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NEW LOCALITIES OF *SENECIO INAEQUIDENS* DC. IN CROATIA

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Senecio inaequidens DC. (*Asteraceae*) is a neophyte of South African origin, accidentally introduced in wool exports to Europe at the end of the 19th and the beginning of the 20th century. Since the 1970s it has spread rapidly in Central, West and South Europe. After the recently published finding in Hrvatsko Zagorje (Sv. Križ Začretje), two new sites from Dalmatia (Dicmo and Biograd) are presented in this paper. Because of the appropriate climate and a large number of suitable habitats, we can expect that *S. inaequidens* will become naturalized and will expand in Croatia.

Key words: *Senecio inaequidens*, neophyte, new findings, Dalmatia, Croatia

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Senecio inaequidens DC. (*Asteraceae*) je neofit podrijetlom iz Južne Afrike koji je u Europu slučajno unesen uvozom vune krajem 19. i početkom 20. stoljeća. Od 70-tih godina prošlog stoljeća brzo se proširio većim dijelom srednje, zapadne i južne Europe. Nakon nedavno objavljenog nalaza u Hrvatskom zagorju (Sv. Križ Začretje), u ovom radu se navode dva nova nalazišta u Dalmaciji (Dicmo i Biograd). Zbog odgovarajuće klime i velikog broja pogodnih staništa, možemo očekivati udomaćenje i širenje svojte *S. inaequidens* u Hrvatskoj.

Key words: *Senecio inaequidens*, neofit, novi nalazi, Dalmacija, Hrvatska

INTRODUCTION

Senecio L. (*Asteraceae*) is one of the largest genera of flowering plants, containing somewhere between 1000 and 3000 species (Jeffrey *et al*., 1977; Bremer, 1994; Vincent, 1996; Mabberley, 1997), the most recent and reliable estimate suggesting that it comprises approximately 1250 species (Nordenstam, 2007). *Senecio* is a cosmopolitan genus and encompasses a very wide range of habitats and the plant habits range from small ephemeral weeds to robust herbaceous perennials, stem- and leaf-succulents and bizarre palm-like "trees" (sect. *Dendrosenecio*). Numerous species of the genus *Senecio* are cultivated as ornamentals because of their attractive flowers and habits (Rowley *et al*., 2000).

Several taxa of South African origin have been introduced in Europe and cultivated for ornaments (e.g. *S. angulata* L.f., *S. elegans* L., *S. tamoides*, *S. mikanioides* Otto ex Walp., etc.) but also occur outside cultivation as casuals (sensu Richardson *et al*., 2000) or naturalized plants (Chater & Walters, 1976; Pignatti, 1982). Currently, *S. mikanioides* (in the most recent literature *Delairea odorata* Lemaire) is recognized as an invasive plant in

Italy, Portugal and the UK, as is *S. angulatus* in France, Spain and Italy. It is widely recognized that ornamental horticulture has been the main pathway of plant invasions and that most invasive plants have been introduced by nurseries and botanic gardens or by individuals (Gordon & Thomas, 1997, Reichard & White, 2001; Kowarik, 2005).

In the Croatian flora, *Senecio* L. is represented by 36 species and subspecies (Nikolić, 2014). Among them, three alien species of South African origin were included recently in the Flora Croatica Database (FCD) (*S. mikanioides*, *S. angulatus* and *S. inaequidens*), while the other taxa are native in the territory of Croatia. Cape ivy, *Senecio mikanioides* and ground ivy, *S. angulatus* are both noted as cultivated plants as well as garden escapees ("casuals") at several localities in North Dalmatia (Nikolić, 2014). *S. mikanioides* is registered on the area of Ćunski on the island of Mali Lošinj (Melzer, 1996) and in the city of Zadar (Perinčić, 2010). *S. angulatus* is found as a casual plant in Zadar (Milović *et al*., 2010) and in several localities on the islands of the Zadar archipelago: Rava (Pandža & Milović, 2008), Ist (Milović & Pandža, 2010), Gangaro, Dugi otok (the settlements of Božava, Verunić and Veli rat) and Pašman (Nikolić, 2014).

