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COMPETITION BETWEEN *ERODIUM MACROPHYLLUM* [GERANIACEAE] AND EXOTIC AND NATIVE SPECIES IN A SOUTHERN CALIFORNIA ANNUAL GRASSLAND

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INTRODUCTION

Aside from habitat loss, exotic species are the primary threat to biological diversity (Pimm and Gilpin 1989; D'Antonio and Vitousek 1992). California grasslands have experienced one of the most dramatic biological invasions in North America, undergoing an almost complete vegetation conversion from native perennial/annual to exotic annual species (Heady et al. 1991). Despite the widespread concern of exotic species, their impacts on community and population dynamics is poorly understood. The objective of this research is to understand how exotics may restrict the distribution of the rare native forb, *Erodium macrophyllum*, and how competition and soil type may interact during restoration of this species.

Interestingly, some plant communities in regions of California with a Mediterranean climate have resisted invasion by exotics and their floral communities have remained relatively intact. Most notable are areas of serpentine soils, vernal pools and highly weathered, shallow soils on exposed slopes (Murphy and Ehrlich 1989). However, some plant communities have remained relatively un-invaded in areas where these edaphic conditions are not found. Given this, it is possible that restricted edaphic conditions in southern California, such as clay soil outcrops, act as refugia for native species. Many rare and endangered plant taxa are found only on these clay soils (e.g., *Allium munzii, Brodiaea filifolia, Brodiaea orcuttii, Convolvulus simulans* and *Harpagonella palmeri* [pers. obs.]), which often have a reduced cover of exotic species (pers. obs.). However, no one has studied the importance of these soils as places of refugia. If clay soil outcrops are places of refugia for native California taxa, then they are important areas for preservation, representing places where rare plants can persist relatively free from human intervention.

Erodium macrophyllum Hook. & Arn. is a rare, native California forb that is apparently restricted to clay soil outcrops (pers. obs.). Anecdotal evidence suggests that this forb was once more common in California (Gray 1876; Abrams 1904) and part of its decline may be due to displacement by exotic forbs and grasses much like what has happened with other grassland species (Bartolome *et al.* 1986). Using *E. macrophyllum* as a model species, the purpose of this study is to assess the importance of clay soil outcrops as refugia.

MATERIALS AND METHODS

In winter and spring 2001, I set up field experiments looking at how *E. macrophyllum* competes with native and exotic species in an annual forbland in Crown Valley at the Lake Skinner/Shipley Multi-Species Reserve. In Crown Valley, soils are a sandy loam (USDA 1971) and the dominant annuals are *Amsinckia menziesii* (native forb), *Bromus diandrus* (exotic grass), *B. madritensis* (exotic grass) and *Erodium brachycarpum* (exotic forb) (Gillespie, unpublished data).

At Crown Valley, I experimentally tested the hypotheses that (1) *E. macrophyllum* would have a greater reproductive output in weeded plots versus non-weeded plots and (2) that *E. macrophyllum* would have a greater reproductive output when grown in plots dominated by *A. menziesii* as opposed to plots dominated by *B. diandrus* or *E. brachycarpum*. To test these hypotheses, I used a 2 by 3 randomized factorial design replicated 5 times. To study competition between *E. macrophyllum* and the various matrix species (those listed above), I selected 0.5 m^2 plots where each matrix species was dominant and sowed in approximately 200 seeds of *E. macrophyllum*. Additionally, each seeded, non-weeded plot was paired with a control plot where I manually weeded all plants . From January to May 2001, I monitored all 30 plots and recorded demographic data weekly.

PRELIMINARY RESULTS AND DISCUSSION

Weeding significantly increased fruit production of *E. macrophyllum*. Within the weeded plots, *E. macrophyllum* growing in plots formally dominated by *Bromus* spp. produced more fruit than the *A. menziesii* and *E. brachycarpum* plots (Figure 1). Interestingly, the specific matrix species competing with *E. macrophyllum* (e.g. *A. menziesii* vs. *E. brachycarpum*) in the non-weeded plots had no affect on fruit production (Figure 1). These results suggest that competition with exotic species is important in restricting the reproductive output of *E. macrophyllum*; however, the specific species does not seem to be important. That is, *E. macrophyllum* does poorly when growing with any of the matrix species: *B. diandrus, E. brachycarpum* or the native, *A. menziesii*.

