

Naturalised species from the genus *Conyza* Less. (Asteraceae) in Croatia

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In this paper, the most recent state in the distribution of the American neophytes *Conyza canadensis*, *C. bonariensis* and *C. sumatrensis* (Asteraceae) in Croatia is presented. *Conyza canadensis* is believed to be one of the most widespread introduced species in the world. It arrived in the territory of Croatia much before the beginning of the 19th century. A great number of new localities in Dalmatia and several new localities in the continental part of Croatia were registered in this investigation. The distribution of *C. bonariensis* in Croatia is limited to the Adriatic littoral, from Istria in the north to Dubrovnik region in the south. Numerous new-discovered localities of *C. sumatrensis* in Dalmatia are presented. Since its first finding this neophyte has become well established and is now in the phase of expanding in the Croatian littoral. *C. sumatrensis* is a new species in the Croatian flora.

Key words: *Conyza canadensis*, *bonariensis*, *sumatrensis*, flora, Croatia

Introduction

The genus of *Conyza* Less. (Asteraceae) comprises more than 50 species, chiefly of warmer regions (MUNZ 1959). Some of them have expanded into practically all the warmer parts of the world, including Europe, mostly in man-made habitats: in the settlements, along the roads and railways and on cultivated ground.

Among seven *Conyza* species that have been introduced into Europe so far (ŠIDA 2003) the most widely distributed ones are: *C. canadensis* (L.) Cronq., *C. bonariensis* (L.) Cronq. and *C. sumatrensis* (Retz.) E. Walker.

Conyza canadensis is an annual plant believed to be a native of North America (CRONQUIST 1976). It was introduced into Europe in the 17th century (FOURNIER 1961; GAJIĆ 1975). Now it is naturalised and widespread almost throughout Europe with the exception of the northern parts (CRONQUIST 1976). As early as the first half of the 19th century it was believed to be widely distributed in the whole area of Croatia (VISIANI 1826, 1847; PETTER 1832; ALSCHINGER 1832; SCHLOSSER and VUKOTINOVIĆ 1869).

Conyza bonariensis (Fig. 1) is a thermo-cosmopolitan species originating from tropical America (MARTINČIĆ et al. 1999). In Europe it was introduced much later than *C. cana-*

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Fig. 1. *Conyza bonariensis*, the upper part of plant. Lateral branches overtop the main axis.



Fig. 2. *Conyza sumatrensis*, basal leaves in rosette.

densis, and has been naturalized almost throughout the Mediterranean region and the south-western parts of Europe (CRONQUIST 1976). Findings out of this range, such as the case of an occurrence of *C. bonariensis* in the British Isles (STACE 1997) and the Czech Republic (PYSEK et al. 2002; ŠIDA 2002; ŠIDA 2003) are very rare. It is established in the neighbouring countries of Croatia: in Italy (PIGNATTI 1982), Slovenia (MARTINEC et al. 1999) and



Fig. 3. *Conyza sumatrensis*, the upper part of plant. The inflorescence is rhombic in outline.



Fig. 4. *Conyza sumatrensis*, detail of inflorescence.

Montenegro (ROHLENA 1942). The first reliable data for Croatia are given by ROHLENA (1923, as *E. linifolius* Willd.), for the area of Dubrovnik, and somewhat later by BOLZON (1925, as *E. crispus* Pourr.) for Mali Lošinj and Krk in the Bay of Kvarner. Since then it has been regularly noted as a naturalised species in the floras of the territory of today's Croatia (HAYEK 1931; DOMAC 1950, 1967, 1994; NIKOLIĆ 2000).

Conyza sumatrensis (Fig. 2–4) is a neophyte originating from tropical America (PIGNATTI 1982) and spread from there into the warmer parts of the world. The fourth volume of *Flora Europaea* mentions only two species of the genus *Conyza* (*C. canadensis* and *C. bonariensis*) but not *C. sumatrensis* (CRONQUIST 1976).

In Europe, in France, it was introduced in the second half of the 19th century. According to ANZALONE (1964), Bonnet registered this plant in the Botanic Garden in Collioure in 1878, where it was cultivated for a long time and spread spontaneously in the town and surroundings. At the beginning of the 20th century it was expanding throughout France, Spain and Portugal and somewhat later in Algeria in North Africa (BONNIER 1922; ANZALONE 1964).

The first reliable data about the presence of this neophyte in Italy come from ANZALONE (1964, as *Erigeron naudini* Bonnet) who registered it in the area extending from Piedmont to Sicily. Later it spread throughout the area of North Italy and for the first time it was found in the area of Trieste in 1977 (MARTINI 2000, as *C. albida*). The first samples of *C. sumatrensis* in the neighbouring Slovenia were collected by Poldini in 1984, and now it is observed throughout almost the whole coastal part of Slovenia (POLDINI and KALIGARIĆ 2000). Recently it has been registered in Greece (DANIN 1976), Albania (BALTISBERGER and LIPPERT 1987), England (WURZELL 1988) and in Austrian Styria (MELZER 1996).

In Croatia it was found for the first time in 1994 in several localities in Istria (ČARNI 1996) and later in several localities in the Bay of Kvarner (ČARNI and JOGAN 1998). But these findings were overlooked and *C. sumatrensis* was not registered in *Flora Croatica* (NIKOLIĆ 2000).

Confusion of these three species of *Conyza* is possible, especially of *C. bonariensis* and *C. sumatrensis*, because of the great morphological and ecological resemblance and the lack of an appropriate literature. Such cases were reported by some authors (ANZALONE 1964; MELZER 1996; POLDINI and KALIGARIĆ 2000). Identification was also made extremely difficult because of the occurrence of hybrids, mostly between *C. canadensis* and *C. bonariensis* (ROHLENA 1923; HAYEK 1931; ANZALONE 1964; CRONQUIST 1976; STACE 1997).

Conyza canadensis differs from *C. bonariensis* and *C. sumatrensis* by having a shorter, nearly glabrous involucre (3–4 mm long), only 25–40 female florets per capitula and having marginal florets with short (up to 1 mm) but well developed ligula (CRONQUIST 1976).

Conyza sumatrensis differs from closely related species *C. bonariensis* mostly by the marginal florets in the capitula. In the species *C. sumatrensis* marginal female florets are zygomorphic, while in *C. bonariensis* all the florets are actinomorphic. *C. sumatrensis* is otherwise much taller, branched out only in the upper part of the stem, lateral branches generally not overtopping the main axis and the inflorescence is rhombic in outline. *C. sumatrensis* also has a greater number of leaves which are bigger, wider and with ramified lateral veins (PIGNATTI 1982; POLDINI and KALIGARIĆ, 2000; ŠIDA 2003). *C. sumatrensis* is recognisable particularly by its often well-developed winter rosettes (ANZALONE 1964, POLDINI and KALIGARIĆ 2000).

