NOBANIS - Invasive Alien Species Fact Sheet

Senecio inaequidens

Authors of this fact sheet: Dr. Tina Heger[1] and Dr. Hans Jürgen Böhmer[2]
[1]Landscape Ecology, Department of Ecology and Ecosystem Management, Technische Universität München, Am Hochanger 6, D-85350 Freising, Germany; +49 8161 71 4150; t.heger@wzw.tum.de
[2]Interdisciplinary Latin America Center (ILZ), c/o Center for Development Research (ZEF), University of Bonn, Walter-Flex-Str. 3, D-53113 Bonn, Germany; +49 228 73 4901;
neobiota@web.de

Bibliographical reference – how to cite this fact sheet:
Heger, T. and Böhmer, H.J. (2006): NOBANIS – Invasive Alien Species Fact Sheet – ***Senecio inaequidens***. – From: Online Database of the European Network on Invasive Alien Species – NOBANIS www.nobanis.org. Date of access x/x/201x.

Species description

Scientific names: *Senecio inaequidens* DC. (1837) Asteraceae.
Synonyms: No commonly used ones
Common names: South African Ragwort (GB), Schmalblättriges Greiskraut, Südafrikanisches Greiskraut, Ungleichzähniges Greiskraut, Schmalblättriges Kreuzkraut (DE), Smalbladet Brandbæger (DK), Buurivillakko (FI), Slender-leaved ragwort (IE), Bezemkruiskruid (NL), Boersvineblom (NO), Starzec nierównozębny (PL), Boerstånds (SE)

Fig. 1. *Senecio inaequidens*, photo Uwe Starfinger.


Fig. 2 and 3. *Senecio inaequidens*, close up, photo Jürgen Böhmer.

Species identification
Senecio inaequidens is a perennial shrubby herb (usually chamaephyte) about 60 cm high. The plant consists of a highly branched stem, woody at its base, with many, mostly slender, linear leaves (1 to 7 mm in width), and lemon-yellow flower heads attaining up to 25 mm in diameter. The species displays a fair amount of variability in leaf shape and width (*inaequidens* = heterodont, *cf.* Adolphi 1997).

Native range
The species is native to South Africa's "Highveld"; its original range covers approximately the provinces of North-West, Northern Province, Gauteng, Mpumalanga, Free State and Kwazulu-Natal, at elevations between 1400 and 2850 m (Werner *et al.* 1991, Meusel and Jäger 1992). There is some evidence that the Central European populations stem from the mountainous regions in southern Africa, which might explain their frost tolerance (Bossdorf *et al.* 2008, see also Lafuma *et al.* 2003).

Alien distribution

History of introduction and geographical spread
Senecio inaequidens is an adventitious plant in wool introduced to Europe from South Africa. Five primary centers of dispersal (sites having wool processing industry) have been reported: Mazamet (southern France), Calais, Verona, Liège and Bremen (*cf.* Werner *et al.* 1991). Its first occurrence in Germany was detected at an area near a wool factory in Hannover-Döhren (Brennenstuhl 1995), and a little later it was found at the overseas port of Bremen (specimen 1896, Bremer Überseemuseum; Kuhbier 1977, 1996). First occurrences in other countries were 1922 in Belgium, 1928 in Scotland, 1935 in France and 1947 in Italy (EPPO 2006). In Denmark *S. inaequidens* was registered first in 1988 (Skovgaard 1993), and in 1995 it was found on railway tracks in Oslo,

Norway (Often 1997). In Finland the species has been found in two container harbours of Helsinki in 1993 (Kurtto and Helynranta 1996), but possibly remained incidental (Kurtto, pers. comm.).

In Poland first sites of occurrence have been reported on railway grounds (Tokarska-Guzik 2005). The species may have migrated to Poland from the territory of Germany, as it has happened many times in the past for other plants (Radkowitsch 2003). In Kraków, Poland, it has been observed since the end of 1990s (Mirek *et al.* 2002).

The first record of *S. inaequidens* in the Netherlands is from 1939 in Tillburg in the vicinity of a wool processing factory that persisted until 1953. Occasional records have been reported along the Meuse river as of 1942. Since 1975 records of the species rise dramatically and the plant has been naturalized since 1976 (Adema and Mennema 1978).

