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Short communication

# Winter establishment of the alien annual *Schismus barbatus* is not affected by insect herbivory in Northern-Central Monte Desert

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ABSTRACT

We studied the effect of ant herbivory on the establishment and survival of the annual plant *Schismus barbatus*. We hypothesized that ants may control this species when biomass of native plants is generally low during their vegetative period. We predicted that ant herbivory will decrease plant survival and reproduction. We tested our prediction with an insect exclosure experiment in a sandy desert of Northern-Central Monte.

We found more than 12 000 established seedlings per square meter on early May, after two consecutive rain pulses of ca. 20 mm each. Overall, we found that almost 75% of recruited plants survived by the end of the cool season (September), and that 22–24% of the initially established plants survived as mature reproductive plants by the end of the growing season (December). Contrary to our expectation, insect herbivory did not affect plant establishment, plant survival or the proportion of flowering and fruiting individuals of *S. barbatus*.

The large number of seedlings reported, the ability to exploit a temporal window free of plant competitors and enemies, and the availability of microsites where this species can succeed, all suggest that *S. barbatus* may have the potential to become an important plant invader in the Monte Desert.



## 1. Introduction

Invasive species perturb natural ecosystems worldwide, including deserts and semideserts (Milton and Dean, 2010). The success of non-indigenous plant species can be determined by a variety of factors (or "filters"), whose relative importance is supposed to vary throughout the different stages along the whole invasion process (Theoharides and Dukes, 2007; Williamson, 2006). Socio-economic, geographic and abiotic filters have been found to be more important during the initial stages, i.e. from the transport or importation stage to the colonization or escape stage (Williamson, 2006; Theoharides and Dukes, 2007). In contrast, the relative importance of biotic filters (pathogens attack, competition and herbivory), increases towards the end of the process, which includes the population-establishment and the landscape-spread stages (Keane and Crawley, 2002; Theoharides and Dukes, 2007). Mixed results are reported in the literature as to whether resident herbivores, either specialists or generalists, may limit or not (or even promote) the establishment and spread of invasive populations (Levine et al., 2004; Maron and Vilá, 2001; Parker et al., 2006). Here we evaluate the effect of herbivory by resident generalist ants on the demography of an invasive annual grass (*Schismus barbatus*) over one growing season in a South American desert.

*S. barbatus* is a winter annual grass native to the Mediterranean region that has mostly colonized deserts where rainfall concentrates during winter (e.g., Sonora, Austral Monte) (Brooks, 2000; Morici et al., 2006). However, *S. barbatus* has been recently observed during the cool season in a Northern-Central Monte Desert, where rainfall concentrates during summer (Pucheta et al., 2011). In spite of the very low frequency of winter rainfall in this area, this non-indigenous plant species has a large non-dormant soil seed bank (>30 000 germinable seeds/m$^2$, Pucheta et al., 2011) and can germinate as soon as five to seven days after small pulses (~15 to 20 mm) of late-summer or early-autumn rains, often coexisting with low densities of native plant species (pers. obs.). We asked whether this species may be affected by generalist ant herbivory. Despite we found almost no studies reporting herbivory on this species other than seed consumption by ants

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(Rissing, 1988; but see Pilati et al., 1997), we have first-hand evidence of *Acromyrmex lobicornis* harvesting entire seedlings, tillers and entire panicles of *S. barbatus* at the study site. The leaf-cutting Attine ants, *Acromyrmex* and *Atta* genus, are the main herbivore species in much of the Neotropics (Bucher, 1987). Within the Monte, *A. lobicornis* may consume as much green biomass as cattle (Claver, 2000). Their feeding behaviour is opportunistic, both for species identity and for plant parts (Claver, 2000; Milesi and López de Casenave, 2004), as observed for *Schismus* leaves and panicules for a semiarid grassland in La Pampa province (Pilati et al., 1997). *A. lobicornis* are active within 11.7–22.6 °C thermal range, being only inactive in July (Pilati and Quirán, 1996).

We hypothesized that ants may forage on *S. barbatus*, especially when alternative food sources (mostly native herbs) are scarce (i.e. during the coldest and driest months). We predicted that generalist insect herbivory will decrease survival and reproduction of *S. barbatus* plants. To test our hypothesis we set up an insect exclosure experiment in a sandy desert of Northern-Central Monte, in western Argentina.

## 2. Materials and methods

### 2.1. The study system

The site (31°44′S; 68°7′W; 576 masl) is a sandy desert within the Northern-Central Monte boundary, near Caucete city, province of San Juan in western Argentina. The area lies within the Monte phytogeographical region. Mean annual rainfall ranges from less than 100 mm in the North to over 350 mm in the South, and the proportion of winter precipitation increases along that gradient (Morello, 1958). The study area belongs to the driest area of the entire Monte and is located south-westwards from Pie de Palo Hills, on a sandy plain which represents the north-western limit for the Médanos Grandes sand sea (erg).

The climate in the area is temperate, with hot summers and cool winters, with 65% of the 100.5 mm total annual precipitation (CV 44%, 1979–2008) falling during the summer months (from December to March). Mean monthly temperatures of the hottest (January) and the coolest (June) months are 27 and 8.2 °C, respectively. The average cool season (April to November) precipitation in the region is 34.21 mm (CV 66%).