Knowing these important diagnostic characteristics, I started my field research in the town of Šibenik and surroundings in summer 2002. In a short period of time I discovered that *C. sumatrensis* was established and widely distributed in this area as well as *C. canadensis* and *C. bonariensis*, but I overlooked it during my recent research (MILOVIĆ 2002) because I did not distinguish this plant from *C. bonariensis*. The field research was continued in the numerous localities in Dalmatia and also in a few localities in the continental lowland part of Croatia.

Methods

This investigation comprised field research as well as the analysis of the literature data and of herbarium specimens from the Croatian Herbarium (ZA) and the Herbarium of Marija and Ivo Horvat (ZAHO) in Zagreb.

Field research was undertaken during the summer and autumn of 2002 and 2003. I visited numerous localities in the area of Dalmatia, extending from Nin in the north to the Makarska region in the south, as well as Stubičke Toplice, Bjelovar, Valpovo and Našice with its surroundings in the continental lowland part of Croatia. Special attention was given to investigating the distribution of *C. sumatrensis* as the most recent newcomer in Croatia and registered only for several localities in Istria and Bay of Kvarner.

The geocoding of all localities in MTB coordinates, the new localities registered during this research as well as these identified in literature and herbaria (ZA and ZAHO), was carried out by the indirect method according to maps 1:100 000 (Kos et al. 2002). From among the previously registered localities, in several cases geocoding was not possible due to insufficiently precise citation of the location, mostly in older literature and older herbarium specimens.

Specimens of *Conyza* species collected during this research are stored in Herbarium Croaticum in Zagreb (ZA).

Results

Conyza canadensis (L.) Conq. (*Erigeron canadensis* L.)

In the beginning of the 19th century, it was mentioned by VISIANI (1826, as *Erigeron canadense*) as generally and well distributed in Dalmatia. In *Flora Croatica*, authors already registered *C. canadensis* as generally and well distributed in the whole continental part of Croatia (SCHLOSSER and VUKOTINOVIĆ 1869, as *E. canadensis* L. – »In agris collibusque totius Croatiae et Slavoniae«). Since then it was registered in the major part of floristic literature as well as in the literature dealing with ruderal and weed vegetation in Croatia.

In Ivo and Marija Horvat Herbarium (ZAHO) there were only 4 specimens of *C. canadensis*: 2 from Dubravice, the district of Klanjec in Hrvatsko Zagorje, collected by Ivo Horvat and 2 from Zagreb (without precise citing of the location) collected by Brzac but defined by Horvat.

In the Herbarium Croaticum (ZA) there was a total of 30 specimens collected in the area of today's Croatia. Among them, 14 were collected in the Croatian Littoral, 12 in other parts of Croatia while 4 specimens by Vukotinić are without any locality cited. The oldest one is the specimen collected by Vukotinić in 1857.

The list of the previously registered localities of *C. canadensis* in Croatia (according herbarium and literature data analysed) are not presented in chronological order but sorted within the geographic macroregions of Croatia proposed by NJEGAČ and PEJNOVIĆ (2002). For these localities, geocoding was made and denotations of MTB plots (10° × 6°) are stated in brackets. Geocoding was impossible in these cases: no data of locality (e.g., herbarium specimens collected by Vukotinić in ZA); the locality is given in the broad sense (»vulgare«, »in agris et cultis totius Dalmatie frequens«, »Da«=Dalmatia), especially in older floristic works (ALSCHINGER 1832; VISIANI 1826, 1847; HAYEK 1931); and in some phytocenologic works where there are no cited locations for the individual relevés from which the synoptic (synthetic) tables of communities were made (BECK-MANNAGETTA 1901; ADAMOVIĆ 1911; HORVATIĆ 1963). Geocoding was impossible for several very small locations too, cited by ROSSI (1924) which I did not find in the maps 1:100 000 (KOS et al. 2002). These localities are presented in the following list but marked with question-marks in brackets (?). For each locality the source data are cited: author, year of publishing, for literature data, as well as the author, the date of collecting and the name of the herbarium (ZA, ZAHO), for herbarium data.

The list of localities of *C. canadensis* registered in Croatia so far:

Eastern Croatia

- Slavonija, Cerević (?), ROSSI (Aug 1874, ZA)
- around Osijek (0477,0478), HIRC (1919)
- Slavonski Kobaš (0872), Slavonski Brod, Zmaj Jovina Street (0874), Velika in the Požega Valley (0572), Jastrebarsko (0359), Bjelovar, Kranjčevićeva Street (0167), S. Požega, Panonska Street (0672), Petrinja, Rokova Street (0563), Samobor, in front of the railway station (0260), Čađavica, near Podravska Slatina (0273); MARKOVIĆ-GOSPODARIĆ (1965)
- bank of the Karašica River between Petrijevcu and Satnica (0377); ILIJANIĆ (1967/1968)
- Čađavica near P. Slatina (0273), Osijek, the right bank of the river Drava (0478), Velika near S. Požega (0572), Slavonska Požega, Rade Končar Street (0672), Gorjani near Đakovo (0676), Slavonski Kobaš (0872), Slavonski Brod, Poloj (0874), Županja (0978); MARKOVIĆ (1975, 1979, 1981)
- Črnkovci (0275), Petrijevcu (0377), Osijek, the road to Darda (0478); TOPIĆ (1978)
- Draž (0178), Bocanjevcu (0375), Vinogradci (0376), Petrijevcu (0377), Valpovačka Gorica (0476), Belišće, along the Drava river (0376), Zelčin near Beli Manastir (0376), Čepinski Martinci (0476), Vukovar, Vukovarska ada (0680), Borovo, Borovska ada (0679), Strizivojna (0776), Đurđanci (0777), Divoševci (0876); RAUŠ and ŠEGULJA (1983, 1985); ŠEGULJA and TOPIĆ (1987)
- Tenja (0478,0578); PANČIĆ (1984)
- Požega valley, village of Nurkovac near Požega (0671), TOMAŠEVIĆ (1972, 1998)
- settlements in the region of Đakovo (0676,0776), MARKOVIĆ (1990)

Central Croatia

- Varaždin, Slavenska Street (9664), Samoborsko gorje, Konščica (0260), Remetinec (9863) and Ključ (9864) near Novi Marof; MARKOVIĆ-GOSPODARIĆ (1965)
- Mursko Središće (9464) and Križovljan (9765) in the surroundings of Varaždin, Jesenice near Zagreb (0160); MARKOVIĆ (1984a)