Fig. 4 shows how *Senecio inaequidens* has spread in Germany since 1979. It may be assumed that the species today is spread throughout Germany (*cf.* Radkowitsch 1997). Nevertheless, its distribution in Germany is full of gaps, and it is quite probable that the species will invade sites in greater distance from the invasion corridors and close the gaps in the near future. For a more detailed description of the range expansion in Germany, and for information on the lag phase see (Böhmer 2001, Böhmer *et al.* 2001, Heger and Böhmer 2005).

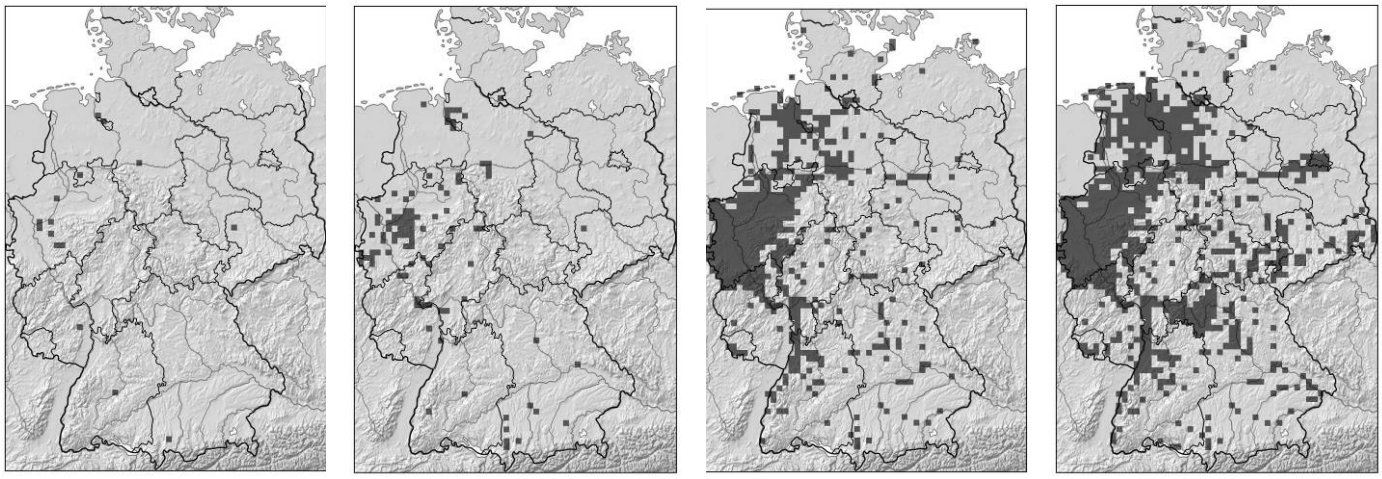

Fig. 4. Spread of *Senecio inaequidens* in Germany (1979, 1989, 1997, 2003) after Radkowitsch 1997, www.floraweb.de and other sources; taken from Heger and Böhmer (2005)

Pathways of introduction

Senecio inaequidens has been introduced with imports of sheep wool (unintended introduction). In the early 1970s *Senecio inaequidens* was propagated with the westerly winds from the region of Liège to western Germany (Werner *et al.* 1991). The species is now spreading eastwards along linear anthropogenic structures (Radkowitsch 1997, Adolphi 1998), in particular along railway lines and highways. In Denmark the species is introduced and spreading from two main areas of introduction – the goods stations of Copenhagen and Aarhus (Skovgaard 1993).

Alien status in region

The species occurs throughout Europe, in Andorra, Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Hungary, Italy, Netherlands, Norway, Poland, Spain, Sweden, Switzerland and the United Kingdom (including Northern Ireland) and also in several regions

outside Europe (see EPPO 2006). It is also starting to appear in the Black Country (Central England), probably introduced with ornamental plants imported from the Netherlands (Tokarska-Guzik 2005). It only occurs at two sites in Northern Ireland and is not considered to be a problem (J. Early, pers. comm.).
In Denmark *S. inaequidens* is spreading quickly. It is now a permanent part of the plant community at railway shunting and storage areas.
The species until now is missing in Estonia, Lithuania, Latvia, Russia, Greenland and the Faroe Islands (see table 1). It is found in a few localities in southern Sweden (Josefsson, pers. comm.). It has been cultivated on two occasions in the Reykjavik Botanic Garden, Iceland, but did not survive the following winters (Jakobsdóttir, pers. comm.). In Poland it is still classified as a casual alien plant species (ephemerophyte) (Mirek *et al.* 2002).