There is a long standing dogma in plant ecology that many taxa are restricted to unusual, infrequent edaphic conditions because they cannot withstand competition on other widespread soil types. In fact, several studies have shown that edaphic endemics often perform better when grown on more favorable soil types (Kruckeberg 1954; McGraw and Levin 1998). *Erodium macrophyllum* is restricted to heavy clay soils where there is little vegetation cover, suggesting that it does not experience very intense competition when growing on these soils. My results provide additional data suggesting that competition on other more common soil types may be an important factor restricting *E. macrophyllum* to nutrient-poor clay soils. Interestingly, however, some of the *E. macrophyllum* plants growing without competitors in Crown Valley died before dispersing their seeds. Plants that did this were robust and appeared healthy until mid-April, when they senesced prematurely compared to adjacent native plants. This suggests that there may be certain properties of clay soils (such as water retention) that are required by *E. macrophyllum*. However, because premature death of *E. macrophyllum* plants in Crown Valley was not consistent, it is difficult to make generalizations regarding the mechanisms by which it is restricted to clay soils. Additional research will be initiated to determine these mechanisms.

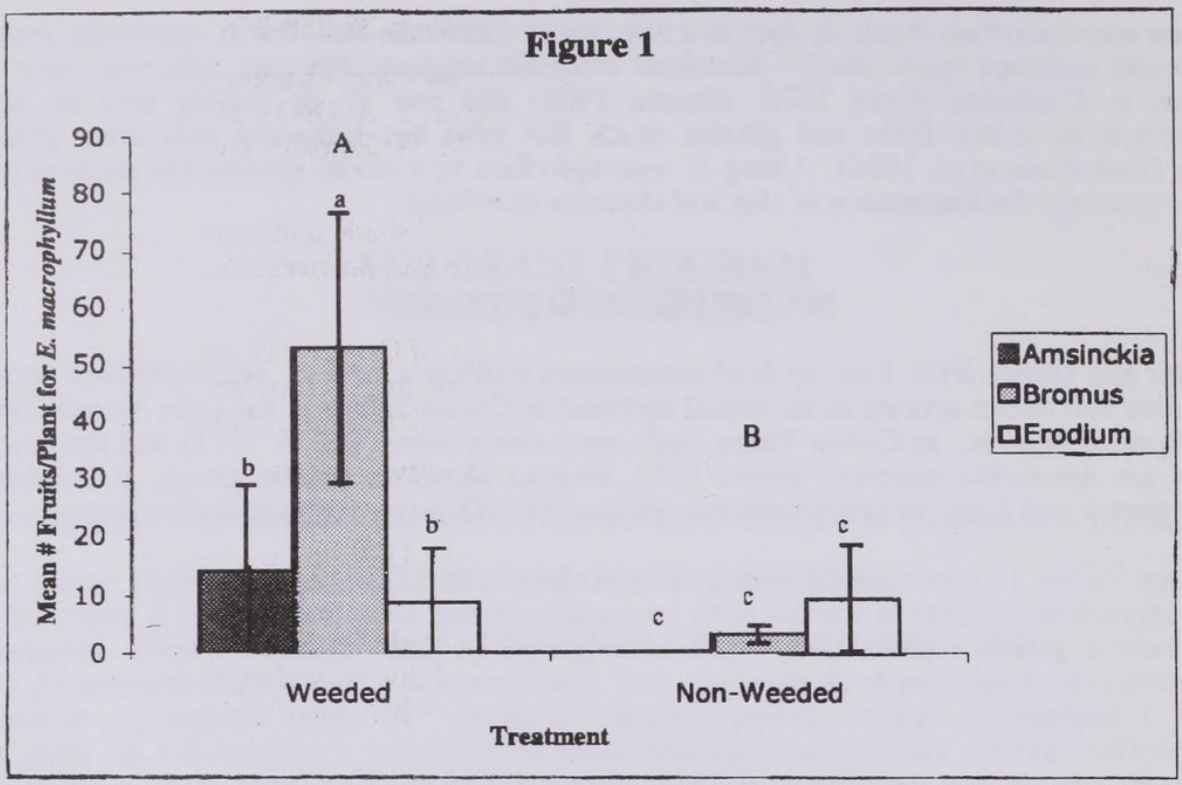

Figure 1. Mean fruit production as a function of different background matrix species within weeded and non-weeded plots. Difference in letters denotes a significant difference ($P<0.05$). Means and standard errors are shown ($N=5$).

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