- Krapinske Toplice (9961); ŠOŠTARIĆ and MARKOVIĆ (1998)
- Dubravica in the district of Klanjec (9960), HORVAT (Aug 1918 and Aug 1950, ZAHO)
- Ivanščica in Hrvatsko Zagorje (9862), MARKOVIĆ and REGULA-BEVILACQUA (1988)
- Strahinščica Mt. in Hrvatsko Zagorje: Žutnica (9861), Presečina stream (9861), the north side of Strahinščica (9861), Radoboj near village of Tuški (9861), Donje Strahinje (9861); REGULA-BEVILACQUA (1979); REGULA-BEVILACQUA and ŠEGULJA (2000)
- Konjščina, Turnišće (9962), STANČIĆ (1994)
- Križevci, Marenčićeva Street (9965), Čazma (0265), Varaždin, railway bridge over the Drava River (9664), Zagreb, Savski most (0261); MARKOVIĆ (1975)
- area of Đurđevački pijesci (9968), Molve (9868), Vukosavljevica (0169); SOKLIĆ (1943)
- Koprivnički Ivanec and Pustakovec (9766), Đelekovec and Mali otok (9766,9767), Močilski Breg (9866), Peteranec and Sigetec (9867), Ivanečki Botinec and Virje (9967,9968); KOVAČEVIĆ (1957)
- Zagreb (?); ROSSI (Sept 1883, ZA), BRZAC (Sept 1948, ZAHO, 2 sheets)
- Zagreb, railway bridge over the Sava River and Savska Street (0261); HORVATIĆ (1947); GOSPODARIĆ (Aug 1954, ZA)
- Zagreb: Podsused and Jarun (0261), Žitnjak and Petruševac (0262); HORVATIĆ and GOSPODARIĆ (1959/1960); MARKOVIĆ (1973, 1978)
- Medvednica, departure station of the cable railway (0161), MARKOVIĆ (Aug 1960, ZA); Medvednica, area of Drage in Vugrovec (0162), HULINA (1979); Zagreb, Sloboština (0262), KUMBARIĆ (Jul 1992, ZA)
- Zagreb, Podsused (0161), Ivanja Rijeka near Zagreb (0262), Galdovo Erdotsko near Sisak (0564); MARKOVIĆ (1980)
- Turopolje: Lukavac (0261), Hrašće (0262), Dragonožec (0361), Gudci (0361), Obrež (0362), Petrovina (0362), Vukovina (0362); HULINA (1989, 1991); GRAČANIN et al. (1971)
- Zdenčina, šuma »Šikara« (9864), ŠTEFANAC (1957, ZA); Crna Mlaka (0360), ŠTEFANAC (Aug 1957, ZA); Vukomeričke Gorice (0361), ŠEGULJA (1977)
- Kostajnica (0765) and Maja (0762); ŠEGULJA et al. (1998)
- Karlovac and the surroundings: small forest of Luščić (?), Logorišće (0559), Mahično (0559); ROSSI (Aug 1886, Sept 1908 and Aug 1918, ZA); ILJANIĆ (1961/1962)
- Samobor and Gornji Kraj (0260); Banovina region: Hrastovica (0563,0663), Glina (0662), Topusko and Vranovina (0761); wider area of Karlovac and Slunj: Ribnik and Stative (0458), Orlovac (0459), Gradec (0461), Mrzlopolje (0558), Selce (?), Banija (?), the forest of Debela Glava (0558), Dubovac, Turanj and Vukmanić (0559), small forest of Luščić (?), Rakovac (?), Krnjak (0659), Vojnić (0660), Slunj and Slunjska Brda (0859); ROSSI (1924, 1930), GJURAŠIN (Aug 1889, ZA)

Mountain Croatia

- Gorski Kotar (?), MARKOVIĆ (1984b)
- Ogulin and Sovinica (0757), hill of Mošunje (?), Drežnica (0856), Znidaršić (?), Modruše (?), Jezerane (0957), Vratnik and Žuta Lokva (1056), Broćanac and Rakovica (1059), Lake of Milanovac (1159); ROSSI (1924, 1930)
- Plitvice, Lake of Milanovac (1159); ROSSI (Jul 1911, ZA)
- Kapela Korenička (1160) and Kapela (1260); ŠEGULJA (2000)

- Sv. Križ (1055), Vratnik and Senjska Draga (1056), Gaj near Pisarola (?), Takalice near Oštarije (0757), Prozor near Otočac (1157), Gospić (1458), Štikada (1660), Ričice (1660), Gračac (1761), Zrmanja near Žegar (1861); DEGEN (1938)

North Croatian Littoral

- Rovinj, St. Andrija and St. Katarina (0947); BENACHIO (1939)
- Vodnjan (1049), Galižana (1048), Fažana (1048), Pula (1149), Veruda (1149), Premantura (1249); FREYN (1877)
- wider area of Rt Kamenjak (1249); TOPIĆ and ŠEGULJA (2000)
- Poreč (0757), Raša (0950), Labin (0950); ČARNI (1996)
- NE part of the Labin area (0950); ŠEGULJA (1981)
- Rijeka (0652), Bakar (0653), Kraljevica (0753); HIRC (1884); ROSSI (1924, 1930)
- Rijeka (0652), Islands of the Bay of Kvarner (?); HAYEK (1931)
- Rijeka, Marx and Engels av., Nr 9 (0652), Senj (1055); MARKOVIĆ (1964)
- Škrlevo near Rijeka (0653); RANDIĆ (Aug 1981, ZA)
- Kraljevica, near the Veritas restaurant (0753), Rijeka, in the port (0652), Crikvenica (0854); ČARNI and JOGAN (1998)
- Senj (1055); DEGEN (1938); MARKOVIĆ (Aug 1962, ZA)
- Island of Krk, »frequente in tutta l'is. di Veglia«, (0753,0852,0853,0952,0953,0954, 1054); LUSINA (1932, 1934)
- Island of Cres: Cres (1052), NW part of Vransko jezero (1152); HIRC (1913); HIRC (Sept 1903, ZA); MARKOVIĆ (Aug 1962, ZA, 2 sheets); MARTINI (1990)
- Island of Male Srakane (1452), Island of Unije, the settlement of Unije and Campo (1351); LUSINA (1936, 1956)
- Mali Lošinj: Čigal (1452), Sv. Jakov (1352), the Bay of Kovcanja (1452); HARAČIĆ (Oct 1889, Oct 1890 and Aug 1899, ZA)
- Island of Susak (1451); HARAČIĆ (Jul 1890, ZA); LUSINA (1933); HODAK (1956)

South Croatian Littoral (Dalmatia)