The third alien species of *Senecio* included in the Flora Croatica Database is *S. inaequidens* that was recently found in the settlement of Sv. Križ Začretje in Hrvatsko Zagorje (Borovečki-Voska, 2013). Apart from this finding, there was no other evidence about the existence of this plant in Croatia (no literature or observation data and no specimens in the main Croatian Herbaria). Pericin (2001) noted *S. inaequidens* on Istria but only in the Italian and Slovenian parts of this region and not in Croatian.

Senecio inaequidens originates from South Africa where it occurs on skeletal sectors on steep, moist and grassy slopes, as well as on sandy and gravelly banks of periodic streams at elevations between 1400 and 2850 m (Hilliard, 1977). It also occurs in Botswana, Lesotho, Mozambique, Namibia, and Swaziland, though it is unclear whether it is native to those areas (EPPO, 2006).

It was accidentally introduced from the native area and then became naturalized and invasive in many regions of Europe, Australia, Central and South America (EPPO, 2006). The introduction and spread of *S. inaequidens* in Europe is quite well documented (Meusel & Jäger, 1992; Heger & Böhmer, 2005, 2006). It was introduced in Europe towards the end of the 19th century through wool imports. It was first found near wool-processing factories in Hanover (in 1889) and Bremen (in 1896) in Germany (Kuhbier, 1977; Wagenitz, 1987); later the first finds were reported for some other European countries (UK in 1908, Belgium in 1922, France in 1935, Netherlands in 1939 and Italy in 1947) at sites also associated with the wool trade and the wool-processing industry (Guillerm *et al*., 1990; Ernst, 1998). From the 1970s onwards, *S. inaequidens* expanded throughout western, central and southern Europe (Heger & Böhmer, 2006). From the affected areas of southern and central Europe the expansion continued into the northern and eastern areas: Denmark (1988), Finland (in 1993), Norway (in 1995), Poland (in 2005) and Sweden (Heger & Böhmer, 2006). Due to the very cold winters it can be assumed that *S. inaequidens* will not be able to establish permanent populations in the northern parts of Europe (Heger & Böhmer, 2006). In recent years it was reported for Romania (Anastasiu & Negrean, 2008; Sirbu & Oprea, 2010), Bulgaria (Vladimirov & Petrova, 2009) and Bosnia & Herzegovina (Maslo, 2014) which, together with a previous finding in Montenegro (Stevanović *et al*., 1990-1991), indicates the beginning of its expansion in South East Europe (the Balkan Peninsula).

S. inaequidens has become one of the most successful invasive alien plants because of its wide ecological plasticity and a high reproductive potential (Heger & Böhmer, 2005;

Cano *et al*., 2007; Monty *et al*., 2008). The plant lives 5-10 years, starts to flower within a few months from germination and has a long flowering period (6-month). It is estimated that it produces more than 10.000 seeds per plant per year and seeds may remain viable in the soil for at least 2 years (Lopez-Garcia & Maillet, 2005). It is highly adaptable and able to withstand hot, dry summers and overwinter in areas where temperatures reach –15 °C. There are numerous pathways of dispersal, including by wind, in soil, in seed, and as a hitchhiker on containers, vehicles, agricultural machinery, agricultural products such as wool and hay, and on animals (Dancza *et al*., 2006).

It colonizes open and disturbed habitats: wastelands, fallows, railway tracks and roadsides, crops (mainly vineyards), burnt land and pastures (Dancza *et al*., 2006) but it is also found in natural environments such as dunes and cliffs in littoral areas, and temporary ponds. When invading natural habitats it may threaten rare or endangered species (Brunel, 2003). *S. inaequidens* contains pyrrolizidine alkaloids and may cause poisoning in grazing animals and humans as well as in aquatic organisms, but evidence for such poisoning is not yet conclusive (Sarcey *et al*. 1992; Dimande *et al*., 2007).

