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Sonoran Desert Plants Climb Warming Santa Catalina Mountains

A University of Arizona husband-wife team of scientists has documented a significant shift in where plants flower in the Santa Catalina Mountains north of Tucson as average temperatures have risen in the Sonoran Desert. The study, by ecologist Theresa Crimmins and climatologist Michael Crimmins, found that the flowering range of 93 out of 363 plants studied migrated significantly during the 10-year period from 1994 through 2003 compared with the previous decade (published online 4 December 2008 in *Global Change Biology*).

The plant migrations came as average temperatures recorded at six weather stations in the Tucson area rose 1 degree Celsius during the study period. Although the Crimminses cannot prove global warming caused the shifts, their findings represent the latest scientific research to tie the migration of plant or animal species to rising temperatures. Their findings also fit the predictions of various computer models of global warming, Michael Crimmins says.

The Crimminses did not generate the data used in their study. Rather, the data were collected by amateur naturalist C. David Bertelsen, a retired university administrator and probation officer who lives in Tucson. Bertelsen gathered the data by observing plants growing along the Finger Rock Canyon Trail in the Santa Catalinas, a trail he has hiked on average at least once a week since 1981. The trail totals 16 kilometers round-trip, but climbs more than 1250 meters through desert scrub and grasslands to oak-and-juniper woodlands and pine forests, reaching an elevation of 2212 meters.

"Curiosity," says Bertelsen, explaining his interest in plants. "I started photographing flowers. Then I wanted to know what I was taking pictures of. And then I wanted to record the plants I saw. I wanted to see what was there. The more you look, the more you see the patterns." Of Finger Rock Canyon, Bertelsen says simply, "I'm in love with it. Every trip [on the trail] is new and different. I can't imagine ever getting bored there."

Beginning in 1983, Bertelsen recorded (in five one-mile segments) where and when along the Finger Rock Canyon trail he found flowering plants as well as where he saw various animals. Since then, he has hiked the trail more than 1200 times and made more than 111,000 observations of nearly 600 plant species. "That's a very rich data set," proclaims Theresa Crimmins, who works at the University of Arizona's Office of Arid Lands Studies. "It's a gold mine for a scientist."

Moreover, Bertelsen recorded where all the plants that he saw were flowering, not just a few key species. "That's an amazing effort," Theresa Crimmins states. "I did not want his effort to go to waste. I didn't go looking for [Bertelsen's data set], but I did not want to let the opportunity pass by."

Actually, it almost did. Bertelsen's work was first reported in *High Country News* in 2001, but the Crimminses did not hear of it until a Regional Partnership System meeting two years later. At that meeting, Michael Crimmins, an assistant professor of climatology, gave a talk about climate change and the need for long-term data. After the meeting, Bertelsen told the group about his 20-year data set. "His eyes lit up," Bertelsen says of the scientist's reaction.

From the nearly 600 plant species in Bertelsen's data set, the Crimminses picked 363 for which there were sufficient data to make comparisons for the entire 20-year period. Of the 93 species that shifted their range significantly, most were perennials, Theresa Crimmins says. Of those, 47 expanded their flowering range uphill: 35 moved their upslope range uphill while their downslope boundary remained the same, and 12 moved both their upper and lower flowering boundaries uphill. Two species expanded their range both uphill and down, and 19 others expanded their flowering range downhill.

Beyond showing how different plants respond to rising temperatures by shifting their ranges, the data suggest that plant species react individually to climate changes, so that scientists cannot predict which plants will move which ways. As a result, existing community composition of plants will likely change, Theresa Crimmins says. Plant communities are "ephemeral," she adds. "They won't stay the same."

On a more personal level, Theresa Crimmins says, the study "changed my career." She has since become involved with the USA National Phenology Network (*www.usanpn.org*), which gathers observations—from citizens and scientists, amateurs and professionals, young and old—of seasonal events, such as leafing and flowering of plants and migration and reproduction of animals. "Now I want to look at how biological communities respond to changing conditions."

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