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NEW NEOPHYTES IN THE FLORA OF CROATIA

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The paper lists sixteen new neophytes for the flora in Croatia. The grass *Setaria parviflora* has been naturalized in the Šibenik area (Solaris, Zablaće) for some time now but the grass *Bromus catharticus* has been found only recently, in Zadar (Voštarnica). Their seed was probably brought in as a seed admixture used to form lawns on public areas. The *Senecio angulata* species has been recently noticed as a decorative garden plant in the Zadar area and on the island of Rava, where it demonstrates the ability of subspontaneous spread. The remaining species were registered in the cargo port of Gaženica where they were probably brought in with raw materials shipments, especially of soy-beans and grains: *Amaranthus spinosus*, *Alternanthera caracasana*, *Commelina benghalensis*, *Ipomoea coccinea*, *I. hederacea*, *I. cordatotriloba*, *Eleusine coracana*, *Pennisetum glaucum*, *Physalis angulata*, *Senna obtusifolia*, *Sida rhombifolia*, *Solanum chenopodioides* and *Solanum sisymbrifolium*.

Key words: new neophytes, flora, Croatia

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U radu se navodi 16 novih neofita za floru Hrvatske. Trava *Setaria parviflora* je već duže vrijeme udomaćena na području Šibenika (Solaris, Zablaće), a trava *Bromus catharticus* je nedavno pronađena u Zadru (Voštarnica). Njihovo sjeme je vjerojatno unešeno kao primjesa u sjemenju za formiranje travnjaka na javnim površinama. Vrsta *Senecio angulata* je odnedavno primjećena kao vrtna ukrasna biljka na području Zadra i otoka Rave, gdje pokazuje sposobnost subspontanog širenja. Ostale vrste su zabilježene u teretnoj luci Gaženica gdje su vjerojatno dospjele transportom sirovina, naročito sojine sačme i žitarica: *Amaranthus spinosus*, *Alternanthera caracasana*, *Commelina benghalensis*, *Ipomoea coccinea*, *I. hederacea*, *I. cordatotriloba*, *Eleusine coracana*, *Pennisetum glaucum*, *Physalis angulata*, *Senna obtusifolia*, *Sida rhombifolia*, *Solanum chenopodioides* i *Solanum sisymbrifolium*.

Ključne riječi: novi neofiti, flora, Hrvatska

INTRODUCTION

The introduction of plants to areas where they are not native has been receiving increasing attention worldwide (PYŠEK *et al.*, 1995, 2006; LONSDALE, 1999; HULME, 2003; LAMBDON *et al.*, 2008). In Croatia, the number of published papers which deal with alien plants has increased significantly over the last 40 or so years. Most of the au-

thors have published individual neophyte findings: HODAK (1959/1960), HORVATIĆ & GOSPODARIĆ (1959/1960), MARKOVIĆ-GOSPODARIĆ (1963), MARKOVIĆ (1970, 1973, 1978), TRINAJSTIĆ (1973, 1975a), GAŽI-BASKOVA & ŠEGULJA (1978), ILIJANIĆ & TOPIĆ (1986), PAVLETIĆ (1987), TRINAJSTIĆ & PAVLETIĆ (1989), TRINAJSTIĆ *et al.* (1995), TRINAJSTIĆ & JASPRICA (1998), MARKOVIĆ & RUŠČIĆ (1999), BOGDANOVIĆ *et al.* (2003, 2006), TOPIĆ & ILIJANIĆ (2003), STRGLUC-KRAJŠEK & JOGAN (2004). Other authors offer an insight into the distribution and spread of neophyte species in Croatia: TRINAJSTIĆ (1974, 1978, 1991, 1993,) ILIJANIĆ *et al.* (1991, 1994), MARKOVIĆ & LUKAČ (1993), TRINAJSTIĆ *et al.* (1993), FRANJIĆ & TRINAJSTIĆ (1996), FRANJIĆ *et al.* (1998), SMITAL *et al.* (1998), PANDŽA & STANČIĆ (1999), ŠILIĆ & ŠOLIĆ (1999), MILOVIĆ (2001, 2004, 2007), MILOVIĆ & RANDIĆ (2001), PANDŽA *et al.* (2001), HULINA (2008), PANDŽA & TAFRA (2008). In several papers, TRINAJSTIĆ (1975b, 1977, 1979) suggests a chronological classification of anthropochorous plants and discusses their role in the structure of regional flora and vegetation.

A proposal of the Croatian national standard and criteria for the treatment of alien flora in accordance with the latest suggestions of the world's most eminent experts who research into alien flora (RICHARDSON *et al.*, 2000; PYŠEK *et al.*, 2004) was recently published (MITIĆ *et al.*, 2006, 2007, 2008). A special module »allochthonous plants« was established in the Flora Croatica database (NIKOLIĆ, 2009; URL: http://hirc.botanic.hr/fcd/AlohtoneVrste).

A preliminary list of neophytes comprising 206 taxa, i.e. 3.7% of the total vascular flora in Croatia was recently published (DOBROVIĆ *et al.*, 2005). This number is significantly smaller than the number of alien flora taxa of other European countries (LAMBDON *et al.*, 2008). Very recently, a preliminary list of alien invasive flora containing 64 taxa was published (BORŠIĆ *et al.* 2008). Croatian botanists have to produce a comprehensive catalogue of alien flora with the floristic status, degree of naturalization, date and mode of introduction as well as the chorological, biological and ecological data for each taxon as soon as possible.

