Persistence of a fugitive species: *Mimulus angustatus* on gopher mounds

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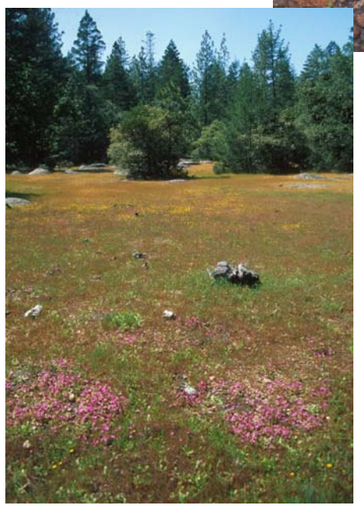
Introduction

Vegetation patterns in many plant communities are affected by disturbance, such as the freshly tilled mounds of soil left by burrowing pocket gophers (Inouye et al. 1987, Hobbs & Mooney 1991, Seabloom & Richards 2003). Gopher mounds have been shown to affect germination, growth, and reproduction, and these effects can be either positive or negative (e.g. Forbis et al. 2004).

Mimulus angustatus (Gray) (Scrophulariaceae) is a small annual (basal rosette 1 – 3 cm diameter) found in California foothills.



Successfully reproducing *M. angustatus* appear to be restricted almost entirely to recently disturbed patches of soil.

Disturbances also suppress populations of grasses and forbs that are likely competitors of *M. angustatus*.

Questions

- How do disturbances affect *M. angustatus* directly through effects on individual plant growth and survival?
- How do disturbances affect *M. angustatus* indirectly through reproductive success?

Materials and methods

We used permanently marked 20 x 20 cm quadrats to follow the success of *M. angustatus* over 1 to 6 years (1999 – 2004) at Las Posadas State Demonstration Forest in Napa County, California.

For each quadrat we recorded:

- the number of *M. angustatus* plants and flowers
- beginning in 2000, the size of *M. angustatus* flowers
- the densities of potential competitors (e.g. *Lasthenia californica*, small annual grasses)
- the % cover of bare soil

We classified quadrats as "undisturbed" (no fresh disturbance, < 15% bare soil), "naturally disturbed" (by pocket gophers, > 15% bare soil), or "artificially disturbed" to mimic gopher mound creation (100% disturbed). We created artificial disturbances in mid-winter. The effects of natural and artificial disturbances were not significantly different, and have been lumped together. Disturbed quadrats were paired with adjacent undisturbed controls; additional undisturbed plots were randomly located.

Fig.1 A pair of control and experimental-disturbance quadrats.

Results

Number of plants

- Quadrats with recently disturbed soil had significantly more *M. angustatus* plants, and fewer potential competitors (*L. californica*, annual grasses) than undisturbed quadrats.
- The effect of a single disturbance event on *M. angustatus* numbers persisted for several years, as the % cover of bare soil decreased and numbers of other plants recovered (Figure 2).

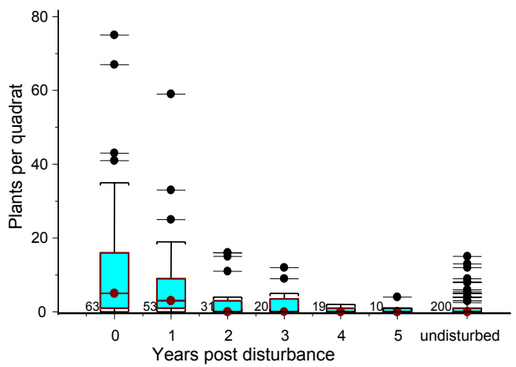


Fig. 2 The number of *M. angustatus* plants per quadrat decreases each year following a disturbance (P < 0.001). Numbers beside boxes are sample sizes.

Flower size

- *M. angustatus* flowers were significantly larger in disturbed quadrats, and this effect persisted beyond the year of the original disturbance (Figure 3).

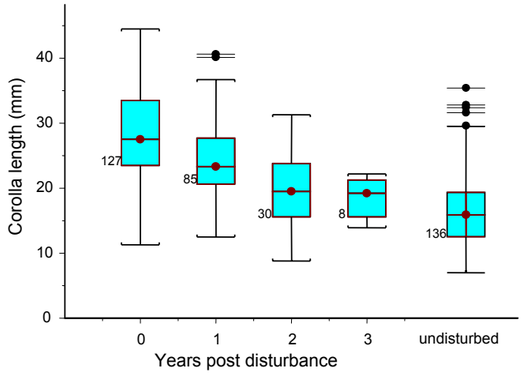
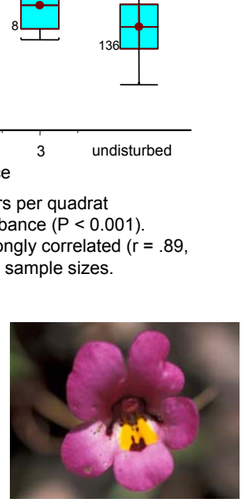


Fig. 3 The size of *M. angustatus* flowers per quadrat decreases each year following a disturbance (P < 0.001). Corolla length and flower width are strongly correlated (r = .89, P < 0.001). Numbers beside boxes are sample sizes.