- Zadar (1857), ALSCHINGER (1832)
- Dugi Otok (?); PLAVŠIĆ-GOJKOVIĆ (1966), TRINAJSTIĆ (1991)
- Krka National Park: near village of Rupe, Dubravice and area between Skradin and Bičine (2161); MARKOVIĆ et al. (1993)
- Betina on the Island of Murter (2159), the Island of Zlarin (2261, 2361), the Island of Krapanj (2361), Prvić Island (2260), small islands near Murter: Prišnjak, Zminjak and Veliki Vinik (2159); PANDŽA (1998a, 1998b, 1998c, 2002)
- Šibenik: Varoš and Crnica (2261); MILOVIĆ (Sept 1982, Aug 1996, ZA)
- Pirovac (2160), Šibenik (2261), Bilice, Novo naselje (2261), Lozovac (2261), Rupići (2261), Dubrava, Škugori and Šišak (2261), Jadrija (2261), Zablaće (2261), Konjevrate, Krnići (2262), Danilo Gornje, Bedrice and Grandeši (2262), Kraljice (2262), Solaris (2361), Jadrtovac (2361), Grebaštica (2361), Perković (2362), Boraja, Kneževići (2362); MILOVIĆ and RANDIĆ (2001); MILOVIĆ (2002)
- Mt Mosor, Gornje Sitno (2465); BEDALOV and ŠEGULJA (1987)
- The Bay of Kaštela (2464); ŠOLIĆ et al. (1998)
- Split (2464); PETTER (1832), RUŠIĆ (2003)

- The Island of Veli Drvenik (2562), BEDALOV (1976); The Island of Mali Drvenik (2562), VLADOVIĆ et al. (2002)
- The Island of Hvar (?); TRINAJSTIĆ (1993)
- The Island of Brač: Milna (2664), Brdo and Bobovišće (2664); BELLOTI (Aug 1976, ZA); ŠTAMOL and MARKOVIĆ (1985)
- The island of Šolta (2663); BEDALOV (1989)
- Makarska coastal region (2667,2668,2768); ŠILIĆ and ŠOLIĆ (1999)
- The Island of Lastovo (3267); TRINAJSTIĆ (1979)
- The Island of Vis, throughout the Island (2962,2963); DOMAC (1955)
- The Island of Svetac (2960); PAVLETIĆ (1980)
- The Island of Biševo (3062); GINZBERGER (1921)
- Mali Ston (3172), Trstenik and Drače (3070) in the peninsula of Pelješac; JASPRICA and KOVAČIĆ (1997a, 1997b); TRINAJSTIĆ and JASPRICA (1998)
- The Island of Mljet, Pinjevica (3272); REGULA-BEVILACQUA and JURKOVIĆ-BEVILACQUA (1980)
- Srđ and the surroundings of Dubrovačka rijeka (3374); BIRAČ (1973)
- The Island of Badija, in the village of Badija (3069); BARČIĆ (1974); TRINAJSTIĆ (1985, 1995)
- The Island of Šipan: Šipanska Luka and Suđurađ (3273); HEĆIMOVIĆ, M. (Aug 1979, ZA); HEĆIMOVIĆ, M. (1981, 1984)
- The Island of Lokrum, Botanic Garden (3374); HEĆIMOVIĆ, S. (Aug 1979, ZA); HEĆIMOVIĆ, S. (1982)
- The Island of Lopud (3373); the Island of Koločep, Gornje and Donje Čelo (3374); HEĆIMOVIĆ, M. and HEĆIMOVIĆ, S. (1986, 1987)

The list of new localities registered during this research:

- Stubičke Toplice (0061); widespread in the settlement and surroundings; herb., 30 Aug 2002, near Matija Gubec Hotel
- Malo Korenovo near Bjelovar (0166); widespread in the settlement and surroundings; herb., 16 Jul 2002
- Narta near Bjelovar (0166); widespread in the settlement; obs., 16 Jul 2002
- Valpovo (0376); widespread in the settlement and surroundings; herb., 11 Jul 2003, in Kolodvorska Street
- Koška (0475), Bizovac (0476), Markovac Našički (0574), Našice and Gradac Našički (0574), Čaglin and Ruševo (0673), Podcerkavlje near S. Brod (0774); very common along the streets in settlements; obs. 15 Aug 2003
- Benkovac (1559); widespread: Primary School, Market place, railway and bus station; herb., 1 Nov 2002, railway station
- Nin (1757), Ždrijac and Zukve (1757); widespread on ruderal sites; obs., 20 Jul 2003.
- Obrovac (1760), Bibinje (1957), Sukošan (1957); widespread throughout the settlements; obs., 1 Nov 2002
- Knin (1963); widespread in the town and its surroundings; obs., 30 Aug and 16 Nov 2002.; herb., 16 Nov 2002, near railway station
- Turanj and Filip Jakov (2058), Biograd (2058), Pakoštane (2059); common by roads and in gardens; obs., 17 Nov 2002
- Stankovci (2060); by the road through the settlement; obs., 1 Nov 2002

- Drniš (2162); widespread in the settlement and surroundings; herb. 16 Nov 2002, near the church »Gospa od Rožarije«
- Tribunj (2260); by roads near the coast; herb., 20 Oct 2002, by the road in the settlement
- Vodice (2260); common in some places in the town and surroundings; herb., 20 Oct 2002, by the road near the Punta Hotel
- Srima (2260); by the roads and as a weed in gardens; obs., 20 Jul 2003
- Unešić (2263); very common in the settlement and its surroundings; obs., 14 Oct 2001.
- The Island of Žirje (2359,2360): Muna, Žirje, Žirjansko polje; common in the ruderal sites in the settlement and as a weed in vineyards and fields; obs., 27 Oct 2001
- The Island of Obonjan (2360); rare, probably came recently; herb., 24 Aug 2002, in the ruderal vegetation near swimming pool and restaurant
- Brodarica (2361); very common in the settlement; obs., 17 Sept 2001
- Primošten (2461); common in the surroundings of the Bay of Porat; obs., 16 Dec 2002
- Rogoznica (2461), very common in the whole settlement; obs., 16 Dec 2002
- Trogir (2463); in ruderal vegetation by the streets near the market; obs., 19 Oct 2002