During research into the vascular flora of the Zadar and Šibenik area, 16 neophyte species that had not been noted in the list of Croatian flora (NIKOLIĆ, 2009) were found. These findings are a significant contribution to the full inventory of the alien flora of Croatia.

METHODS

In this paper, all species that are not native to any area within the boundaries of the Republic of Croatia are considered to be alien. The definition of subsets within alien flora (neophytes, casual, naturalized and invasive) in this paper is used according to the suggestion of RICHARDSON *et al.* (2000), PYŠEK *et al.* (2004) and MITIĆ *et al.* (2008).

In order to determine the species diverse literature sources were used: HITCHCOCK (1971), FOURNIER (1961), TÄCKHOLM (1974), TUTIN *et al.* (1968–1980; 1993), MUNZ (1974), PIGNATTI (1982), CLEMENT & FOSTER (1994), RYVES *et al.* (1996), STACE (1997), EFLORAS (2009), PLANTNET (2009).

The neophyte species that are listed in this paper were not listed in the Flora Croatica database (NIKOLIĆ, 2009) and can therefore be considered to be new spe-

cies for the flora of Croatia. The nomenclature of the species and subspecies has been adjusted according to the GRIN Taxonomy for Plants, online Database (2009).

The paper lists the coordinates of all localities where the species were found according to the Gaus-Krüger coordinate system as well as the allocation of the localities to their corresponding MTB 1/64 quadrants.

The neophyte specimens that were collected are stored in the herbarium of the Botanical Institute of the University of Zagreb, Faculty of Science (Hb ZA). Photographs of the neophytes found, taken by the first author of the paper, are in the attachment.

RESULTS

During research into the flora of the Zadar and Šibenik area conducted over a period of several years, a total of 16 alien taxa, new for the flora of Croatia, was registered (Tab. 1). With the exception of *S. angulatus*, which was introduced in the culture as an ornamental plant on purpose, all of the remaining taxa were introduced by accident either during the import of merchandise via Gaženica port or were a part of the seed admixture used for lawns.

NEW NEOPHYTES FOUND IN THE PORT OF GAŽENICA (ZADAR)

From a total of 16 new species of neophytes, 13 were found in Zadar, in the port of Gaženica (Fig. 1), at the dock for reloading bulk cargo (mostly soy-bean and cereals) or in its vicinity (x=5521681, y=4882676; MTB: 1957–212). All plant species

Tab. 1. New neophytes for the flora of Croatia

Species	Family	Geographic origin	Locality
Alternathera caracasana Kunth	Amaranthaceae	tropical Asia & America	Gaženica (Zadar)
Amaranthus spinosus L.	Amaranthaceae	tropical America	Gaženica (Zadar)
Bromus catharticus Vahl	Poaceae	South America	Voštarnica (Zadar)
Commelina benghalensis L.	Commelinaceae	palaeotropics	Gaženica (Zadar)
Eleusine coracana (L.) Gaertn.	Poaceae	palaeotropics	Gaženica (Zadar)
Ipomoea coccinea L.	Convolvulaceae	tropical America	Gaženica (Zadar)
I. hederacea Jacq.	Convolvulaceae	tropical America	Gaženica (Zadar)
I. cordatotriloba Dennst.	Convolvulaceae	trop. & subtrop. America	Gaženica (Zadar)
Pennisetum glaucum (L.) R. Br.	Poaceae	tropical Africa	Gaženica (Zadar)
Physalis angulata L.	Solanaceae	tropical America	Gaženica (Zadar)
Senecio angulatus L. f.	Asteraceae	South Africa	Arbanasi (Zadar), island of Rava
Senna obtusifolia (L.) H. S. Irwin & Barneby	Caesalpinaceae	tropical America	Gaženica (Zadar)
Setaria parviflora (Poir.) Kerguélen	Poaceae	tropical America	Solaris and Zablaće (Šibenik)
Sida rhombifolia L.	Malvaceae	paleotropics	Gaženica (Zadar)
Solanum chenopodioides Lam.	Solanaceae	South America	Gaženica (Zadar)
S. sisymbrifolium Lam.	Solanaceae	South America	Gaženica (Zadar)

Fig. 1. Gaženica cargo port (Zadar), bulk-cargo reloading dock

found in the port of Gaženica grow on ruderal habitats enriched with soy-bean and cereal waste.

Alternanthera caracasana Kunth (Amaranthaceae)

Syn.: *A. peploides* (Humb. & Bonpl.) Urban, *A achyrantha* (L.) Swartz, *A. repens* auct.

This perennial plant (Fig. 2) originates from tropical areas of western Asia and tropical America (TUTIN & EDMONSON, 1993). In the Europe it was registered in Spain (SANZ ELORZA *et al.*, 2004) and in Great Britain (CLEMENT & FOSTER, 1994). It

Fig. 2. *Alternanthera caracasana* Kunth (Amaranthaceae)

Fig. 3. *Amaranthus spinosus* L. (Amaranthaceae)

is believed that it entered Great Britain with a wool cargo (CLEMENT & FOSTER, 1994). It differs from the similar species of *A. pungens*, which is recorded in Spain as a casual, by the shorter points of outer perianth segments, and by filaments about twice as long as the anthers.

