



## ***Cytisus scoparius* (Fam. Fabaceae) in southern Brazil – first step of an invasion process?**

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### **ABSTRACT**

The occurrence of Scotch broom *Cytisus scoparius* (L.) Link (Fabaceae), is reported for the first time in Brazil. The species has been registered in the species-rich Campos Sulinos grasslands, in the Campos de Cima da Serra, and in the Serra do Sudeste. Naturalizing populations were frequently formed in natural habitats near to human settlements, where prevailing land uses and disturbances facilitate dispersal and establishment. The plant is an invasive species that has globally caused significant damage to biodiversity and economic losses. In Brazil, the species has a strong potential for spreading into a wide range of ecosystems. The Atlantic Forest biome and part of the Pampa biome, together known as the Campos Sulinos, represent optimal areas for the species. Features of the observed populations and recommendations for management are presented.

**Key words:** alien species, early detection, ecology, grassland, Scotch broom.

### **INTRODUCTION**

Scotch broom (*Cytisus scoparius*) is widely identified as a global pervasive species, causing extensive environmental and economic damage (Memmott et al. 1993, Sheppard et al. 2002). It has been detected in multiple countries including Chile, United States of America, India, Iran, Canada, Australia, New Zealand, and South Africa (Memmott et al. 1993, Fowler et al. 1996, Mkhize et al. 2013), and its range still is expanding (Memmott et al. 1993). There are still important gaps and country-to-country differences regarding

threat identification and suitable response level. Many species-rich ecosystems of South America's Southern Cone have been identified as places potentially suitable for invasion by Scotch broom in regard to general climatic conditions for the species (Potter et al. 2009). The southern part of the Atlantic Forest biome and the Campos grasslands are among the most at risk, with part of the Pampas and the Andean Patagonian biomes, also at risk but to a lesser extent (Potter et al. 2009). However, until now Scotch broom has only been cited from scattered montane localities in the Valdivian temperate forests of Chile and Argentina

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(Simberloff and Martín Nuñez 2003, Pauchard and Alaback 2004, INBIAR 2014).

South Brazilian grasslands have experienced severe habitat loss and degradation as a consequence of extensive land exploitation (Overbeck et al. 2007, Vega et al. 2009). Land use changes have been shown to be among the most important drivers of exotic plant invasions (Vitousek et al. 1997). In southern Brazil, general consensus exists regarding the environmental problems associated to the exotic invaders: tough lovegrass (*Eragrostis plana*), gorse (*Ulex europaeus*) and pine (*Pinus elliotti* and *Pinus taeda*), which cause the displacement of native flora and the modification of natural habitats. Here, we report on the first finding of Scotch broom in this region, which likely represents the first step of a new invasion process.

## MATERIALS AND METHODS

### GEOGRAPHIC AREAS

Our two study regions belong to the *Campos Sulinos* grasslands in the state of Rio Grande do Sul, southern Brazil (Overbeck et al. 2007): the highland grasslands on the South Brazilian Plateau, and the grasslands of the Serra do Sudeste, a low mountain range in the south of the state. The natural vegetation is characterized by species-rich grasslands, in mosaics with forests (Araucaria forests in the highlands, semi-deciduous forests in the Serra do Sudeste). The *Campos Sulinos* are subject to rapid land use changes that reduce the area of natural vegetation (Overbeck et al. 2007) and may increase vulnerability to the establishment of non-native species.

### GENERAL DESCRIPTION, ECOLOGY AND INVASIVENESS OF *Cytisus scoparius*

Scotch broom is a shrub native to the temperate mixed and broadleaf forests of Europe (Polunin 1991), constrained by drought at the southern and cold at the northern limit of this region (Hegi 1926

