

Abiotic influences on the behaviour of rodents, ants, and plants affect an ant-seed mutualism¹

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Arid environments are characterized by striking changes in temperature, moisture, and light regimes. These changes influence the foraging of arthropods and vertebrates. For example, many ant species in arid environments respond to increases in temperature, moisture stress, and light intensity by increasing the proportion of nocturnal activity (Whitford & Ettershank, 1975; Briese & Macauley, 1980) or by altering their daytime foraging (MacKay & Mackay, 1989; MacMahon, Mull & Crist, 2000). The foraging patterns of desert mammals and

arthropods can also change with the phase of the lunar cycle, perhaps indicating avoidance of visually-hunting predators during periods of greater illumination and hence vulnerability (Kotler, Ayal & Subach, 1994; Tigar & Osborne, 1999). It is well appreciated that ants and mammals compete for seeds in arid environments (Brown & Davidson, 1977; MacMahon, Mull & Crist, 2000) and that a seed's likelihood of being collected by either group differs among seasons (Pulliam & Brand, 1975). This study focuses on seed collection and competition during a shorter time scale, the 24-h cycle, and how the responses of ants, mammals, and maternal plants to the changes in the abiotic environment during that cycle influence seed fate.

The seeds of *Datura wrightii* (Solanaceae), a Sonoran Desert native, are collected by both ants and mammals.

wrightii by the seed-collecting ant community. Below, we discuss differences in seed collection by ants and rodents, the evidence for competition between those two groups, how the timing of seed presentation may favour collection by ant mutualists, and the fate of seeds subsequent to their collection by ants.

In our study, the total number of seeds removed from depots where ants and rodents foraged separately exceeded the number taken from depots where they shared access. This difference indicates that seed removal by one group may deprive the other of access to seeds (Heithaus, 1981). Competition among ants and rodents for seeds has been well documented in the deserts of the southwestern United States (Brown & Davidson, 1977; MacMahon, Mull & Crist, 2000), although in that setting both groups typically act as seed predators. Because ants collect *Datura* seeds to consume the elaiosome rather than the seed itself (O'Dowd & Hay, 1980), this inter-guild competition may rescue seeds from predation by small mammals. Competition was greatest at night, as rodents foraged most intensively during that period. The

secondary dispersal by wind or water. Unlike these passive flows, however, ant transport can also move seeds upstream or between washes (O'Dowd & Hay, 1980).

Ant-collected seeds arrive at the ant nest. After the elaiosome is detached and eaten, *Datura* seeds collected by harvester ants (*P. californicus* and *Veromessor pergandei*) are