A. caracasana was first observed in Gaženica in the autumn of 2005, and since then several specimens of this species have occurred in the same site but did not spread to the surrounding area.

Amaranthus spinosus L. (Amaranthaceae)

A. spinosus (Fig. 3) is an annual plant that probably originates from lowland tropical South and Central America and was introduced into other warmer parts of the world. Presently it occurs in all tropical and subtropical regions (JANSEN, 2004). *A. spinosus* is a very noxious weed in many parts of the world, especially in Africa – where it is found in maize, cassava, groundnut, cotton and in sugar cane (JANSEN, 2004). In TUTIN & EDMONDSON (1993) this species was not registered for the flora of Europe but it is reported to occur as a rare and casual newcomer in several countries: Italy (PIGNATTI, 1982), Great Britain (CLEMENT & FOSTER, 1994), Czech Republic (PYŠEK *et al.*, 2002) as well as Denmark, the European part of Russia, Latvia and Sweden (NOBANIS, 2009). It can easily be distinguished from other species belonging to the genus *Amaranthus* by its leaf-axil spines (PIGNATTI, 1982).

Until this research, *A. spinosus* was not recorded for the Croatian flora (NIKOLIĆ, 2009). In the fall of 2005, several specimens of these taxa have been found in Gaženica port but they were not noticed thereafter.

Commelina benghalensis L. (Commelinaceae)

C. communis occurs both in crops and sub-spontaneously in most parts of Europe (WEBB, 1980) as well as in Croatia (NIKOLIĆ, 2009) whereas for the area of north

Fig. 4. *Commelina benghalensis* L. (Commelinaceae)

Italy *C. virginica* was registered as well (PIGNATTI, 1982; WEBB, 1980). *C. benghalensis* (Fig. 4) is originally an Old World species and was naturalized in the Americas and Hawaii (VAN DER BURG, 2004). It is a widely distributed weed that commonly invades agricultural sites and disturbed areas. Listed as an alien casual plant it was registered in Spain by SANZ ELORZA *et al.* (2004) but was not registered for other parts of Europe. TÄCKHOLM (1974) noted *C. benghalensis* for Egypt. It differs from the very similar species *C. virginica*, that was registered for Croatia previously, by ovate to lanceolate elliptic leaves, smaller sphates and by the sometimes present subterranean, cleistogamous flowers (EFLORAS, 2009).

In 2004, several specimens of *C. benghalensis* were found in the harbour of Gaženica (Zadar) at the dock for reloading bulk cargo, mostly soy-bean and cereals, and have, since then, persisted in the site where they were found, without spreading, however.

Eleusine coracana (L.) Gaertn. (Poaceae)

Syn.: *Eleusine indica* (L.) Gaertn. subsp. *coracana* (L.) Lye

The genus *Eleusine* comprises about 10 species, distributed in the tropical and subtropical parts of the world (DE WET, 2006). This genus is represented by two neophyte taxa – *E. indica* and *E. tristachya* in the European as well as in the Croatian flora (HANSEN, 1980, NIKOLIĆ, 2009) but not by *E. coracana*. *E. coracana* is an annual grass (Fig. 5) of East African origin but is widely cultivated as a cereal crop in the tropical and subtropical regions of Africa and southern Asia (HITCHCOCK, 1971; DE WET, 2006). In the Americas and Europe it is rare and occurs in culture and/or as a casual escape. It is very similar to *E. indica*, from which it differs by it more robust habit (up to 170 cm tall), stout and mostly incurved racemes and by spikelets not disarticulating at maturity (PIGNATTI, 1982; DE WET, 2006).

Several examples of this species were first found in Gaženica port in the autumn of 2005, but the plant was not found in the same locality thereafter.

Fig. 5. *Eleusine coracana* (L.) Gaertn. (Poaceae)

Ipomoea sp. (Convolvulaceae)

The genus *Ipomoea* comprises 600–700 species that are widespread in tropical and subtropical areas worldwide. The majority of species occur in the Americas and Africa (AUSTIN, 1980; AUSTIN & HUÁMAN, 1996). In Europe, the genus *Ipomoea* is represented by only five species. *I. stolonifera* (Cyr.) J. F. Gmelin and *I. sagittata* Poiret, are usually considered to be native for the Mediterranean region but *I. acuminata* (Vahl) Roemer & Schultes, *I. purpurea* Roth and *I. batatas* (L.) occur in the culture and/or as an escape from culture (STACE, 1972).

The flora of Croatia referred *I. batatas* and *I. purpurea* (NIKOLIĆ, 2009), which comes in the culture and sometime escaping. In Zadar, in the port of Gaženica, a lot of examples of different plants from the genus *Ipomoea* have been found but were difficult to determine due to the lack of appropriate literature. Apart from *I. purpurea*, recorded previously, three other species, new for the flora of Croatia, were identified: *I. coccinea* (Fig. 6), *I. hederacea* (Fig. 7) and *I. cordatotriloba* (Fig. 8). A larger number of specimens of all three species have been growing in the Gaženica port during the whole period of the research (2005–2008).

Ipomoea coccinea L.