The soil is sandy and deep (>6 m depth) with a slight southwest faced slope (<1%) that receives ephemeral streams from the Pie de Palo Hills. Vegetation is an open shrubland dominated by scattered shrubs of *Bulnesia retama* (Gillies ex Hook. and Arn.) Griseb. The native annual stratum is mainly composed of herbs and ephemerals (e.g. *Gomphrena martiana* Gillies ex Moq., *Heliotropium mendocinum* (Phil.), *Portulaca echinosperma* Hauman, *Portulaca grandiflora* Hook, *Ibicella parodii* Abbiatti and *Sclerophylax arnottii* Miers). Species nomenclature follows Zuloaga and Morrone (1996, 1999).

The Mediterranean grass *S. barbatus* (Loefl. ex L.) Thellung (Poaceae: Arundinoideae) is an annual cool season species 5–20 cm tall (3–15 cm tall in the study site). Specifically for Argentine arid lands, *S. barbatus* has been found in areas with variable incidence of winter rains, such as some areas of Central Monte (Martínez Carretero and Dalmasso, 1992), Austral Monte (Morici et al., 2006) and in a more mesic ecosystem, under halophytic conditions in the Atlantic shore, near Bahía Blanca (Nebbia and Zalba, 2007).

### 2.2. Field sampling and data analysis

To study the effects of insect herbivory on *S. barbatus* population dynamics we laid out an experiment in which we excluded insect herbivory and recorded emergence, survival and reproduction of individuals of *S. barbatus* over a period of 235 days.

Before the beginning onset of the cool season (April 20th, 2007), we installed 12 pairs of 50 × 50 × 35 cm plastic mesh (1 cm openings) cages to exclude large herbivores (rodents and goats). Cages were installed, in pairs under *B. retama* canopies interspersed (over 30 m apart from each other) within an area of ca. 4 ha. Within each pair, one cage was additionally covered with white nylon mesh (0.5 mm openings) to exclude small insects. We assumed that the nylon net did not change the temperature or the light quality inside cages. Within each cage a permanent 12 × 19 cm quadrat was installed in which the number of individual plants in vegetative, flowering, and fruiting phases was recorded. Records were taken sequentially on May 1th 2007, May 16th, July 26th, September 24th, December 8th and December 28th 2007. Given that, in this particular year, *Schismus* could only found beneath *B. retama* shrubs we restricted our measurements to that microsite alone despite the fact that *Schismus* may indeed colonize open patches, particularly under wetter conditions (pers. obs.).

Repeated measures ANOVA was used to compare total number of established plants between treatments and across sampling dates, using sampling dates and herbivory treatment as the within-subject effects. The proportions of flowering and fruiting plants at the end of the study were compared between treatments using quasi-likelihood models (Crawley, 2007). Inference on treatments' effects was based on *F* tests (Crawley, 2007). All data analyses were performed using R (R Development Core Team, 2009).

## 3. Results

At the beginning of the experiment, after 40 mm of accumulated rainfall from March to April (Fig. 1), the initial number of

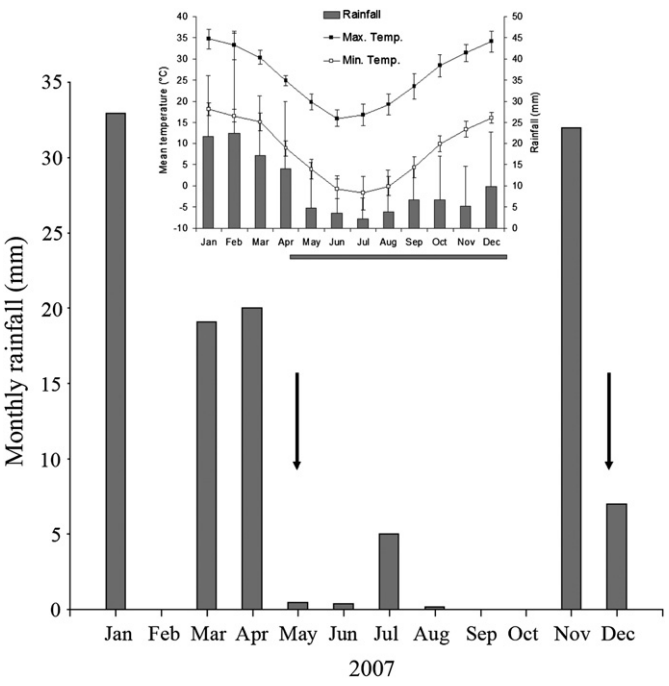


**Fig. 1.** Monthly rainfall recorded during the study year in a sandy desert ecosystem from central-northern Monte, San Juan, Argentina. Arrows indicate the beginning and the end of the field experiment. Minor graph shows means maximum and minimum temperatures and average monthly rainfall for a thirty-yr record data from San Juan Airport, 28.9 km NE from the study site. The horizontal grey bar at the bottom indicates length of the growing season of *Schismus barbatus*.