Competition in a rough neighborhood: Plant success in a desert environment

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Many people think of deserts as inhospitable places devoid of life, but numerous plants and animals have adapted to this harsh environment, where they often compete for limited resources. In desert environments, the most limited resource is usually water, forcing plants to adopt different strategies to compete with their neighbors for this precious resource.

In natural environments, water availability is often stochastic—some years and localities receive lots of rain, while other areas and times remain dry. During dry years, plants that are more efficient with water use often are the most successful. With this success comes a trade-off; in wetter years, these efficient plants may struggle against faster-growing plants.

For deserts, variable weather is common so that plant community patterns can change between wet and dry years, with high densities and a diversity of plants in wet years, and a reduction in both quantity and number of species in dry years. The effect that two important variables have on plant communities—competition and water usage—was investigated in the Sonoran Desert by a research group at the University of Arizona and published in a recent issue of the *American Journal of Botany*.

Jennifer Gremer and colleagues looked at three widespread and abundant plants native to the Sonoran Desert that use different strategies to cope in this variable desert environment by occupying different

positions on a trade-off spectrum between relative growth rate and water use efficiency. They interpreted how well plants responded to different conditions, such as high and low water availability and competition, by measuring plant biomass of shoots, stems, and roots.

With the onset of climate change, the deserts are getting hotter and drier, and have been a focus of global change models. "The Sonoran Desert has already begun to exhibit such changes," explains Gremer. "Specifically, the composition of plant communities has changed over the last 30 years, with species that have high water-use efficiency becoming more common and species with high relative growth rates declining."

The research showed that all species did better in wet environments when grown alone; however, water availability had additional effects when competition was included. Species that have faster growth rates were less affected by competition in wet environments, whereas those more efficient with water were less affected in dry environments.

"These observed effects explain the patterns seen in long-term data and are counterintuitive to many readers because some plants might actually do better when conditions are not optimal," explains Gremer. In most settings of this research, though, the intermediate species had the largest competitive effect of all species. The intermediate was also observed to have a high level of intraspecific competitiveness, suggesting a reason why the intermediate does not competitively exclude other species.

Their results demonstrate that some plants are better at competing in wet environments, while others are better in dry environments. They were able to predict this pattern by looking at important characteristics, efficiency of water use and growth rate, to determine how they would react to limited resources. This has implications on future studies. According to Gremer, "A major challenge in ecology is to find traits or characteristics that can be used as indicators to predict how plants will

respond without having to study each and every individual species. In our system, we have had remarkable success at doing that." However, these traits may not be the most important factors in all systems. Increased understanding of how these traits mediate competition under different conditions, for both native and non-native plants, is important considering the threats of climate change and invasive species.

"We need to understand the role of competition and water availability in long-term patterns of diversity in our system," Gremer said. "This has implications for understanding responses to climate change and predicting what these communities will look like in the future."

More information: Gremer, Jennifer R., Sarah Kimball, Katie R. Keck, Travis E. Huxman, Amy L. Angert and D. Lawrence Venable. 2013. Water-use efficiency and relative growth rate mediate competitive interactions in Sonoran Desert winter annual plants. *American Journal of Botany* 100(10): 2009-2015. www.amjbot.org/content/100/10/2009.full.pdf+html

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