Syn.: *Quamoclit coccinea* (L.) Moench

The native range of *I. coccinea* (Fig. 6) consists of the tropical regions of America, but it is widely naturalized elsewhere (BRITTON & BROWN, 1913, as *Quamoclit coccinea*). In Europe it is very rare; it occurs as a casual plant in Lithuania (NOBANIS, 2009) and Great Britain, where it was introduced unintentionally as an oil-seed ad-

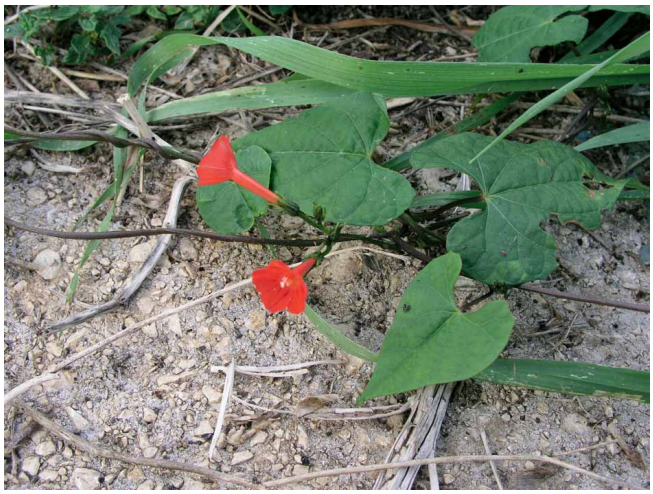

Fig. 6. *Ipomoea coccinea* L. (Convolvulaceae)

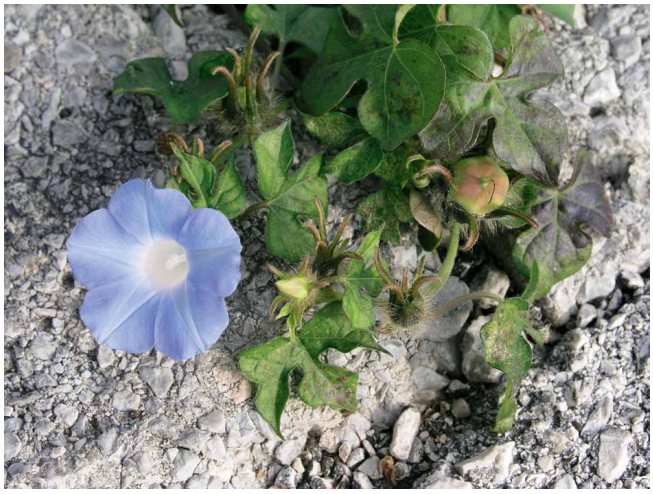

Fig. 7. *Ipomoea hederacea* Jacq. (Convolvulaceae)

mixture (CLEMENT & FOSTER, 1994). The red flowers and the entire or angulate-lobed leaves with points along the margins are two characteristics that help to distinguish *I. coccinea* from most of the other similar *Ipomoea* species (KNIGHT, 1959).

I. hederacea Jacq.

Syn.: *Pharbitis hederacea* (Jacq.) Choisy, *Ipomoea barbigera* Sweet

It is native in tropical America but it is cultivated worldwide as an ornamental plant and it seldom occurs naturalized or as a garden escapee. As a rare and casual weed it was registered in Denmark, Russia and Lithuania (NOBANIS, 2009) and in

the Czech Republic (KUBAT *et al.*, 2002). In Great Britain it was noted as an oil-seed and grain casual (CLEMENT & FOSTER, 1994). *I. hederacea* was included on the warning list of species that are weedy in America and are either invasive or naturalized or casual in Europe (FORMAN, 2003). It differs from *I. purpurea* by leaves cordate at base and deeply 3-lobed, by the light blue corolla and mostly by lanceolate sepals with long linear often recurved tips, much longer then the body of the sepals (KRINGS, 2002; STACE, 1997).

I. cordatotriloba Dennst.

Syn.: *Ipomoea trichocarpa* Elliott

This twining, herbaceous annual is native in tropical and subtropical regions of Americas where it grows along roadsides as well as on disturbed areas and fields. Leaves are heart-shaped, deeply 3-or 5-lobed, and corolla is 2.8–5 cm long, pink with a darker purple centre (BRITTON & BROWN, 1913, as *I. trichocarpa* Ell.; KRINGS, 2002). It differs from *I. purpurea* and *I hederacea* by leaves that are glabrous above and below as well as by lanceolate sepals without tips but with ciliolate margins (KRINGS, 2002).

I. cordatotriloba is closely related to the *I. batatas*, cultivated in tropical regions of the world for edible tuberous roots (»sweet potato«) and is registered in Europe and Croatia (NIKOLIĆ, 2009) in cultivation or more rarely as a vegetable escapee. In Europe, *I. cordatotriloba* is very rare and was registered by CLEMENT & FOSTER (1994, as *I. trichocarpa* Elliot) for Great Britain where it has grown from soy-bean waste.

Pennisetum glaucum (L.) R.Br. (Poaceae)

Syn.: *Pennisetum spicatum* (L.) Körn., *P. americanum* (L.) Leecke, *P. typhoides* (Burm. f.) Stapf & C. E. Hubb.

The genus *Pennisetum* comprises about 80 species and occurs throughout the tropics. In Europe, only two species of *Pennisetum* occur – *P. setaceum* (Forskal)

Fig. 8. *Ipomoea cordatotriloba* Dennst. (Convolvulaceae)

Chiov. and *P. villosum* R. Br. ex Frexen (CLAYTON, 1980). However, in Croatia only *P. villosum* has been recorded so far (NIKOLIĆ, 2009).