RESULTS AND DISCUSSION

During 2012 and 2013, we have found *S. inaequidens* at two localities in Dalmatia, in Dicmo (between Split and Sinj) and in the vicinity of Biograd (Figs. 1-3). These are the only known sites of this neophyte in Dalmatia.

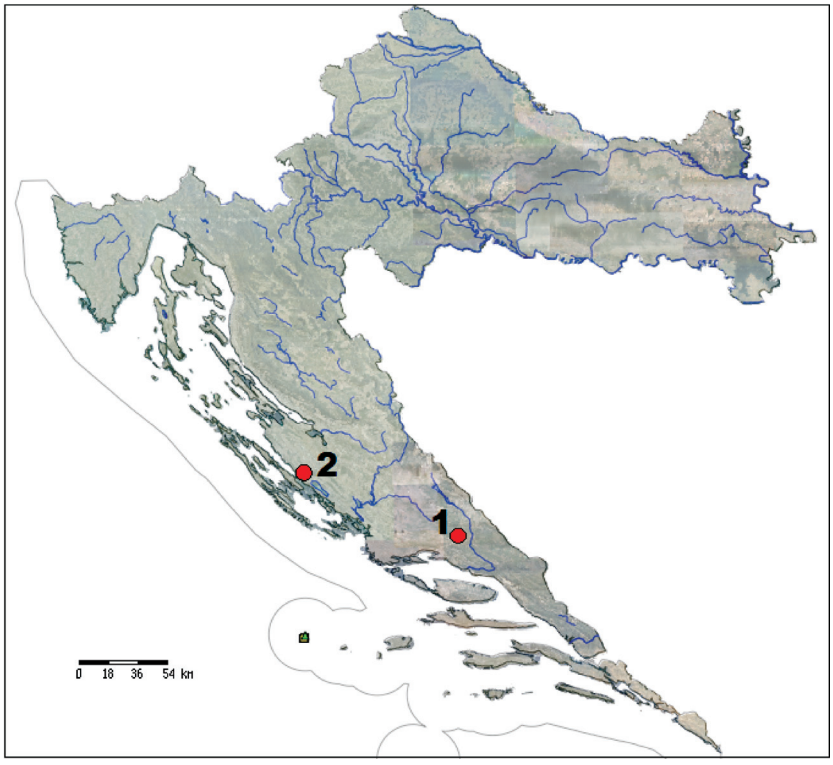

Fig. 1. The new finding sites of *S. inaequidens* in Dalmatia (1-Dicmo, 2-Biograd).

On October 20, 2012, in the settlement of Dicmo, along the road opposite the Mariva coffee bar (x=6387499; y=4833961), we found a large population of approximately 100 specimens (40-60 cm height) in ruderal vegetation (Fig. 2) in the company of the following plants: *Berteroa mutabilis* (Vent.) DC., *Crepis foetida* L., *Dactylis glomerata* L. ssp. *hispanica* (Roth) Nyman, *Dichanthium ischaemum* (L.) Roberty, *Picris hieracioides* L., *Plantago lanceolata* L., *Sanguisorba minor* Scop. ssp. *muricata* Briq., *Silene vulgaris* (Moench) Garcke ssp. *angustifolia* Hayek, *Teucrium polium* L. ssp. *capitatum* (L.) Arcang., etc. Plants were in the stage of full flowering and fruiting (Fig. 4, 5 and 6). The finding site is in the vicinity of the entrepreneurial zone of Dicmo. We carefully searched the whole settlement and its entrepreneurial zone, but new sites with *S. inaquidens* were not found. We

Fig. 2. The finding site of *S. inaequidens* in Dicmo.

Fig. 3. The finding site of *S. inaequidens* near the town of Biograd.

Fig. 4. *S. inaequidens* – habitus.

Fig. 5. *S. inaequidens* – flowering capitulas.

visited the same site, again on July 2 and on October 19, 2013. The population was also in the stage of flowering and fruiting but no significant change in the abundance of the population and the spread outside the original site was observed.