Pollination success



Because seed production by *M. angustatus* is pollen limited (Underwood & Inouye, unpublished data), in 2003 we collected data on pollination success. The number of bright yellow *M. angustatus* pollen grains on the purple stigmatic surface was counted in the field using a 10x hand lens.

- The amount of pollen on *M. angustatus* stigmas was affected by flower size and the local density of conspecific flowers (Figure 4).

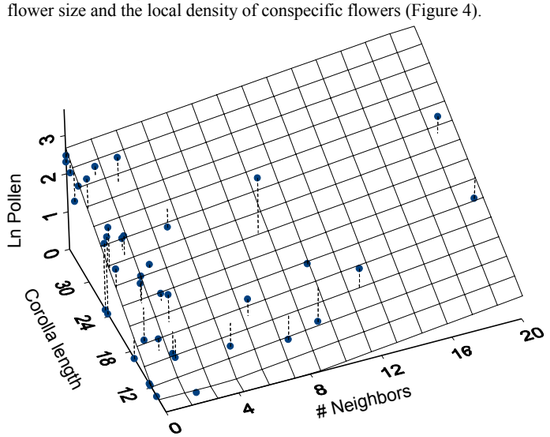
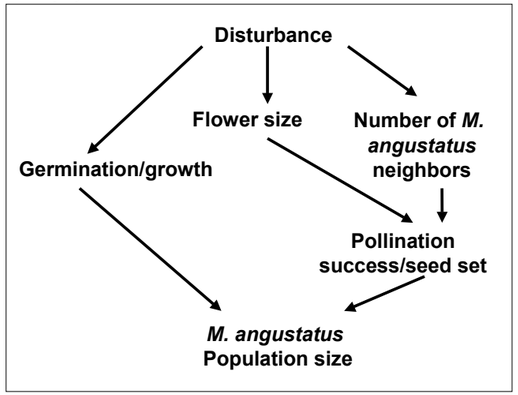


Fig. 4 The number of pollen grains on *M. angustatus* stigmatic surfaces increases with flower size (P < 0.001) and the number of other *M. angustatus* flowers within 10 cm of the focal plant (P = 0.026).

Conclusions

Disturbance is important for at least two critical life-history stages of *M. angustatus*: germination/growth, and pollination/ seed set. While effects of disturbance on plant germination and growth have been well studied, effects on plant reproduction via changes in both individual and patch floral display are less well known.



Mimulus angustatus recruitment is affected by local disturbances through both paths shown above. We plan to use a demographic model to investigate the relative importance of these paths for population dynamics, using field data on the annual distribution of new gopher disturbances.

Indirect effects of disturbance on the dynamics of small annuals through changes in local floral display may be important for other species well. Other small *Mimulus* species appear to have a similar dependency on recurrent disturbance (e.g. *M. jepsonii*, *nanus*, *pilosus*, *tricolor*, pers. obs), and pollinators can respond to the local density of plants (Groom 1998) as well as traits of individual flowers.

Literature cited

Forbis, T. A., J. Larmore and E. Addis. 2004. Temporal patterns in seedling establishment on pocket gopher disturbances. Oecologia **138**: 112 – 121.

Groom, M.J. 1998. Allee effects limit population viability of an annual plant. American Naturalist 151: 487 – 496.

Hobbs, R. J. and H. A. Moony. 1991. Effects of rainfall variability and gopher disturbance on serpentine annual grassland dynamics. Ecology **72**: 59 – 68.

Inouye, R. S., N. J. Huntly, D. Tilman, and J. R. Tester. 1987. Pocket gophers (*Geomys bursarius*), vegetation, and soil nitrogen along a successional sere in east central Minnesota. Oecologia **72**: 178 – 184.

Seabloom, E. W. and S. A. Richards. 2003. Multiple stable equilibria in grasslands mediated by herbivore population dynamics and foraging behavior. Ecology **84**: 2891 – 2904.

Acknowledgments

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