P. glaucum (Fig. 9) is an annual robust grass (up to 4 m tall) and it originates from tropical Africa (ANDREWS & KUMAR, 2006). It is commonly grown as a grain crop in the semi-arid regions of Africa and the Indian subcontinent as well as a fodder crop in the Americas, South Africa and Australia (ANDREWS & KUMAR, 2006). *P. glaucum* was recorded as a casual neophyte in the Great Britain where it occurs as a garden weed and in a mixture of maize and millet cultures (RYVES *et al.*, 1996).

Just a few specimens of this species were found in Gaženica port in the autumn of 2005, andthe plant was not observed on the same locality thereafter.

Physalis angulata L. (Solanaceae)

The genus *Physalis* comprises about 90 species native to tropical and temperate America with Mexico as a centre of diversity (MARTINEZ, 1998). The species are variable and taxonomically confusing and no comprehensive study of the genus exists (MAIRURA, 2008). Several species (*P. philadelphica* Lam., *P. peruviana* L.) have been under cultivation for their edible fruits in their native region as well as in India, Australia and Africa.

P. angulata (Fig. 10) is an annual herb, native in tropical America and now distributed pantropically as a weed (MAIRURA, 2008). It is very rare in Europe and is cultivated locally for its edible fruits and is found as an occasional casual (HAWKES, 1972). It was reported for Great Britain (CLEMENT & FOSTER, 1994), Czech Republic (PYŠEK *et al.*, 2002), Denmark (NOBANIS, 2009) and Turkey (GÖNEN *et al.*, 2000). In appearance *P angulata* is most like *P. ixocarpa* Brot ex Hornem and *P. philadelphica*

Fig. 9. *Pennisetum glaucum* (L.) R. Br. (Poaceae)

Fig. 10. *Physalis angulata* L. (Solanaceae)

Lam., but it has longer flower pedicels, shorter anthers (1.5–2 mm), and smaller (10–12 mm), yellowish-green berries (HAWKES, 1972).

For the area of Croatia, along with the native *Ph. alkekengi*, three more adventive species – *P. heterophylla* Nees, *P. peruviana* L. and *P. pubescens* L., have been recorded but not *P. angulata* (NIKOLIĆ, 2009). Several specimens of *P. angulata* were found in Gaženica port in May 2005. Since then, it has been growing in the port of Gaženica and was noticed during the entire period of the research (2004–2008).

Senna obtusifolia (L.) H.S. Irvin & Barneby (Caesalpinaceae)

Syn.: *Cassia obtusifolia* L.

S. obtusifolia is an annual or short-lived perennial herb or shrub up to 2 (–2,5) m tall (Fig. 11), a native of tropical America but widely cultivated for medicinal uses and naturalized. It is found along rivers and on lake shores, as well as on cultivated land (BOSCH, 2004). It is considered a serious invader of crops and pasture land in the wet tropics of Americas, Australia, Africa and Asia (MACKEY *et al.*, 1997).

In the most recent time, several species of *Senna* have been reported as rare casuals from a few European countries – Spain (SANZ ELORZA *et al.*, 2004, as *Cassia* sp.), Great Britain (CLEMENT & FOSTER, 1994) and Denmark (NOBANIS, 2009, as *Cassia* sp.).

S. obtusifolia has been reported only from Great Britain (CLEMENT & FOSTER, 1994) where it is considered as a casual from soy-bean waste that rarely reaches flowering (STACE, 1997) and from Spain (SANZ ELORZA *et al.*, 2004). It is distinguished from the similar *Senna* species by leaves with 3 pairs of obovate leaflets and by glands (petiolar nectaries) between the lower and occasionally the second pair of leaflets (WAGNER *et al.*, 1999).

Several specimens of *Senna obtusifolia* were found growing in the port of during the entire period of this research (2004–2008).

Fig. 11. *Senna obtusifolia* (L.) H. S. Irwin & Barneby (Caesalpinaceae)

Sida rhombifolia L. (Malvaceae)

S. rhombifolia (Fig. 12) is a short-lived perennial sub-shrub (woody stem and herbaceous branches) commonly growing up to 60 cm, but sometimes reaching 1.5 m in height. Today, it grows in over 70 countries throughout the tropical, subtropical and warm temperate regions (HOLM *et al.*, 1997). Its native range is unknown, but the presence of multiple subspecies and varieties seems to indicate that it originates from the palaeotropics. It is a common weed in pastures and cultivated fields as well as along roadsides and in ruderal sites in urban areas. *S.*

Fig. 12. *Sida rhombifolia* L. (Malvaceae)

rhombifolia plants have been used for medicinal purposes and the stems for fibre (HOLM *et al.*, 1997).

In Europe this plant is very rare; it was registered in Great Britain (STACE, 1997), Czech Republic (PYŠEK *et al.*, 2002), Spain (SANZ ELORZA *et al.*, 2004), Denmark, Sweden and Lithuania (NOBANIS, 2009). In Great Britain it has been growing as a wool and oil-seed casual (CLEMENT & FOSTER, 1994).

In the summer of 2005, several specimens of *Sida rhombifolia* were found in Gaženica port (Zadar). Since then, the plant has been growing in the same place throughout the duration of this research, but it did not spread to the surrounding area.