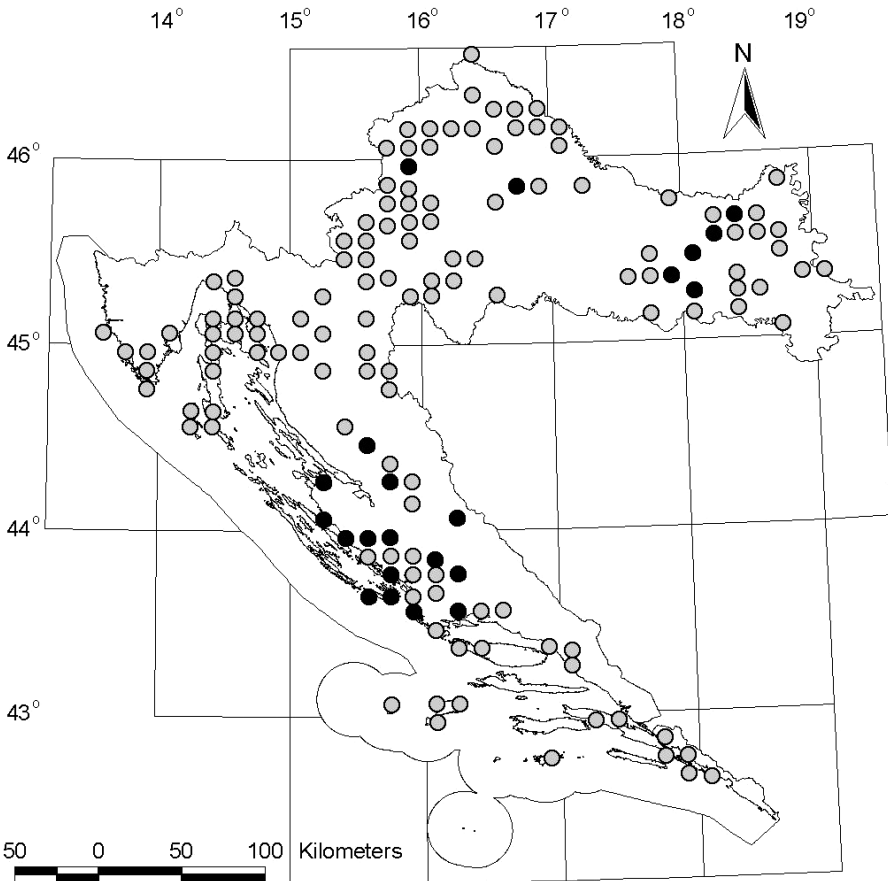


Fig. 5. Geographic distribution of *C. canadensis* in Croatia. ○ previously registered localities, ● new localities

***Conyza bonariensis* (L.) Cronq.**

Synonyms: *Conyza ambigua* DC., *Erigeron crispus* Pourr., *E. linifolius* Willd.

According to the available literature, the first reliable data concerning the establishment of *C. bonariensis* in Croatia were from ROHLENA (1923, as *E. linifolius* Willd) for the area of Dubrovnik («circa Dubrovnik, praecipue in peninsula Lapad frequens»). Somewhat later it was found by BOLZON (1925) in Mali Lošinj and Krk in the Bay of Kvarner. In the first half of the 20th century it was registered also for the islands of Kvarner (Lošinj, Unije and Male Srakane) by LUSINA (1936) and for the Island of Korčula in 1940 by MAILLEFER (according to TRINAJSTIĆ 1985). Not a single specimen of this neophyte was stored in ZAHO while in ZA there were only 6 specimens, collected in the area of Croatian Littoral in the period from 1961 to 1996. Because of the possibility of confusion with *C. sumatrensis*, all the specimens of *C. bonariensis* were carefully examined but they turned to be correctly defined.

The list of previously registered localities of *C. bonariensis* in Croatia:

- The Island of Krk, Krk (0953); the Island of Lošinj, Mali Lošinj (1452); BOLZON (1925)
- Rovinj (0947), Krk (0953); SCHULTE (1989)
- The Island of Susak (1451); HODAK (1956)
- The Island of Lošinj: wider area of Mali Lošinj («Cigale, Calvario, Duomo, Istmo, Curila, Poliana») (1452); the Island of Unije, settlement and Campo (1351); the Island of Male Srakane (1452); LUSINA (1936); MARKOVIĆ (Aug 1962, ZA)
- The Krka National Park: Rupe (2161), Dubravice (2161), Skradin (2161), Raslina (2261), Mikulandre and Vrulje (2261); MARKOVIĆ et al. (1993)
- Šibenik and surroundings: Šibenik (2261), Jadrija (2261), Zablacé (2261), Solaris (2361), Jadrtovac (2361), Grebaštica (2361), Bilice (2261), Konjevrate (2262), Rupići (2261), Dubrava (2261), Vrpolje (2362), Perković (2362), Boraja (2362); MARKOVIĆ (1964); MILOVIĆ (Jun 1996, ZA); MILOVIĆ (2002)
- The Island of Murter: Murter (2159), Betina (2159), Tisno (2259), Jezera (2259); small islands of Murter: Prišnjak, Tegina, Veliki Vinik and Sustipanac (2159); PANDŽA (1998a, 2002)
- The Island of Zlarin (2261, 2361), the Island of Prvić (2260), the Island of Krapanj (2361), the Island of Kaprije (2360); FRANJIĆ and PANDŽA (1996); PANDŽA (1998b, 1998c)
- The Island of Žut (2157); GAŽI-BASKOVA and BEDALOV (1978)
- The Bay of Kaštela (2464); ŠOLIĆ et al. (1998)
- Split (2464); RUŠČIĆ (2003)
- The Island of Čiovo (2463), the Island of Brač, Sutivan (2664), the Island of Korčula, Lumbarda (3069); MARKOVIĆ (1964)
- The Island of Brač: Bijaka, Vlaška, Racić and Brdo (2664), road from Milna to Bobovišće (2664), Sutivan (2664); BELLOTTI (Jun 1976, ZA); ŠTAMOL and MARKOVIĆ (1985)
- Makarska coastal region (2667,2668,2768); ŠILIĆ and ŠOLIĆ (1999)
- The Islands of Palagruža (3663), the Island of Svetac (2960); PAVLETIĆ (1978, 1980)
- The Island of Korčula (?); MAILLEFER 1940 (according TRINAJSTIĆ 1985)

- The Bay of Mali Ston (3172); Peninsula of Pelješac: Trstenik (3070), Drače (3070), Janjina (3070); JASPRICA and KOVAČIĆ (1997a, 1997b)
- The Island of Šipan (3273); HEĆIMOVIĆ, M. (Aug 1979, ZA); HEĆIMOVIĆ, M. (1981)
- The Island of Lokrum, Botanic Garden (3374); HEĆIMOVIĆ, S. (Jun 1979, ZA); HEĆIMOVIĆ, S. (1982)
- The Island of Lopud (3373); the Island of Koločep, Gornje and Donje Čelo (3374); HEĆIMOVIĆ, M. and HEĆIMOVIĆ, S. (1986, 1987)
- Dubrovnik, the peninsula of Lapad and around the town (3374); ROHLENA (1923)
- Cavtat, in the port (3475); MARKOVIĆ (May 1961, ZA)

The list of new localities of *C. bonariensis*:

