

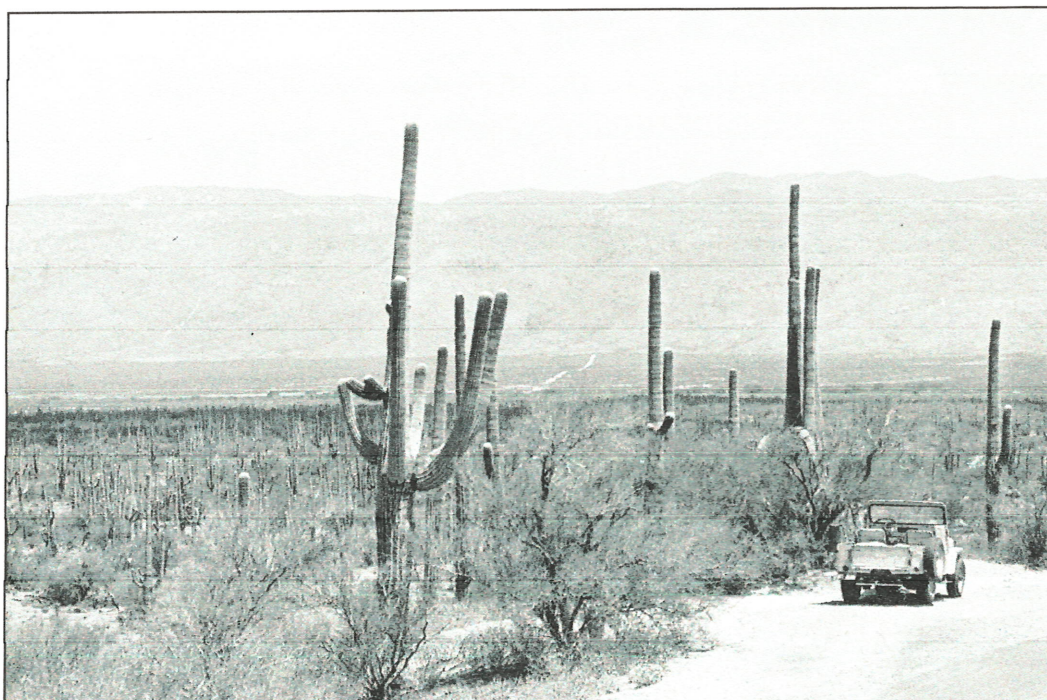
A New View of Saguaros

JEFFREY P. COHN



The photograph above and the two on the following pages were taken from the same spot in the eastern division of Saguaro National Park in 1935, 1960, and 1995, respectively. They show how plant communities in the Sonoran Desert near Tucson, Arizona, change over time. The view is to the north, with the Santa Catalina Mountains in the background. Photograph: National Park Service (photographer unknown).

Ray Turner aims his camera with great care at a precise spot on a nearby ridge at Saguaro National Park, east of Tucson, Arizona. First, Turner makes sure that two large saguaros—one with four armlike branches reaching out and up, candelabra-style, and the other just a column with no branches yet—are aligned with the same Santa Catalina mountain peaks in the background in exactly the same position as in previous pictures. Then, carefully, Turner checks his position and camera direction with his compass and global positioning system. Finally, he snaps several pictures of the saguaros and their surroundings, just as he has done periodically since 1962.



The number of saguaros, especially old, large ones, has clearly declined in the quarter century between this and the previous photograph. Note that the large saguaro on the left in the 1935 photo on the previous page is not found in this picture from 1960 and presumably has died, but the one second from the left has added several new armlike branches on its left side. Photograph: J. R. Hastings, Desert Laboratory Repeat Photography Collection.

“We have photos from our study sites going as far back as 1867,” says Turner, a retired US Geological Survey (USGS) botanist and perhaps the foremost authority on saguaros. He pulls out a 1984 photograph of the same site that shows four large saguaros. Today, only the two remain. The 1984 photo also shows several palo verde trees that are now gone. In their place, prickly pear cacti glisten in the early morning sun. “These photos show how the desert changes over the years,” Turner says. “These sites are important for long-term research. They are among the oldest continually monitored plots in the world.”