Country	Not found	Not established	Rare	local	Common	Very common	Not known
Denmark					X		
Estonia	X						
European part of Russia	X						
Finland		X					
Faroe Islands	X						
Germany					X		
Greenland	X						
Iceland	X						
Ireland			X				
Latvia	X						
Lithuania	X						
Netherlands						X	
Norway			X				
Poland			X				
Sweden				X			

Table 1. The frequency and establishment of *Senecio inaequidens*, please refer also to the information provided for this species at www.nobanis.org/search.asp. Legend for this table: **Not found** –The species is not found in the country; **Not established** - The species has not formed self-reproducing populations (but is found as a casual or incidental species); **Rare** - Few sites where it is found in the country; **Local** - Locally abundant, many individuals in some areas of the country; **Common** - Many sites in the country; **Very common** - Many sites and many individuals; **Not known** – No information was available.

Climate change can be considered to have favoured the invasion of *Senecio inaequidens* in Europe. The species' persistence in the vicinity of wool-washing and wool-carding facilities in Bremen, and its recent proliferation (Kuhbier 1977) could be the result of a slight prolongation of the vegetation period. Werner (pers. comm.) believes that in Central Europe *S. inaequidens* was initially capable of producing fertile seeds only in particularly favourable years, the vegetation period usually being too brief here. The plant's ability to reproduce increases considerably with a gradual warming of the climate. Werner *et al.* (1991) think that its proliferation in the Cologne-Aachen area during the early 1990s was due to the warm and dry vegetation periods in the aftermath of very mild winters. It therefore can be assumed that *Senecio inaequidens* will not be able to establish permanent populations in the northern parts of the region.

Ecology

Habitat description

In its native region, *Senecio inaequidens* DC. originally colonizes skeletal sectors on steep, moist and grassy slopes, as well as the sandy and gravelly banks of periodic streams at elevations between 1400 and 2850 m (Hilliard 1977). In Europe *S. inaequidens* grows on warm and dry ruderal sites, mostly with gravelly or sandy soil, but it can also be found in tall herbaceous vegetation and among young shrubs, though never in dense thickets or in deep shade of trees (Bornkamm 2002). The species is often found on railroad locations, in Germany (both highly frequented and dead tracks, Düring 1997) as well as in Helsinki, Finland (gravelly railway areas and filling earth in harbours at sea level, Kurtto, pers. comm.), Denmark (also along the railway at the artificial island Peberholm in Oresund) and in Poland (only as small populations, Tokarska-Guzik, pers. comm.). Other sites colonized by the species include the dividing strip of highways (Werner, pers. comm.), river ports (Richter 1997), flat roofs and flower tubs (Büscher and Loos 1993), logging areas and storm-damaged forests (Werner *et al.* 1991), industrial sites (Hard 1993, Meierott, pers. comm.), and disused quarries "mostly on surfaces ranging from fine gravel to stone at dry and exposed slopes" (Mückschel 2000). Moreover, it occurs on near-natural sites as *e.g.* volcanic soils in Rodderberg, Germany, and rocky sites in the central Rhine valley, Germany, (Klingenstein, pers. comm.), and coastal dunes of Belgium and Germany (Kuhbier and Weber 2003, Kuhbier 2006). It can be suspected that the species is missing on calcareous soils in general (Adolphi, pers. comm.). A list with other sites at which *S. inaequidens* may occur can be found in Werner *et al.* (1991), along with data on the species' sociology (see also Bornkamm 2002). In elevation, its range extends from sea level to almost 600 m (Mengen railroad station, after Sebald *et al.* 1996).