- Benkovac (1559); rare, near the market place, on the railway station; herb., 1 Nov 2002, by the street near market place
- Zadar, Voštarnica (1857); in the ruderal vegetation beside roads and pathways; herb., 17 Nov 2002, Voštarnica, by the road
- Bibinje (1957); in the ruderal vegetation beside roads and pathways, trampled sites; obs., 17 Nov 2002
- Sukošan (1957), widespread in ruderal vegetation beside roads and pathways in the settlement; obs., 17 Nov 2002
- Turanj and Filip Jakov (2058), common beside roads and pathways; obs., 17 Nov 2002.
- Biograd (2058); common on ruderal sites in the settlement; herb., 17 Nov 2002, grassland by the road, between the School and clinic
- Pakoštane (2059); very common in the ruderal sites in the settlement; herb., 17 Nov 2002, trampled site by the street near the Adriatic autocamp
- Pirovac (2160); common in the ruderal sites, grasslands and gardens in settlement; herb., 20 Oct 2002, untilled garden near Pirovčanka department store
- Tribunj (2260); widespread in the settlement; herb., 20 Oct 2002, by road near coast
- Vodice (2260); common by the roads and in the cracks of pavements; herb., 20 Oct 2002, grassland near Punta Hotel
- Srima (2260); common in settlements, on trampled habitats by roads and pathways; obs., 20 Sept 2003
- The Island of Žirje: Muna, Žirje (2359), Žirjansko polje (2360); ruderal habitats in the settlement, in vineyards, untilled fields; obs., 27 Oct 2001
- The Island of Obonjan (2360); rare, on ruderal sites; herb., 24 Aug 2002, ruderal vegetation near swimming pool and restaurant
- Brodarica (2361); widespread by the roads and pathways, on grasslands; obs., 18 Oct 2002 and 26 Jul 2003
- Primošten (2461); ruderal sites in the settlement and surroundings; herb., 16 Dec 2002, Porat, untilled vegetable garden
- Rogoznica (2461); widespread in the settlement and surroundings; herb., 16 Dec 2002, by the road near Frappa Marina
- Trogir (2463); common by the streets, pathways, grasslands and gardens; obs., 23 Nov 2002

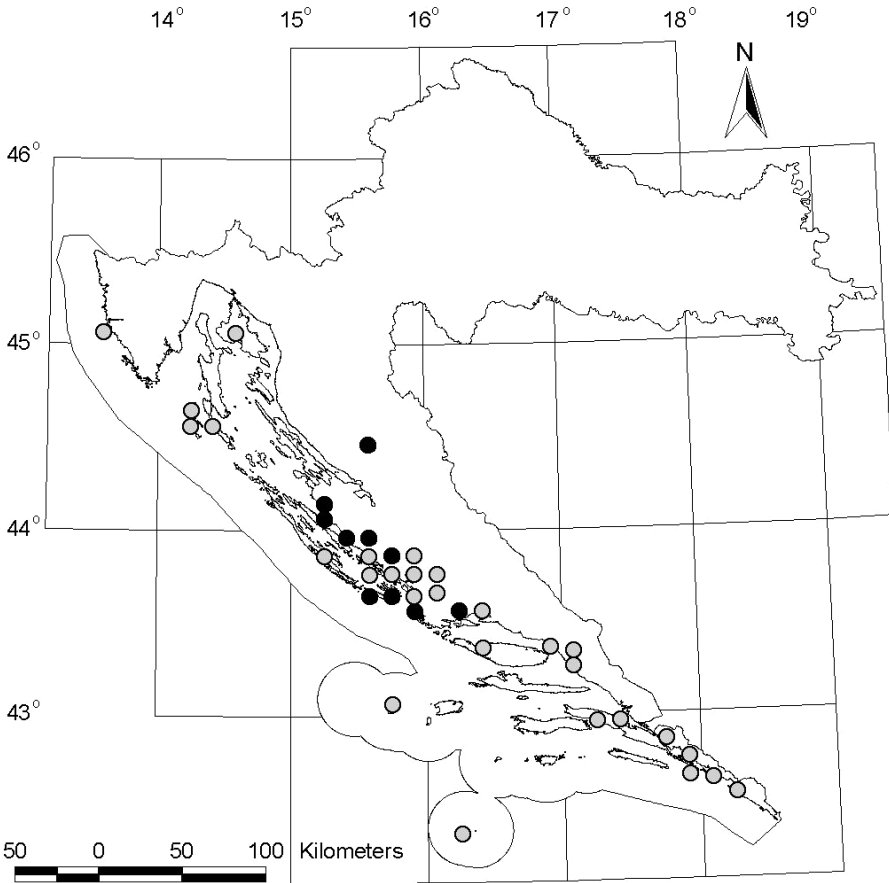


Fig. 6. Geographic distribution of *C. bonariensis* in Croatia. ○ previously registered localities, ● new localities

***Conyza sumatrensis* (Retz.) E. Walker**

Synonyms: *Conyza albida* Willd. ex Sprengel, *C. altissima* Naud. et Deb., *C. naudini* Bonet

Not a single specimen of *C. sumatrensis* was stored in the two largest public herbaria in Croatia (ZA, ZAHO).

This neophyte was registered for the first time in Croatia in summer 1994 in Istria within thermophilous vegetation of trampled habitats classified into the *Euphorbion prostratae* alliance, the *Eragrostietalia*, the *Stellarietea mediae* (ČARNI 1996, as *C. albida*), on these localities:

- Poreč, in front of the Obala restaurant (0747)
- Vrsar, in the town (0847)
- Rovinj, in front of the Adriatic restaurant and on the coast near the shipyard (0947)
- Pula, on the coast, in front of the department store, in front of the military Command, in the port, in front of the Uljanik shipyard and at the railway station (1149)

- Rabac, along the road on the coast (0950,0951)

Soon after that it was registered also on the several localities in the Bay of Kvarner within similar type of vegetation (ČARNI and JOGAN 1998, as *C. albida*)

- Lovran, in front of the hotel Excelsior (0751)
- Ičići, in the marina (0651)
- Opatija, Viktora cara Emina Street (0651)
- Volosko, in the street above the church (0651)
- Rijeka, Trsat, in front of the church (0652)
- Bakar, on the sand at the shore (0653)
- Kraljevica, along the street near the Veritas restaurant (0753)
- The Island of Krk: Vrbnik, in front of the church and Vitezovićeve Street (0954); Krk, between the port and bus station (0953); Baška, along the path (1054); Punat, Hotel Park parking lot (0953)
- Senj, Pavlinski trg (1055)
- The Island of Rab: Rab, the church of St. Euphemia (1254)
- The Island of Lošinj: Mali Lošinj, on the sand at the shore and in front of the local church (1452)

The list of new localities of *C. sumatrensis*:

- Obrovac (1760); rare, probably common in the recent time; herb., 1 Nov 2002, neglected flower garden near the School
- Benkovac (1559); common on ruderal sites; herb., 1 Nov 2002, grassland near market
- Nin, old part of town (1757), Ždrijac and Zukve (1757); common by roads and pathways in settlements; obs., 20 Jul 2003
- Zadar (1857); widespread in ruderal sites in the town and on the fields in surroundings; herb., 17 Nov 2002, Voštarnica, by the road
- Bibinje (1957); widespread in the settlement and surroundings; herb., 17 Nov 2002, Špirini Street, by the road near the railway
- Sukošan (1957); widespread in the settlement by the roads; obs., 17 Nov 2002
- Turanj and Filip Jakov (2058); common by the roads and pathways near coast; obs., 17 Nov 2002
- Biograd (2058); common on ruderal sites in the town; herb., 17 Nov 2002, ruderal vegetation between the School and clinic
- Pakoštane (2059); widespread in the whole settlement; herb., 17 Nov 2002, by the road near the Adriatic autocamp
- Stankovci (2060); common by the main road through settlement; obs. 1 Nov 2002
- Pirovac (2160); widespread by the roads, on grasslands and gardens; herb. 20 Oct 2002, neglected garden near the Pirovčanka department store
- The Island of Murter: Betina and Murter (2159); Tisno and Jezera (2259); ruderal sites in settlements, gardens, untilled fields in surroundings; obs. 1 Nov 2002. and 4 Jul 2003
- Tribunj (2260); very common by the roads and pathways near the coast, trampled sites; herb., 20 Oct 2002., by road near coast
- Vodice (2260); common by the roads and pathways; herb., 20 Oct 2002, by the road near the Punta Hotel
- Srma (2260); common by the roads; obs., 20 Oct 2002

