic. Only two seeds may be poisonous to children (Roth et al., 1994).

(14) The attractive bushy perennial *Reynoutria japonica* (Polygonaceae) was of great interest of botanists in the conti-

nenal part of Croatia (Marković, 1977; Gaži-Baskova, 1978; Marković, 1979; Trinajstić, 1990; Trinajstić et al., 1994; Hulina, 1989, Hulina et Đumija, 1999; Vrbek, 2000). It was introduced from Asia to Europe for ornament and forage around 1825. However, during the last four decades *R. japonica* has become an aggressive ruderal weed in Europe. It is especially invasive in riparian habitats and roadsides (urbanophil species), where it usually forms compact, thick stands. The robust growth, high aerial biomass, vegetative means of spread, high resistance to mechanical damage and adverse environmental conditions (frost, drought, atmospheric pollutions) are responsible for strong competitiveness of the *R. japonica*.

(15) The yellow strawberry (*Duchesnea indica*, Rosaceae) is one very attractive, decorative and mimicric herbaceous plant. This plant is the combination of the morphological features of the genera *Fragaria*, with the trifoliate leaves and *Potentilla* – like yellow flowers. It was introduced as ornamental plant in Europe in the 19th century. This plant was noted as adventitious species within forest vegetation in Croatia the first time by Trinajstić (1973). It has creeping or decumbent stems, rooting at the nodes. It is reproducing by seeds and runners and it forms a dense, low and green “carpet” on the edges of roads, dikes, home gardens and elsewhere. It drastically reduces plant diversity, and it can be an aggressive weed. During the past several decades *Duchesnea indica* has expanded especially in and about cities (Hulina, 1991a, 1991b, 1998 a).

(16) The biotypes *Panicum miliaceum ssp. agricolum* (Poaceae) is one of the weedy forms of the crop, proso millet. It is noted as the weed crop in Croatia the first time by Hulina (1994). This rapidly growing grass has become an extremely competitive weed in maize, but also in other row crops such as soybean and some vegetables. It shows rapid expansion (Hulina, 1994, 1995).

(17) An ornamental tree *Ailanthus altissima*, commonly known as “tree of heaven” (Simarubaceae) is originally from China. In the 18th century it was introduced in Europe (Kramer, 1995). It is rapidly growing deciduous tree that can reach over 18.5 m in height. It was preferred for its potential insecticide activity against the pea aphid. It is able to sprout from roots and from seed prolifically. It also has allelopathic compound and kills all surrounding plants. It has become one of most notoriously invasive species in the world. Its appearance is particularly evident in the urban environment growing along roads, on debris and in gardens (Forstner et Hübl, 1971; Gutte et al., 1987; Turk, 1990; Landolt, 1991; Siniscolo et Montacchini, 1993; Facsar et Udvary, 1995; Hulina, 1998 a). It is noted as ruderal species in the continental part of Croatia (Ilijanić, 1977; Marković, 1977; Rešetnik et al., 2007), and its real presence as the urbanophil and ruderal species in the flora of Croatia is very extensive. The bark, seeds and sap are very toxic to humans and animals (Roth et al., 1994). Its pollens causes allergenic manifestations in the human population (Staffolani et Hruska, 2008).

c.) Among the plant species of Euroasian origin (10) of the significance are:

(18) the wormwood (*Artemisia absinthium*, Asteraceae). It has been valued as a medicinal, aromatic and bitter herb since antiquity. Both the Roman naturalist, Pliny and Dioscorides, a physician of the Roman army, recommended it for expelling intestinal roundworms from humans and animals. In the 19<sup>th</sup> cen-

tury, the liqueur “absinthe”, which consists oil of wormwood and several other herbs, was very popular as a drink. But, it provokes the dependence and has toxic effect on human health. Absinthe was banned in many countries when experimental evidence confirmed its toxicity. Also wormwood produces the typical allergic symptoms: sneezing, runny nose and red, itchy, puffy and teary eyes (Hulina, 2000 a). Wormwood is an herbaceous, almost shrubby plant and a common garden herb. It grows well on drier, sunny and poor soil. It consists allelopathic substances and it is strong competitor and can suppress the growth of neighbouring plants. So, it rapidly occupies a large part of the garden and frequently escapes from gardens.