Turner’s research and that of others has helped shed new light on saguaros and other columnar cacti, recording changes in their numbers over time and illuminating their relationship with other plants and animals. At the same time, their studies demonstrate how much scientists still have to learn about what is cer-

tainly the Sonoran Desert’s most-studied plant—and its most recognizable one.

Saguaros are the largest cacti in the United States. Averaging 30 to 40 feet in height and sometimes reaching 50 feet or more, they tower over most other Sonoran Desert plants. Among cacti, only the similarly shaped cardon of the Baja California peninsula and western Sonora in Mexico is taller, although some cacti in the Tehuacan Valley southeast of Mexico City are as tall. Saguaros range from Phoenix and Kingman in Arizona south through Sonora into northern Sinaloa in Mexico. A few grow west of the Colorado River in southeastern California, but none are found on the Baja peninsula.

For decades, some scientific and news media accounts have predicted the saguaro’s imminent demise. Enter Ray Turner, who has not only photographed saguaros at seven study sites in Arizona and two in Mexico but also recorded their population trends. At one typical 400-foot by 1000-foot site at Saguaro National Park, Turner found that saguaro

numbers declined from 209 in 1961 to 126 in 1973 to 100 by 1983. Some of the decline resulted from earlier cattle grazing and wood cutting within the park, which ended in the 1950s, says Mark Holden, a National Park Service biologist. Also, severe freezes in 1962 and 1978 killed many saguaros in some places, says Mark Dimmit, director of natural history at the Arizona Sonora Desert Museum in Tucson.

Researchers in the 1940s had blamed saguaros’ decline on a disease they termed *bacterial necrosis*. The disease turned out to be a largely noncontagious, natural rotting in aging saguaros that had been injured by subfreezing temperatures on cold winter nights or by lightning strikes. Later, in the 1970s, National Park Service plant pathologist Lance Evans warned that he thought saguaros were dying because of rising ultraviolet radiation, which produced a brown discoloration on their outer skin. But the discoloration turned out to be a natural process unrelated to UV radiation, which

had not increased at the Sonoran Desert's latitude. Instead, the browning was associated with aging: Older saguaros naturally lose spines, says Joseph McAuliffe, a research ecologist at the Desert Botanical Garden in Phoenix. Spines shade saguaros from the effects of sunlight.

Meanwhile, Turner noted that most dead saguaros were old plants that had probably been standing a century or more. Could the dense saguaro growth around Tucson and elsewhere reflect unusually favorable conditions from a time past? Turner checked Tucson rainfall records from the 19th century. He found *above-normal summer rains—the most important for saguaros, whose seeds germinate in July and August—occurred on average every 3 years from the 1860s (when weather records were first kept in southern Arizona) to the 1890s. Since then, above-average rains have fallen only every 11 years. “The dense saguaro stands were a legacy of those [19th-century] rains,”* Turner says.

But why for decades were scientists not finding many young saguaros that could eventually replace the older, dying ones? *In fact, saguaro seedlings are very difficult to find. They grow slowly, taking up to 5 years to reach one inch and 10 or more years to reach a foot. Additionally, nearly all saguaro seedlings that survive grow under the protection of a palo verde, ironwood, or mesquite tree, where they are hard to see. “The only way to find them is on your hands and knees,”* Turner says.