- The Island of Prvić (2260): widespread in the settlement of Luka and Šepurine, by roads, in grasslands and gardens; herb., 26 Oct 2002, Prvić Luka, untilled vegetable garden
- Šibenik (2261); widespread in the whole town and its surroundings; herb., 13 Aug 2002, Vidici, by the road; 19 Aug 2002, Šubićevac, on the bottom of the wall
- Zablacé (2261); common in the settlement; herb. 16 Dec 2002., trampled grassland by the road in the central part of settlement
- Solaris (2361); very common in ruderal sites through tourist complex; herb., 4 Aug 1996, mistaken for *C. bonariensis*
- The Island of Zlarin (2261,2361), widespread in settlement and Zlarinsko polje; herb., 23 Aug 2002, by road in village
- Brodarica (2361); widespread in the settlement and surroundings, by the roads, pathways, trampled grasslands, neglected gardens; obs. 18 Jun 2002 and 26 Jul 2003
- The Island of Krapanj (2361); widespread on the whole Island; herb., 18 May 2002, by road near the coast
- The Island of Žirje: Muna and Žirje (2359), Žirjansko polje (2359,2360); common in the settlement and in the area of Zlarinsko polje; obs., 27 Oct 2001
- The Island of Obonjan (2360); rare, probably approached recently; herb., 24 Aug 2002 on ruderal site near swimming pool and restaurant
- Skradin, (2161); widespread in town and surroundings; herb., 5 Nov 2002, by the road near the football stadium
- Drniš (2162); only few specimens in front of church Gospa od Rožarije, probably came recently; herb., 16 Nov 2002
- Unešić (2263); rare in the settlement and surroundings; obs., 16 Nov 2002
- Perković (2362); widespread in the whole settlement, mostly in the area of railway station; obs. 16 Nov 2002
- Vrpolje (2362); widespread by the roads in the settlement and on fields in surroundings; obs., 16 Nov 2002
- Grebaštica (2361); widespread through the whole settlement; herb. 16 Dec 2002, by the road along the coast
- Primošten (2461); common in the whole settlement, by the roads and pathways; herb. 16 Dec 2002, untilled vegetable garden by small Bay of Porat
- Rogoznica (2461); widespread in the whole settlement; herb. 16 Dec 2002, by the road near Frappa Marina
- Trogir (2463); by the roads and pathways near bus station and market; obs., 23 Nov 2002
- Split (2464); widespread in the whole town and its surroundings; herb., by the road near railway station, 23 Nov 2002
- Jesenice (2565), by the roads; Omiš (2566), common on ruderal sites in town; obs., 19 Oct 2002
- Omiš, Radmanove mlinice on the Cetina River (2566); rare; herb., 19 Oct 2002, by the road
- Makarska (2668,2768), widespread on ruderal sites in the whole town and its surroundings: Brela, Baška Voda and Kravice (2667); herb., 19 Oct 2002, Makarska, by the road along the coast near the Biokovka Hotel

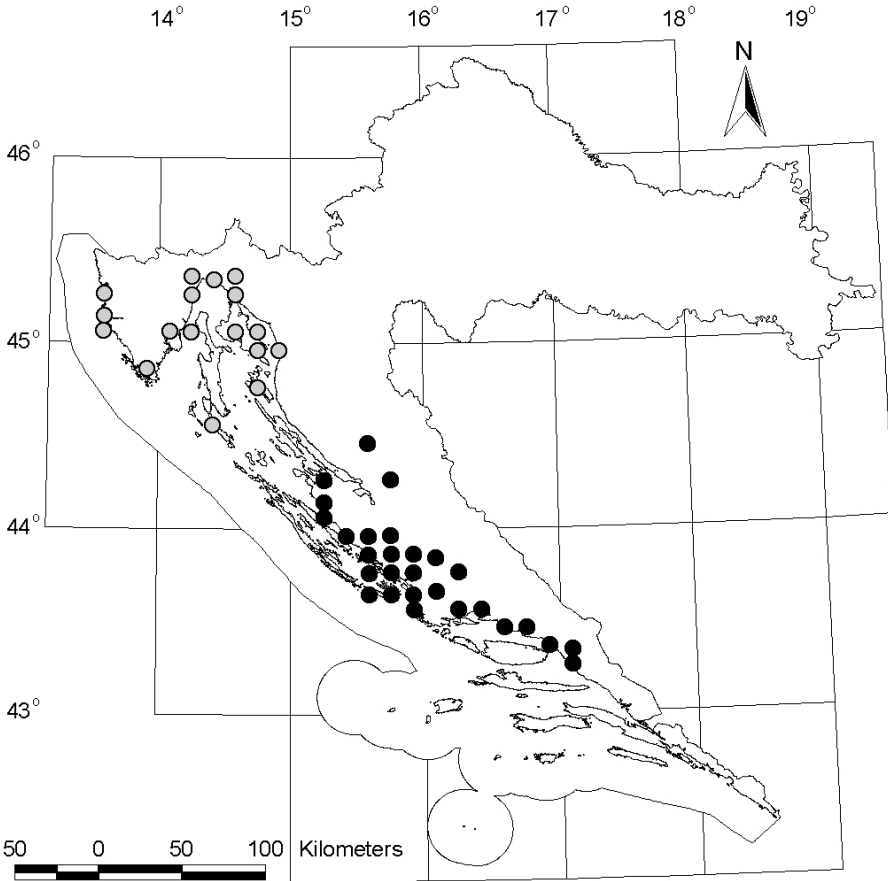


Fig. 7. Geographic distribution of *C. sumatrensis* in Croatia. ○ previously registered localities, ● new localities

Discussion

Among the three *Conyza* species investigated, *C. canadensis* became established in Croatia a long time ago. In the botanic literature from the 19th century already, this annual neophyte was recognized as a widespread and naturalized species in the Croatian littoral (VISIANI 1826, 1847; FREYN 1877) as well as in the continental lowland parts of Croatia (SCHLOSSER and VUKOTINOVIĆ 1869). The results of the analysis of numerous botanic works in the 20th century and the analysis of herbarium specimens (ZA, ZAHO) as well as the great number of new localities registered during this research confirm that this species is one of the most common adventitious plants in the appropriate habitats in the whole of Croatia (Fig. 5).