Solanum sp. (Solanaceae)

During this research several newcomers from the genus of *Solanum* L. were found in the port of Gaženica. *S. eleagnifolium* Cav., *S. rostratum* Dunal and *S. carolinense* L. have been previously recorded but findings of *S. chenopodioides* and *S. sisymbrifolium* were new for the flora of Croatia (NIKOLIĆ, 2009). In the period observed (2004–2008), both species have been growing with a larger number of specimens in ruderal habitats in Gaženica.

Solanum chenopodioides Lam.

Syn.: *S. gracile* Dunal, *S. gracilius* Herter, *S. sublobatum* Willd. ex Roem. & Schult.

S. chenopodioides is an erect perennial herb (Fig. 13) native to eastern parts of South America whence it has been introduced to other regions of the world. It belongs to *Solanum nigrum* L. group of closely related species (EDMONDS & CHWEYA, 1997) from which it is distinguished by umbellate cymes, strongly deflexed fruiting penducles and by ovoid, dull purple berries (HAWKES & EDMONDS, 1972: 197, as *S. sublobatum*).

Fig. 13. *Solanum chenopodioides* Lam. (Solanaceae)

Fig. 14. *Solanum sisymbrifolium* Lam. (Solanaceae)

S. chenopodioides is locally naturalized in South-West Europe (HAWKES & EDMONDS, 1972) but it occurs as a casual plant in other parts of Europe as well: Italy (BANFI, 1987), Great Britain (CLEMENT & FOSTER, 1997) and Denmark (NOBANIS, 2009). Its occurrence around railway stations and cuttings, docksides and mills, especially in Europe, is undoubtedly associated with the importation of wool as well as the importation of grain and oil seeds from South America, especially from Argentina (EDMONDS & CHWEYA, 1997; CLEMENT & FOSTER, 1994).

S. sisymbriifolium Lam.

S. sisymbrifolium (Fig. 14) is an erect annual or short-lived perennial herb up to 1.5 m high, with a number of spines on the stalk, leaves and calyx (STACE, 1997). *S. sisymbrifolium* is most similar in appearance to *S. sodomeum* L. but is distinguished from it by its larger corolla (30–35 mm in diameter) and red berry partly enclosed by the accrescent calyx (HAWKES & EDMONDS, 1972). It originates from South America but has been introduced into warm and temperate regions worldwide. It occurs in waste places and in cultivated ground both in its native as well as most of its non-native range (BEAN, 2006). Recently, it is best known for its use as a trap crop for potato cyst nematodes (PCN) (TIMMERMANS *et al.*, 2006). In Great Britain it is occasionally found as a wool, oil-seed, bird-seed and agricultural seed casual (CLEMENT & FOSTER, 1997). As a casual plant it is referred to also for Italy (PIGNATTI, 1982), Czech Republic (PYŠEK *et al.*, 2002), Spain (SANZ ELORZA *et al.*, 2004), Turkey (KARAER & KUTBAY, 2007), Estonia and Germany (NOBANIS, 2009).

In 2004, for the first time, a population of about ten individuals of *Solanum sisymbrifolium* was found in Gaženica port near dock nr. 3, for reloading bulk cargo (soy-bean and cereals). Since then this species has been well established in three populations, each a bit more remote from the other, but the species did not expand past those sites. Each of these populations consists of 10 to 20 well developed and fertile individuals.

NEW NEOPHYTES FOUND IN OTHER PARTS OF THE ZADAR AND ŠIBENIK AREA

Bromus catharticus Vahl (Poaceae)

Syn.: *B. wildenowii* Kunth, *B. unioloides* Kunth

According to SMITH (1980), two species from the *Bromus* sect. *Ceratochloa*, occur in Europe – *B. carinatus* Hook & Arn and *B. catharticus* (SMITH, 1980). Neither species mentioned has been recorded in Croatia so far (NIKOLIĆ, 2008).

B. catharticus is a South American short-lived perennial grass (Fig. 15), widely introduced as a winter forage and is found as an escapee in most temperate regions. Commercial pasture varieties of this grass are available and are suited to the tablelands (CLAYTON *et al.*, 2009). In South Europe, *B. catharticus*, occasionally cultivated for fodder, is locally naturalized and occurs as a casual elsewhere (SMITH, 1980). It was recorded for the flora of Italy (PIGNATTI, 1982), Czech Republic (PYŠEK *et al.*, 2002), Great Britain (RYVES *et al.*, 1996), Spain (SANZ ELORZA *et al.*, 2004) as well as in Denmark, Germany, the European part of Russia and Lithuania (NOBANIS, 2009).

In May 2006, *B. catharticus* was found in Zadar (Voštarnica district) in the city park of »Vrulja« (x=5518924, y=4886332; MTB:1857–342) where it has been growing on green-lawn. It can be assumed that it was introduced as part of seed admixture to the green-lawn establishment.

Senecio angulatus L. f. (Asteraceae)

S. angulatus (Fig. 16) is a scrambling, glabrous perennial up to two metres tall and native to South Africa. It has thick, fleshy, coarsely toothed leaves, with one to three teeth on each side and produces yellow daisy-like flowers in compound corymbs or panicles. It is cultivated for ornamental purposes and sometimes occurs as a garden escapee in North Italy (Liguria) and South Spain (PIGNATTI, 1982; CHATTER & WALTERS, 1976). *S. angulatus* resembles *Delairea odorata* Lem. (=*Senecio micanoides*) most in its being a scrambling fleshy-leaved plant with a more or less woody stem, but it is distinguished from it by the absence of auricles at petiole bases, the more fleshy leaf lamina, the outwardly curved leaf teeth and by yellow ligules present in the flower capitula.