in Memmott et al. 1993). Individuals may reach over 3 m in height, and occur, in the species' native range, in a wide variety of habitats (Srinivasan 2012). Leaves are composed of 1-3 leaflets and are deciduous, growing in alternate disposition across smooth stems (Zielke et al. 1992). Flowers are distributed on terminal axes, grouped with leaves, and have characteristic short-toothed bilabiated calices (Polunin 1991). Flowering begins in the third year, with yellow flowers that open during the months of spring, and subsequently form seedpods (Memmott et al. 1993). Seedpods range between 2.5 – 5 cm in width by 8 – 10 cm in length, and have hairs on the margins, which also help in the identification of the species (Polunin 1991). The global distribution of Scotch broom is related to European colonization around the world, to land conversion into agricultural lands and exotic tree plantations of economic value (Pauchard and Alaback 2004). A globally pervasive species and a common garden escapee (Peterson and Prasad 1998, Mkhize et al. 2013), *Cytisus scoparius* has been shown to cause significant declines in native biodiversity around the world (Bossard 1996, Simberloff and Martín Nuñez 2003, Shaben and Myers 2010, Srinivasan 2012). The species has negative impacts on forestry in natural forests and tree plantations, modifies the species composition at invaded sites, and hampers the establishment of rare endemic taxa, favoring generalist fauna, along with shade-tolerant and exotic flora (Zielke et al. 1992, Zarri et al. 2006, Shaben and Myers 2010, Srinivasan 2012).

### FIELD WORK

The populations of Scotch Broom reported here were detected during the course of field work on the invasion by *Ulex europaeus* (gorse) in the region.

## RESULTS

The current study has for the first time recorded the presence of naturalized *Cytisus scoparius*

populations in Brazil (Table I). The species was detected in two regions of Rio Grande do Sul, Brazil's southernmost state: in the highland grasslands near São Francisco de Paula and in the grasslands of the Serra do Sudeste. In both areas, shrubs were in the early stages of development, but two spontaneous populations had already established in the southeastern region. A young stand of about 3 years old, consisting of 17 individuals (Pinheiro Machado 2), was located at approximately 2 km from a single mature individual occurring in a private garden in the town periphery of Pinheiro Machado. The population was growing on sandy banks of roadsides, where the frequent passage of vehicles over an unpaved

track can facilitate seed dispersal (Pippa et al. 2012). The role of roadsides as biological corridors and their importance in spreading this weed is well known (Pauchard and Alaback 2004). In Herval, a well-established population grew on disturbed roadsides next to abandoned land. The specimen of São Francisco de Paula, constitutes the only record for the highland region, and occurred at < 0.5 km from areas heavily invaded by gorse.

This scenario sets the initial stages of habitat colonization for Scotch broom in Brazil. In the observed populations, flowering took place between October and mid-January, during Austral Hemisphere spring, which matches well with the flowering period observed in native ranges.

TABLE I

**Locations across the state of Rio Grande do Sul where Scotch broom has been detected, these include gardens (Pinheiro Machado 1 and São Francisco de Paula), abandoned urban lands (Herval) and naturalized field settings (Pinheiro Machado 2). The field population of Pinheiro Machado was located at about 2 km from the closest neighborhood, and probably originated from a single garden individual growing in the outskirts (Pinheiro Machado 1). Height for individuals growing in gardens was estimated.**

Region	Locality	Latitude	Longitude	N	Mean Height (cm)
Highland grasslands (Eastern Planalto)	São Francisco de Paula	S 29°26'43.98"	W 50°35'04.62"	1	240
Serra do Sudeste	Herval	S 32°01'32.85"	W 53°23'44.93"	9	260
	Pinheiro Machado 1	S 31°34'39.29"	W 53°23'08.67"	1	220
	Pinheiro Machado 2	S 31°35'55.89"	W 53°24'16.57"	17	225

## DISCUSSION

The early detection of first naturalized populations of invasive species can have a significant outcome for conservation (Pauchard and Alaback 2004), enabling the analysis of the behavior of the invasive species, its potential effects and, if necessary, facilitating a prompt eradication and the prevention of damage (Westbrooks 2004). Recent arrivals of alien weeds offer the chance of better understanding the processes involved in the early stages of species invasions, and in the ecological dynamics in recipient communities. This is especially important in the case of Scotch broom which is regarded as a

globally noxious species. Presence of the species generally is associated to early stages of succession and to degraded areas (Zielke et al. 1992, Fowler et al. 1996, Peterson and Prasad 1998, Sheppard et al. 2002, Holst et al. 2004, Potter et al. 2009, Srinivasan et al. 2007, Srinivasan 2012).