Conyza canadensis most frequently occurs within nitrophilous weed communities on cultivated land and ruderal communities in the settlements classified within the *Chenopodieta* (the *Chenopodietea*) in the coastal region of Croatia (HORVATIĆ 1963) as well as in its continental regions (MARKOVIĆ-GOSPODARIĆ 1965; RAUŠ and ŠEGULJA 1985). In the

continental, lowland parts of Croatia it frequently occurs in the nitrophilous ass. *Polygono-Bidentetum* (the *Bidentalia tripartiti*, *Bidentetea tripartiti*) which grows on natural and seminatural habitats along river banks but also in anthropogenic habitats in villages: along channels, ditches, swamps and pasture-grounds (MARKOVIĆ 1975; RAUŠ and ŠEGULJA 1985). In Istria and the Bay of Kvarner it occurs in the thermophilous vegetation of trampled habitats from the *Eragrostietalia*, the *Stellarietea mediae* (ČARNI 1996; ČARNI and JOGAN 1998).

Conyza bonariensis was not mentioned in the classic floristic works of the 19th century concerning the territory of today's Croatia (VISIANI 1826; SCHLOSSER and VUKOTINOVIĆ 1869; FREYN 1877) but was registered for the first time for the area of Dubrovnik (ROHLENA 1923) and after that on the Kvarnerian islands: Krk, Lošinj, Unije and Male Srakane (BOLZON 1925; LUSINA 1936). The analysis of the literature and herbarium data show that majority of the findings were from the second part of the 20th century. This analysis indicates that *C. bonariensis* was established in Croatia in the first half but spread along the Croatian littoral in the second half of the 20th century. There have been no data of findings of this species in the continental part of Croatia so far. Numerous new localities in the area of Dalmatia, from Nin in the north to Makarska in the south, were registered during this research. With exception of Benkovac, *C. bonariensis* was not found in the settlements of the Dalmatian hinterland (Obrovac, Knin, Drniš and Unešić) researched. It occurs frequently in communities on the ruderal habitats (the *Erigeron-Xanthietum* and *Hordeetum leporini*) and also in communities in cultivated soil (the *Tribulo-Amaranthetum* and *Fumario-Cyperetum rotundi*) from the *Chenopodietalia*, the *Chenopodietea* (HORVATIĆ 1963; MARKOVIĆ 1964; HEĆIMOVIĆ, M. 1981).

The range of *C. bonariensis* in Croatia so far (Fig. 6) has been limited to the narrow area of the Adriatic coast with the islands, extending from Istria in the north to the region of Dubrovnik in the south. The majority of localities are situated in the Mediterranean zone proper with potential natural vegetation from the *Quercion ilicis* alliance. This tropical-subtropical neophyte has become well acclimatized and widely spread along the Croatian littoral with a dry and warm Mediterranean climate.

Conyza sumatrensis, origin from tropical America, was introduced in Europe in the second part of the 19th century (Bonnier 1878, according to ANZALONE 1964). Since then it has been expanding mostly into the warmer parts of the Mediterranean region. According to the literature data the most invasive phase has been since the middle of the 20th century so far (ANZALONE 1964; DANIN 1976; BALTISBERGER and LIPPERT 1987; WURZELL 1988; MELZER 1996; ČARNI 1996; POLDINI and KALIGARIĆ 2000).

Among the three researched species of *Conyza*, *C. sumatrensis* was established in Croatia the latest. The first and only findings for Croatia were registered in Istria and the Bay of Kvarner where it occurs in thermophilous vegetation on trampled sites from the *Eragrostietalia*, the *Stellarietea mediae* (ČARNI 1996; ČARNI and JOGAN 1998). These findings were overlooked and this plant was not mentioned in Index of Flora Croatica by NIKOLIĆ (2000).

During this research *C. sumatrensis* was found in numerous new localities in Dalmatia, from Nin in the north to Makarska in the south (Fig. 7). In several of the most recent investigations of the flora of Dalmatia, authors have not mentioned this species (FRANJIĆ and PANDŽA 1996; PANDŽA 1998a,b,c; ŠILIĆ and ŠOLIĆ 1999) probably because they have not

distinguished it from *C. bonariensis*. This was the case during my most recent research into the flora of the wider area of Šibenik (MILOVIĆ and RANDIĆ 2001, MILOVIĆ 2002). The confusion of *C. sumatrensis* for *C. bonariensis* also happened in the neighbouring countries of Austria and Slovenia (MELZER 1996; POLDINI and KALIGARIĆ 2000).

The geographic distribution of *C. sumatrensis* so far has been limited to the coastal region of Croatia: Istria, the Bay of Kvarner and Dalmatia, extending to the Makarska region in the south (Fig. 7). It occurs in dense populations in a large number of localities in Dalmatia, especially in the wider area of Šibenik. In the last ten years, it has become well acclimatized almost throughout the Croatian coast, which is also due to the warm Mediterranean climate of this area. We can suppose it was already spread in the rest of Croatian littoral, south of Makaraska region as well as on some of the islands.

Through their native geographic range all the three species of *Conyza* occur in open sites in abandoned fields, vineyards, waste areas, railways and roadsides, and disturbed sites in natural communities (MUNZ 1959; THEBAUD and ABBOTT 1995). It occurs in the Croatian littoral on the similar habitats too, but more frequently in ruderal sites in the settlements and its surroundings than in cultivated soil.

Following the recent proposal of »invasiveness« given by RICHARDSON et al. (2000), all the three *Conyza* species are considered invasive in Spain (SANZ-ELORZA et al. 2001; DANA et al. 2001). *C. canadensis* was the one of the most common and widespread weed (LORENZI and JEFFREY 1987). As a weed it was considered invasive in the region of former Yugoslavia and today's Croatia, too (ŠABIĆ ed. 1982; KOJIĆ 1985; HULINA 1991,1998). In recent times *C. bonariensis* and *C. sumatrensis* have become, widespread and dangerous weeds in agricultural and horticultural practice and in the invasion of natural and semi-natural vegetation (THEBAUD and ABBOTT 1995; PRATHER 2000; SANZ-ELORZA et al. 2001).

The expansion of *C. bonariensis* and *C. sumatrensis* has been limited to the coastal region of Croatia so far, for these plants prefer the warm climate of the Mediterranean proper without or with only late frost. It can be expected not to expand out of this area in future, but individual findings cannot be excluded. Such cases are seen in the sporadic occurrence of these species out of the Mediterranean region: *C. sumatrensis* in Austrian Styria (MELZER 1996), *C. bonariensis* in the Czech Republic (PYŠEK et al. 2002; ŠIDA 2002, 2003) and both of the species in the British Isles (STACE 1997). The occurrence of these tropical-subtropical species out of the warm regions especially in the big cities (London) can be explained as a consequence of »global warming« and of the phenomena grouped as »heat island effect«.

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