Among alien species from the genus *Senecio*, *S. mikanioides* Otto ex Walp. and *S. inaequidens* DC. have been noted for the flora of Croatia so far but not *S. angulatus* (NIKOLIĆ, 2009).

In September 2005, *S. angulatus* was found in Zadar, in the city region of Arbanasi (x=5520181, y=4884515; MTB:1857–433), where several specimens have been growing in the courtyard of a house that has been abandoned for some time now. This plant was originally introduced into cultivation as an ornamental but in the meantime it managed not only to maintain itself but also to spread by runners all over the yard of the abandoned house. Most recently, this plant is observed growing as an ornamental plant in gardens as well as a garden escapee in the settlement of Vela Rava (x=5505167, y=4875267; MTB: 1956–341) on the island of Rava (Zadar archipelago).

Fig. 15. *Bromus catharticus* Vahl (Poaceae)

Fig. 16. *Senecio angulatus* L. f. (Asteraceae)

Setaria parviflora (Poir.) Kerguélen (Poaceae)

Syn.: *Setaria geniculata* (Lam.) Beauv

This grass (Fig. 17 and 18) is native to tropical America (HITCHCOCK, 1971). In parts of South-West Europe it is more or less naturalized on cultivated ground or waste places (CLAYTON, 1980). As a rare casual it is registered in Italy (PIGNATTI, 1982), Denmark (NOBANIS, 2009) and in Great Britain where it was introduced by

wool or bird-seed (RYVES *et al.*, 1996). *S. parviflora* mostly resembles *Setaria pumila* (Poir.) Roem. & Schult., but it is a perennial, with short creeping rhizomes, more slender panicles and smaller spikelets (HUBBARD, 1984).

In 1997, *S. parviflora* was observed for the first time by the first author in the Šibenik area – in the Solaris hotel resort and in the settlement of Zablaće. In Solaris, it has been growing on lawns situated around hotel Niko and along nearby paths

Fig. 17. *Setaria parviflora* (Poir.) Kerguélen (Poaceae)

Fig. 18. *Setaria parviflora* – upper part of plant with spikes

(x=5571425; y=4839405; MTB: 2361–121). In the centre of the settlement of Zablaće it was found on a lawn in a house yard (x=5570302; y=4840803; MTB: 2261–334). Since 1997, the plant has managed to survive in the habitats where it was originally observed and has spread along nearby roads and footways, at both localities where it was first found. Therefore, according to the definition of RICHARDSON *et al.* (2000), this alien grass can be considered as a naturalised species in the area of Šibenik.

DISCUSSION AND CONCLUSION

Out of 16 species of neophytes that are listed in the paper, 13 were registered in the area of Gaženica cargo port (Tab. 1). Most of the neophytes registered originate from the tropical and subtropical areas of the Americas.

Only three species (*Amaranthus spinosus, Eleusine coracana* and *Pennisetum glaucum*) were observed only once in the Gaženica port, whereas nine species (*Alternanthera caracasana, Commelina benghalensis, Ipomoea coccinea, I. hederacea, I. cordatotriloba, Physalis angulata, Senna obtusifolia, Sida rhombifolia, Solanum chenopodioides*) were found during the entire period in which the research was conducted (2004–2008). Given the fact that neither of the above mentioned species has emerged on localities outside of the original point of entry (Gaženica port, dock nr. 3), all of them can be considered to be casuals, whose occurrence depends on the repeated import of seeds during the transport of raw materials, especially soy-bean and cereals.

During the research (2004–2008), only *Solanum sisymbrifolium* managed to produce three self-reproducing populations, approximately a hundred meters from the original point of entry. Due to this fact, this species can, according to the definition of RICHARDSON *et al.* (2000), be considered a naturalized one. In the future, we should monitor the behaviour of this species due to the peril of its invasive expansion outside of the Gaženica port into the surrounding areas.

The *Senecio angulatus* is a South African species that was brought into the Zadar area and the Island of Rava very recently and occurs as an escapee from the culture very rarely. We should investigate whether this species is present in other parts of Dalmatia, and monitor its possible spread outside the culture in the future, because in certain parts of the world it is registered as a dangerous weed (RICHARDSON *et al.*, 2006).

Introduced plant taxa once cultivated as ornamentals that escaped from cultivation make a significant share of the total number of taxa in alien floras of the European countries (PYŠEK *et al.*, 2002; KOWARIK, 2003). In the area of Croatia the research and recording of cultivated alien plants that possess a smaller or a larger ability to survive outside of cultivation has been unjustly neglected. Croatian authors have, mostly, included only the taxa that have naturalized outside of cultivation and those taxa that possess the ability of invasive expansion to the surrounding areas into the lists of flora. The cultivated species with a limited ability of sub-spontaneous expansion (casuals) are usually left out of the lists. This is the one of the main reasons why alien flora of Croatia (DOBROVIĆ *et al.*, 2005) contains a significantly smaller number of taxa than the lists of alien flora of other European countries (LAMBDON *et al.*, 2008).