A noteworthy phenomenon is that *S. inaequidens* has also extended its range in South Africa to anthropogenic locations with weak competition (particularly on verges of roads and on areas damaged by fire, but also on coastal dunes) of the Eastern Cape Province, and in Lesotho, Botswana, Namibia and Mozambique. "In South Africa the species now also colonizes a wide ecological range of areas, from dry to humid habitats, stone to clay soils, exposed to shaded locations" (Werner *et al.* 1991; *cf.* Adolphi 1997).

Reproduction and life cycle

Senecio inaequidens is able to produce seeds during its first year of growth (López-García and Maillet 2005). It flowers from July to December, according to reports from south-western Germany (Oberdorfer 1983, Sebald *et al.* 1996), and from early May to December, according to reports from the Bremen region (Kuhbier 1996) (for a discussion of an adaptation of the flowering period to European climatic conditions, see Böhmer *et al.* 2001, Heger and Böhmer 2005).

Dense stands ("*Senecio inaequidens* stands", *cf. e.g.* Brandes 1993, Reidl 1995) produce "enormous seed quantities" (Adolphi 1997), creating great colonisation pressure, even in unusual habitats (*e.g.* lawns, and the façade of the cathedral at Cologne, see below). One plant is able to produce up to 29,000 achenes (Ernst 1998). The plants - as are all *Asteraceae* - are protandrous. Opposed to the results of Ernst (1998), a recent study suggests that *S. inaequidens* is a self-incompatible species (Lafuma and Maurice 2007).Clonal reproduction has not been observed. It is estimated that seeds may remain viable in the soil for 30-40 years. Germination can take place during most of the year, and may be favoured by compacted soils (see EPPO 2006).

Until now, 62 phytophagous insects have been observed feeding on *S. inaequidens* in Europe (Schmitz and Werner 2000, see also Scherber 2002). Of these, 11 feed on flowers and fruits. Three of these species are specialists for the genus *Senecio*, and three for *Asteraceae*. No data have been

found concerning the phytophagous complex of the species in its home range. A comparison with the indigenous species *Senecio jacobaea* (96 phytophagous insects) supports the assumption that *S. inaequidens* profits from being an alien; its co-evolved predators are missing in the new range (see Heger and Böhmer 2005). But as other species of the genus *Senecio* are present in Europe, specialized predators had (and have in the future) the possibility of switching to the new host (Strong *et al.* 1984; but see Frenzel *et al.* 2001). Host switching of specialist insect herbivores from native to alien species of the genus *Senecio* has been observed in New Zealand (Sullivan *et al.* 2008)
The impact of phytophagous insects on the growth of *S. inaequidens* in Europe nevertheless seems negligible until now. This may be due to the ability of the plant to produce alkaloids (Ernst 1998). Another favourable species characteristic especially concerning grazers is the ability of the species to regenerate lost tissue (see Guillerm *et al.* 1990). In an experiment rabbit grazing significantly reduced growth and reproduction. But, the species was able to resprout, and the regenerated tissue was not consumed by rabbits any more, probably because of a change in the pyrrolizidin alkaloid composition. Mollusc herbivory significantly reduced the number of capitulae produced (Scherber *et al.* 2003). The ability to tolerate herbivory by generalist insects seems to be one result of a selection of pre-adapted individuals: In a greenhouse experiment the European plants showed higher allocation to root biomass, more tolerance to insect herbivory, less genetic variability and greater plasticity in response to fertilization compared to plants from several different South African populations (Bossdorf *et al*. 2008).

Not much is known concerning non-insect predators of *S. inaequidens*. An alien rust (*Puccinia laenophorae* Cooke) grows on the plant, and an indigenous fungus (*Coleosporium senecionis* (Pers.) J.J. Kickx) has also been observed (Schmitz and Werner 2000). An open question is what influence these and other pathogens have on the plant in Europe and the home range.

Dispersal and spread
The achenes are small (3 mm) with relatively long pappus hairs (5 mm), helping them not only to be transported by wind, but also to stick to many different structures (e.g. animal fur). Wind seems to be a major vector for dispersal. Griese (1996) believes that diaspores may additionally be transported over considerable distances in the profile of tires. The air turbulence along the edge of transportation routes concentrates the diaspores, promoting the development of stands. Radkowitsch (pers. comm.) thinks that frequent maintenance measures (creation of open soil surfaces by "stripping") on the dividing median of highways represent an important vector. It may also be spread due to transportation of building materials. Düring (1997) mentions dispersal via the transport of soil and by drift into open surfaces. The finds in Helsinki, Finland, point to the possibility of spreading of achenes on surfaces of containers (Kurtto, pers. comm.).