To our knowledge, no other study has yet shown evidence of existing Scotch broom populations in South America's Atlantic shores, despite a high potentiality (Potter et al. 2009). Even though the first populations still have a limited range and, therefore, a low impact, it is known that the appearance of impacts of invasive species may lag in time, and

not be immediately noticeable (Simberloff 2005, 2011, Goodenough 2010, Schlaepfer et al. 2011). The fact that we found the naturalized populations along roadsides can be considered quite typical for invasion processes (Parendes and Jones 2000, Christen and Matlack 2009, Mortensen et al. 2009, Pippa et al. 2012), and the importance of roadsides for invasion, has been shown for *Cytisus scoparius* before (Pauchard and Alaback 2004).

Given the impacts of the species in other regions of the world and the results of potential distribution modelling (Potter et al. 2009), efforts should also be made to detect further sources and foci of invasions, to monitor behavior of the species and, if necessary, to include Scotch broom into the Brazilian federal and states noxious species lists and to eradicate, where possible, the existing populations. As evidenced in other countries around the world, the eradication of the species is quite difficult once it has established, often requiring a combination of methods (e.g. biological, mechanical and chemical) (Peterson and Prasad 1998, Herrera-Reddy et al. 2012). Mkhize et al. (2013) described how since the 1980's infructuous attempts are still being made for eradicating Scotch broom from South Africa, as plants re-appeared a decade after initial removal, likely as a result of recolonization from the seed bank (Paynter et al. 1998). The challenge of controlling this invasive species is reinforced by the fact that no method can independently achieve completely satisfactory results. Biological control with insects is not totally effective, as Scotch broom is not seed-limited (Memmott et al. 1993), and high seed predation rates (between 70 and 99.9%, in different studies) are needed, which is very difficult to achieve in most circumstances (Paynter et al. 1998, Parker 2000).

Climatic envelope modeling may constitute a suitable tool to evaluate the risk of exotic species and to project the likelihood of successful establishment (Hyvönen et al. 2012). The subtropical climate of Rio Grande do Sul produces optimal conditions for

Scotch broom invasion (Potter et al. 2009), with abundant precipitations and mild winters, that release the species from significant climatological constraints (Polunin 1991). However, generalized extrapolation to other regions should be made with caution. Given current and future trends of climate change (Potter et al. 2009), and rapid adaptability of many invasive plants (Clements and DiTommaso 2012), it is likely that present range-expansion projections fall short of a full comprehension of future scenarios. Moreover, it is highly relevant to build up sufficient knowledge on autecology of invasive species in exotic ranges, and the complex matrix of environmental and anthropogenic factors affecting them.

#### CONCLUSIONS

We stress the importance of early detection for invasive species of global concern like *Cytisus scoparius*: given the species' high capacity for dispersal (Bossard 1991), isolated escapees constitute a threat. We thus emphasize the need for strengthening surveying efforts to detect the presence of scattered populations. Early detection can have an important outcome in facilitating the management of populations at this stage, when eradication efforts also have a high likelihood of success. Special attention should be also given to the identification and preservation of vulnerable habitats. The study of early naturalizing populations can also provide important insights for, a better understanding, and subsequent prevention, of future invasion processes.

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### RESUMO

A ocorrência da giesta-brava *Cytisus scoparius* (L.) Link (Fabaceae) é citada pela primeira vez no Brasil. A espécie foi localizada em áreas com alta diversidade biológica nos Campos Sulinos, nos Campos de Cima da Serra, e na Serra do Sudeste. As populações naturalizadas são formadas frequentemente em habitats naturais, próximos a zonas povoadas, onde os diferentes usos da terra e os distúrbios facilitam a dispersão e o estabelecimento. A giesta-brava é uma espécie invasora que tem causado significativos danos à biodiversidade e perdas econômicas globalmente. No Brasil, a espécie tem um forte potencial de se propagar a um vasto conjunto de ecossistemas. O bioma Mata Atlântica e parte do bioma Pampa, conhecidos como os Campos Sulinos, representam áreas ótimas para a espécie. São apresentadas as características observadas nas populações e recomendações para o manejo.

**Palavras-chave:** espécies exóticas, detecção precoce, ecologia, campos, giesta-brava.

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