In the upcoming period, special attention should be given to alien grass, *Bromus catharticus* and *Setaria parviflora*, probably imported as a seed admixture for lawn establishment. The *B. catharticus* species was, until now, found only in the Zadar area and, for the time being, can be considered an impermanent species that however possesses a potential to become naturalized. Since 1997, *S. parviflora* has been present in the Šibenik area (Solaris, Zablaće), where it has, in the meantime, become naturalized on lawns and alongside paths. For the time being it does not show the ability of invasive expansion, but this possibility cannot be excluded. One can assume that both these grass species are present on suitable habitats, as well as other parts of Dalmatia. This assumption should be investigated into more detail.

The considerable amount of newly found neophytes in Gaženica port confirms the assumption that ports (sea, river, air) are in fact the key locations through which alien species from remote geographic areas come into local areas and local floras (MACK, 2003; JEHLIK, 1998). For instance, the largest amount of impermanent alien species in the total flora of the United Kingdom was brought in by accident during the transporation of wool, cereals or soy-beans (CLEMENTS & FOSTER, 1994; RYVES *et al.*, 1996).

Thus it is of the utmost importance to conduct detailed research into the flora in the areas of larger ports along Croatian littoral (Ploče, Rijeka, Split, Šibenik), with a special emphasis on the recording of alien species that come to Croatia via cargo transport. This will enable us to take the necessary steps to efficiently suppress potentially invasive alien species in the early stages of their arrival.

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SAŽETAK

Novi neofiti u flori Hrvatske

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Tijekom višegodišnjeg istraživanja flore zadarskog i šibenskog područja pronađeno je 16 vrsta neofita koji su novi za floru Hrvatske. Među njima, 13 je zabilježeno na području teretne luke Gaženica, dok su tri vrste pronađene u drugim dijelovima Zadra i na širem području Šibenika.

Tri su vrste (*Amaranthus spinosus, Eleusine coracana* i *Pennisetum glaucum*) zapažene samo u jednom navratu, a devet je vrsta (*Alternanthera caracasana, Commelina*

benghalensis, Ipomoea coccinea, I. hederacea, I. cordatotriloba, Physalis angulata, Senna obtusifolia, Sida rhombifolia, Solanum chenopodioides) nalaženo u Gaženici kroz cijelo vrijeme trajanja istraživanja (2004–2008). Kako se ni jedna od navedenih 12 vrsta ne pojavljuje na okolnim staništima izvan gata za pretovar rasutih tereta, sve se one mogu smatrati nestalnim vrstama (»casual«) čije je pojavljivanje ovisno o ponavljanom unošenju dijaspora u transportu različitih sirovina, naročito sojine sačme i žitarica.

U istraživanom razdoblju (2004–2008) jedino je vrsta *Solanum sisymbrifolium* uspjela stvoriti tri manje populacije, čije se jedinke samostalno razmnožavaju. Zbog toga se ova vrsta može smatrati naturaliziranom prema definiciji RICHARDSON *et al*. (2000). U budućnosti bi trebalo pratiti ponašanje ove vrste zbog opasnosti njenog širenja izvan luke Gaženica na okolna područja.

Vrsta *Senecio angulatus* je južnoafrička vrsta koja je na područje Zadra unešena u hortikulturu u najnovije vrijeme i za sada rijetko dolazi kao prebjeg iz kulture. Treba obratiti pažnju da li je ova vrsta prisutna u drugim dijelovima Dalmacije, te pratiti njeno moguće širenje u budućnosti, jer je u nekim područjima svijeta zabilježena kao opasan korov.

Proučavanje i evidentiranje hortikulturnih biljaka koje imaju manju ili veću sposobnost održavanja izvan uzgoja u Hrvatskoj je do sada bilo neopravdano zanemareno. Domaći autori, od stranih kultiviranih vrsta, u popise flore uglavnom uključuju samo one svojte koje su se udomaćile (»naturalized«) izvan uzgoja i imaju sposobnost invazivnog širenja (»invasive«) na okolna staništa. Kultivirane vrste s manjom sposobnošću subspontanog širenja (»casual«) uglavnom su zanemarene. To je jedan od razloga zašto je strana flora Hrvatske znatno siromašnija vrstama od stranih flora drugih europskih država.

Posebnu pažnju treba posvetiti stranim travama, *Bromus catharticus* i *Setaria parviflora*, koje su vjerojatno unešene kao primjesa u sjemenju uvezenom za ozelenjavanje tratina (travnjaka). Vrsta *B. catharticus* je do sada pronađena samo u Zadru i za sada se može smatrati nestalnom vrstom, ali s potencijalom da se udomaći. *S. parviflora* je već duže vrijeme prisutna u okolici Šibenika (Solaris, Zablaće) gdje se udomaćila na travnjacima te uz rubove pješačkih staza. Za sada ne pokazuje sposobnost invazivnog širenja što se u budućnosti ne može isključiti. Za pretpostaviti je da su obje ove vrste trava prisutne, na odgovarajućim staništima, i u drugim dijelovima Dalmacije, što bi trebalo detaljnije istražiti.

Veliki broj novozabilježenih neofita na području Gaženice potvrđuje zaključke da su upravo luke (morske, riječne, zračne) ključna mjesta preko kojih strane vrste iz udaljenih geografskih područja dospijevaju u lokalna područja i lokalne flore.