(19) Euroasian species *Abutilon theophrasti* draws our special attention. It has been used as a medicinal, fibre and oil crop since ancient times. It was noted as an unstable ruderal plant for some localities in Croatia (Schlosser et Vukotinović, 1869; Rossi, 1924). Since the 1980’s it is an aggressive weed in maize, soybean, sugar beet, potato, sunflower and onion in the continental part of Croatia (Hulina, 1989, 1995, 2000 b; Topić 1998), but also it is the member of the ruderal vegetation (Rauš et al., 1985).

d.) Non invasive species *Commelina communis* (Commelinaceae), common or Asiatic dayflower also attracts our interest. As an ornamental plant it was introduced from East-Asia. In spite of its bright blue flowers being very effective, especially when they are in masses, its appearance out of culture in Croatia at the moment has been neglected by Croatian botanists. In fact, in the last several years in Zagreb and surroundings, it is widely distributed and it can be found in ruderal places, in pavement crevices etc., where it can persist for several years and to expand in an area owing to rooting at the nodes. Its thriving is mostly connected to shaded and humid habitats and its localities are scattered particularly in urban environment.

The plant species *Asclepias syriaca*, *Helianthus tuberosus*, *Solidago* spp., *Impatiens* spp., *Echinocystis lobata*, *Amorpha fruticosa*, *Robinia pseudacacia*, *Reynoutria japonica* and *Ailanthus altissima* have reached a high degree of naturalization in the continental part of Croatia and they are the threat to the survival of autochthonous plants and the stability of plant communities.

The plant species *Echinocystis lobata*, *Abutilon theophrasti*, *Panicum capillare*, *P. miliaceum* have caused economic harm in agriculture, *Amorpha fruticosa* and *Robinia pseudacacia* in forestry and *Amorpha fruticosa* in drainage systems.

The plant species *Rhus typhina*, *Asclepias syriaca*, *Solidago* spp., *Robinia pseudocacia*, *Wisteria sinensis*, *Ailanthus altissima* and *Artemisia absinthium* are harmful for humans. Plant species *Asclepias syriaca*, *Robinia pseudocacia* and *Ailanthus altissima* may be harmful for animals.

Results of this investigation may be used for assessing the risk of spreading cultivated plants. They illustrate why it is necessary to pay attention to an appearance of cultivated species out of the place of the cultivation.

## Conclusions

It may be concluded:

1. In this paper “planta hortifuga” are cultivated species (autochthonous or introduced) that escaped from culture and established themselves in different habitats.

2. List of "planta hortifuga" in the continental part of Croatia consists a total of 120 taxa belonging to 53 families.
3. Families Asteraceae (17 species) and Poaceae (10 species) were the most numerous.
4. Dominant life forms are therophytes (54), followed by phanerophytes (20), hemicriptophytes (17), chamaephytes (13), geophytes (eight), lianes (seven) and hydrophytes (one).
5. In consideration of origin predominant are: Northamerican group (35), Asiatic group (31) and Mediterranean group including the species from the Middle East (26).
6. The vaste majority of taxa were initially cultivated as ornamental annuals (32) or herbaceous perennial plants (18), park trees or orchard trees (15), ornamental shrubs (12) lianes (seven), vegetable (seven) and crops (seven). Among "planta hortifuga" are included "sua sponte" growing meliferous plants (four), herbs (three), spices (two), forage (two) as birds plants (two), weedy crops (two) and others manifold used (four).
7. The "open" ecosystems as the riverbanks, forest clearings, abandoned fiels, ruderal places, border of the drainage system are very favourable habitats for "planta hortifuga"
8. Only few species of "planta hortifuga" have reached a high degree of naturalization and were able to realize up to now dramatically increasing in distribution and density and to endanger the survival and regeneration of autochthonous plant species and the stability of communities. Such invasive species include the americanophytes: *Asclepias syriaca*, *Helianthus tuberosus*, *Solidago* spp., *Echinocystis lobata*, *Amorpha fruticosa* and *Robinia pseudacacia*; then Asiatic species: *Impatiens* spp., *Reynoutria japonica* and *Ailanthus altissima*.
9. From an agronomical point of view particularly dangerous species are: *Echinocystis lobata*, *Panicum capillare* and *P. miliaceum* ssp. *agricolum*, and *Abutilon theophrasti*. The species *Amorpha fruticosa* and *Robinia pseudacacia* have caused harm in forestry, and *Amorpha fruticosa* in drainage systems.
10. Plants species harmful to human health are: *Rhus typhina*, *Asclepias syriaca*, *Solidago* spp., *Robinia pseudacacia*, *Wisteria sinensis*, *Ailanthus altissima* and *Artemisia absinthium*. Plant species *Asclepias syriaca*, *Robinia pseudacacia* and *Ailanthus altissimum* may be harmful to animals.
11. Results of this investigation may be used for assessing the risk of cultivated plants spreading out of the places of their cultivation. They illustrate why it is necessary to pay attention to an appearance of cultivated species out of the place of their cultivation.

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