Impact

Affected habitats and indigenous organisms
The German experts interviewed agree that *Senecio inaequidens* DC. does not demonstrably pose a threat to indigenous species or plant communities at present. This also seems to be true for Denmark (F. Skovgaard, pers. comm.) In Europe the plant rather appears to fill vacant ecological niches (Asmus 1988, Adolphi 1997, Kuhbier 1996, and others; *cf.* also Dettmar 1993). Adolphi (1997) discusses the possible ecological displacement of indigenous species, concluding that in the end *S. inaequidens* depends upon a protracted anthropogenically disturbed regime (*cf.* also Asmus 1988, Bornkamm 2002), and remains incapable of permanent establishment in an undisturbed process of succession. Species such as the perennial wall rocket (*Diplotaxis tenuifolia*) are able to

resist *S. inaequidens* even in the early stages of succession (Adolphi 1995). It appears that willowherbs (*Epilobium angustifolium* and *E. hirsutum*) as well as creeping thistles (*Cirsium arvense*) may be expelled. This does not constitute an actual threat to these species, however, as it is usually restricted to local shifts in dominance in favour of *S. inaequidens* (Adolphi 1997). However, recent investigations suggest that the species might develop the potential to invade also established native communities in Central Europe in the future (Bossdorf *et al.* 2008), as is the case in the Mediterranean (López-García and Maillet 2005). With the closing of current gaps in its geographic distribution, a gene flow between populations originating from independent introductions might possibly further promote its invasiveness in Central Europe (Lafuma & Maurice 2007, see also Monty and Mahy 2009).
Concerning the occurrences on near natural sites it has not been investigated yet whether the species puts indigenous species at risk. But it has lately been observed that *S. inaequidens* does form dominant populations on rocky sites (Adolphi and Klingenstein, pers. comm.). It is therefore impossible to exclude a threat to indigenous plant species of great importance to nature conservation (*e.g.* blue lettuce, *Lactuca perennis*). Its colonisation success on open rocky sites moreover may pose a risk to endangered animal species (*e.g.* Saltatoria). In coastal dunes it occurs especially in yellow dunes with marram grass (*Ammophila arenaria*) and in sea-buckthorn scrub (*Hippophaë rhamnoides*), where it changes the floristic composition of the dune vegetation (Isermann, pers. comm.).

Genetic effects
No genetic effects have been detected until now.

Human health effects
The spreading of *S. inaequidens* to cereal cultures (*e.g.* wheat) may entail another problem, not just due to the species' competitive capacity, but particularly because of its poisonous quality (*cf.* Dimande *et al.* 2007). According to Bromilow (1995), *S. inaequidens* is a crop weed in South Africa and repeatedly finds its way into bread. Cases of lethal poisoning have supposedly occurred. The poison has repeatedly been detected in milk as well, even though *S. inaequidens* is usually avoided by grazing animals.
In Germany *S. inaequidens* has been found on fallow fields (according to Sumser in Adolphi 1997), but it has not yet been detected on cultivated surfaces. In France, though, it can be found in vineyards and pastures, and the poisoning of horses after ingestion of *Sencio inaequidens* has been observed (Passemard and Priymenko 2007). In Denmark the species has been found in apple tree orchards (Skovgaard, pers. comm.).

Economic and societal effects (positive/negative)
The species is not used in Europe in any way. Negative economic effects due to its resistance to herbicides are reported from the German railways (100.000 €/a, Reinhardt *et al.* 2003).

Management approaches

Prevention methods
Senecio inaequidens is included in the EPPO list of invasive alien species (see EPPO 2006). As the species already is present in the region and spreads with wind and various other vectors (as described above), preventing its further dispersal will be impossible.

Eradication, control and monitoring efforts

As far as the authors know, there is no experience with species specific control measures, and there are no monitoring programs for this species in the region.