The second site of *S inaequidens* was found along the edge of the Adriatic highway near Biograd (x=5536314; y=4867483) on June 2, 2013 (Fig. 3). Along the right edge of the road (towards Zadar), within ruderal vegetation, a scattered population of about 50 specimens in full bloom was found. During the recent construction of the road junction with the highway to the town of Biograd, the natural vegetation was removed along the road and new ruderal habitats suitable for the immigration *S. inaequidens* were created.

Fig. 6. *S. inaequidens* – fruiting capitula with ripe achenes.

Subsequently, we have repeatedly driven from Šibenik to Zadar, but new sites along the highway were not found.

Since 1947, when *S. inaequidens* was first reported for Italy (Kiem, 1975), it has spread rapidly, particularly in the northern and central parts of the country (Pignatti, 1982, Vacchiano *et al*. 2013). It is recognized as an invasive species in Italy (Celesti-Grapow *et al*., 2011). In Montenegro the first occurrence was reported in 1990 near the town of Kotor (Boka Kotorska bay) on the banks of a polluted stream (Stevanović *et al*., 1990-1991) but since then there have been no data on its naturalization and spread in the area. Kaligarič (1992) reports the first record of *S. inaequidens* for the neighboring Slovenia. Since then it has spread to the Mediterranean and inland regions of the country (Pavletić & Trinajstić, 1994, Dakskobler & Čušin, 2002, Martinčič *et al*., 2010). Recently, it was registered in Hungary (Dancza & Király, 2000) where it spread on areas along the Vienna-Budapest international railway line (Dancza *et al*., 2006). In Bosnia & Herzegovina, *S. inaequidens* was found for the first time in 1996 in the central part of the city of Mostar (Maslo, 2014) but since then there have been no data on its spread in the area.

Although the first certain data for the presence of *S. inaequidens* in the territory of Croatia were published last year, when a large population was found in ruderal vegetation along the road in August of 2013, in the industrial area of Sv. Križ Začretje by Borovečki-Voska (2013), we found *S. inaequidens* in Dalmatia in 2012.

Considering that the sites in Dicmo and Biograd are about a 150 km away from each other, and the site in Sv. Križ Začretje (Hrvatsko Zagorje) is more than 300 km from both of them it can be assumed that these are three separate and independent inputs of the plant. All three sites are located along the edge of the road, indicating that the plant has probably been transferred by road from the affected areas along the Croatian border (Italy, Slovenia and Bosnia & Herzegovina). Several authors agree that the main transport pathways for the long distance transport of *S. inaequidens* from the affected to the not yet affected areas of Europe are roads and railways (Radkowitsch, 1997; Adolphi, 1998; Ernst, 1998; Griese, 1996; Heger & Böhmer, 2005, 2006). It is possible that the introduc-

tion of the new finding sites in Dalmatia occurred across the Adriatic Sea, because both of them are situated in the vicinity of Split (the locality in Dicmo) and Zadar (the locality in Biograd), which have constant ship and ferry connections to Ancona in Italy.

Since there is no organized system for monitoring the spread of alien plantsfin Croatia, the majority of the known locations of alien plants are casual findings as is the case with all three findings of *S. inaequidens*.

It is likely that the introduction of this neophyte has already occurred in some other places in Croatia that have not yet beenrecorded. For now, *S. inaequidens* in Croatia can be categorized as casual (according to Richardson *et al*., 2004; Pyšek *et al*., 2004), while in the future it can be expected to become naturalized and an invasive plant, as it is already in most European countries.

CONCLUSION

The assumption that the neophyte *S. inaequidens* has been spread from neighboring countries to land in Croatia has been confirmed by recent findings in Hrvatsko Zagorje, as well as by the new findings from Dalmatia presented in this paper. These findings in Croatia show that this neophyte has spread towards the southeastern regions of Europe, which until recently were not affected by the invasion.

For now it can be stated that *S. inaequidens* is rather rare in Croatia and limited to ruderal habitats along the roads. It is possible that in the near future it could become a threat to the agricultural and natural ecosystems of the country.

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