Analyzing data from study sites established a century ago at the Desert Research Laboratory on Tumamoc Hill in Tucson as well as from his own, Turner found that few if any saguaro seedlings survive most years, unless at least average summer rains are followed by mild winter temperatures at night and more rain for several years. *Such conditions occur only rarely,* Turner says. The result is population cohorts of similarly aged saguaros rather than a balanced one with plants of all ages. Recruitment of young saguaros comes in occasional spurts, often decades apart. One such spurt dates to the 1970s and early 1980s, when above-average rains led to an increase in saguaros at Turner's study site—the saguaros num-

bered 178 in 1989 and 242 in 2001. The latter figure is higher than the 1962 count but less than the number seen in photos from the 1930s. Separate field studies at Saguaro National Park by USGS researcher Dale Turner and by Thomas Orum, a retired University of Arizona researcher, show similar growth in saguaro numbers since the early 1980s.

Meanwhile, Theodore Fleming, a University of Miami biologist, became interested in the relationship between saguaros and their pollinators. Like many

other columnar cacti, saguaros produce large white or cream-colored flowers that open at night. Such flowers are usually pollinated by bats—for saguaros, cardons, and organ pipes, lesser long-nosed bats. But, unlike cardons, saguaro flowers stay open well into the afternoon, when bats are asleep. They also continue producing nectar and pollen during the day, a surprising fact given that the months when saguaros are in bloom—April through June—are the hottest and driest in the Sonoran Desert.



The most recent photograph in this series has only a few large saguaros, but it is too broad a picture to show the young saguaros that became established in the wet years of the 1980s and early 1990s. As a result, palo verde trees, creosote, and brittlebush appear to dominate this portion of the desert thorn scrub community, not saguaros. Photograph: R. M. Turner, Desert Laboratory Repeat Photography Collection.

Researchers have known since the 1920s that birds and honeybees as well as bats pollinate saguaros. Nevertheless, in a series of studies beginning in 1989 in Arizona and Sonora, Fleming found that successful pollination of most saguaros resulted from daytime visitors. On average, he found that bats contributed about 25 to 30 percent of saguaro pollination, not a trivial amount. But birds, especially white-winged doves, account for about 45 percent of a saguaro's seed production. In parts of Arizona beyond the range of the bats, birds and bees accomplish almost all of the pollination. Moreover, the bats preferred cardon flowers to those of saguaros where the two cacti's ranges overlap in western Sonora. Only in years when cardons flower later than usual do bats pollinate most saguaros.

Fleming made two further discoveries of particular interest, not about saguaros but about two other columnar cacti. First, he found that senitas, cacti whose arms look like organ pipes reaching up from the ground, were actively pollinated by a pyralid moth. The moth relies exclusively

on senita flowers. Not only does the moth pollinate senitas, but it lays its eggs on the flowers so the larvae can eat some of the resulting seeds. Only yuccas are similarly actively pollinated by moths. Second, Fleming found that cardons have not one or two sexes like most plants, but four: complete with both male and female organs, male alone, female alone, and neuter. The neuter plants produce sterile flowers. Cardons are the only known plant species with neuters, he says.

In yet another area of research, James Mauseth, professor of integrative biology at the University of Texas–Austin, wondered how saguaros and other large columnar cacti could grow so big. Saguaros survive Sonoran Desert droughts by absorbing huge amounts of rainwater and storing it in tissues in the center of their column and arms. Because saguaros have no leaves, photosynthesis is carried out in cells in the outer layers of the column and arms. Thus the photosynthetic cells, separate from the water-holding ones, are more vulnerable to dehydration, Mauseth says.

But in laboratory studies of saguaros and other columnar cacti, Mauseth discovered a set of vascular tissues he calls cortical bundles. The veinlike cortical bundles conduct water quickly from the center to the outer cells. "That is virtually unknown among other plants, even among other succulents like euphorbias," he says of the cactus-like Old World family of plants. "Without cortical bundles, saguaros could not have become as large as they have."

In the end, the scientific advances in understanding saguaros and their role in plant and animal communities have been made more rewarding by the sheer fun of doing research in the Sonoran Desert. "I love the desert," Fleming states. "You can see here in ways you cannot in tropical forests. Everything is open and viewable. You can do experiments and actually sit and watch what is happening."

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