It has variously been observed that the species is exceptionally resistant to herbicides (Hard, pers. comm.), and it is apparently promoted by mowing as well. Radkowitsch (pers. comm.) terms the species as "resistant to mowing". Werner (pers. comm.) observed near Aschaffenburg, Germany, that after the dividing strips of highways were mowed, the stumps cut down in June to a length of 5 cm began to sprout at once, blooming after a few weeks. It may be assumed, therefore, that non-specific control measures in these sites provide a competitive advantage for *S. inaequidens* over other ruderal plants (*cf.* also Guillerm *et al.* 1990).

Specific control measures (mechanical or chemical control, eventually biocontrol with the aphid *Aphis jacobaea*, EPPO 2006, or the beetle *Longitarsus jacobaeae, cf.* Scherber *et al.* 2003) may not be easy to apply in practice or only be applicable for small areas (*cf.* EPPO 2006).

Information and awareness
To raise awareness for the species it has been included in the EPPO list of invasive alien plants as well as the German database NeoFlora (URLs see below). In the countries of the region, more and more information about this species is available.

Knowledge and research
As the species is still spreading and awareness of its invasiveness is rising, the number of records of floristic finds and descriptions of extensions in range is still increasing. In addition there is a growing number of detailed ecological, physiological and genetic case studies (see references). .

Recommendations or comments from experts and local communities
A monitoring program is advisable in those parts of the range of *Senecio inaequidens* where the species has either begun to exert massive colonisation pressure on locations outside of the ruderal sites preferred in the past (*e.g.* xerothermic locations on rocks), or is capable of doing so (cereal cultures). A monitoring program should focus particularly on expulsion mechanisms between *S. inaequidens* and thermophilous native species with poor competitive capacity, as well as potential impacts on agriculture (resulting from this poisonous species' invasion of food products).

References and other resources

Contact persons
Prof. Dr. Klaus Adolphi (DE), Universität zu Köln, Institut für Biologie und ihre Didaktik- Botanik, Gronewaldstraße 2, D-50931 Köln, Germany; +49 221 470 6901; E-mail: k_adolphi@yahoo.com

Prof. em. Dr. Dietrich J. Werner (DE), Universität zu Köln, Geographisches Institut, Albertus-Magnus-Platz, D-50923 Köln, Germany; +49 221 470 2549; E-mail: dj.werner@uni-koeln.de

Dipl.-Biol. Annemarie Radkowitsch (DE), ForumNatur, Hohenwarter Str. 1, D-75181 Pforzheim, Germany; +49 7231 788897; E-mail:a.radkowitsch@t-online.de

Dr. Maike Isermann (DE), University of Bremen, NW II, Vegetation Ecology and Conservation Biology, Leobener Strasse, D-28359 Bremen, Germany; E-mail: iserm@uni-bremen.de

Finn Skovgaard (DK), Tværmarksvej 5, DK-2860 Søborg, Denmark; E-mail: finn.skovgaard@jubii.dk

Dr. Barbara Tokarska-Guzik (PL), University of Silesia, Faculty of Biology and Environmental Protection, Department of Plant Systematics, Jagiellonska str. 28, PL-40-032 Katowice, Poland; +48 32 2009479; E-mail: tokarska@us.edu.pl

Christina Birnbaum (EE), Estonian University of Life Sciences, Institute of Agricultural and Environmental Sciences, Kreutzwaldi 64, Tartu 51014, Estonia; E-mail: chbirnbaum@yahoo.com

Dr. Melanie Josefsson (SE), Swedish Environmental Protection Agency, S-106 48 Stockholm, Sweden; +46 (0)8 698 1541; E-mail: Melanie.Josefsson@snv.slu.se

Arto Kurtto (FI), Curator, Botanical Museum, Finnish Museum of Natural History, University of Helsinki, Finland; E-mail: arto.kurtto@helsinki.fi

Dora Jakobsdottir (IS), curator, Reykjavik Botanic Garden, Laugardalur, IS-104 Reykjavik, Iceland; E-mail: dora.jakobsdottir@reykjavik.is

Links

Senecio inaequidens on the EPPO List of invasive alien plants (English)

German site on *Senecio inaequidens* (German)

Swiss site on *Senecio inaequidens* (German)

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Date of creation/modification of this species fact sheet: 20-05-2009