FOURTEEN

Pollination in the Sonoran Desert Region

Stephen Buchmann

Most of the world's 330,000 flowering plants (angiosperms) have flowers that need pollination—that is, the transfer of pollen from the pollen-containing male anthers to the female stigma (see flower anatomy illustration on page 140). Some flowers can pollinate themselves (in other words, pollen is deposited on the stigmas of the same flowers). Most, however, require pollen from another plant of the same species. The biggest and best seeds—and strongest seedlings—result from pollination and subsequent fertilization with pollen from an unrelated father plant. Fertilization results not only in seeds but often in a fleshy, edible fruit growing around the seeds. These fruits (e.g., desert hackberry) provide essential food for birds and other animals.

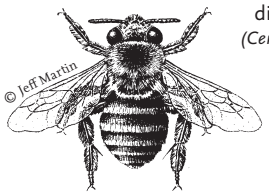
Since flowering plants are literally rooted in one place for their entire lives, they can't get up and find a mate like we do. Instead, they rely on animal pollinators or the wind as "go-betweens" to move their pollen around. Of course, flower visitors, like bees, aren't intentionally providing a mating service. Rather, pollinators are enticed to visit blooms so they can gather their sugary nectar and protein-rich pollen to feed themselves or their offspring. Certain flowers, like sunflowers, have exposed pollen and stigmas and can be pollinated by many kinds of insects. Sunflower heads are actually composed of hundreds of tiny flowers. Their open platforms reward many kinds of visitors, including flies, beetles, wasps, bees, and butterflies. Other flowers, such as those of the Southwestern pipevine, restrict their rewards to a much narrower set of pollinators.

The Sonoran Desert Region of Arizona, California, and Sonora, Mexico, is one of the richest areas in the world for native flowering plants. There are about 3900 vascular plant species known from the state of Arizona, with more than 650 documented in the Tucson Mountains alone. Accompanying this amazing floral diversity is an equally impressive diversity of insect and vertebrate pollinators.

Most of our desert plants are adapted to pollination by native bees, while others have adaptations that attract beetles, flies, wasps, butterflies, and moths, as well as vertebrates, including hummingbirds and bats. A few cast

Buzz Pollination

If you hike in the desert on an early morning, you may hear something that makes you think one of your companions just gave you the "raspberry." Instead, the comical noises you hear are made by bumble bees and other native bees using a specialized behavior known as *buzz pollination*. About 8 percent of the world's 330,000 flowering plant species have anthers that release their pollen only through small pores at the anther tips, which makes them look and function a bit like saltshakers. Bumble bees, digger bees (e.g., *Anthophora, Centris*), certain sweat bees (*Augochorella, Agapostemon, Halictus*), and the large carpenter bees turn themselves into living tuning forks and sonicate the pollen from these flowers! Honey bees can buzz as well, but they never use buzzing to harvest pollen.



digger bee
(Centris pallida)

Using their powerful flight muscles, the buzz-pollinating bees vibrate the stamens to collect pollen from the flowers. Female bees bite into an anther with their mandibles and hold on tightly while sonicating at frequencies between 200 and 400 hertz (which includes the musical notes A and C). A sonogram (sound print) reveals the lower dominant frequency and harmonic frequencies (overtones) rising to more than 10,000 hertz. (Actually, the harmonics are the same as those produced when a violin string is plucked or bowed.) When the anther is vibrated, the pollen sprays out in a few tenths of a second, hitting the bees on their undersides and between their legs. The pollen is accelerated with a force of up to 30 times the force of gravity!

The bees groom themselves, packing the pollen into special parts of their bodies, and then carry the protein-rich pollen back to their nests as larval food. Most of these "buzz flowers" produce only pollen, so the bees have to go elsewhere for nectar. A few crop plants must be sonicated by bees to set fruits. Tomatoes, peppers, eggplant, and kiwifruit have typical pollen-only buzz-pollinated blossoms, while blueberries and cranberries offer nectar plus pollen. If the right bees aren't in your garden, shaking the plants every day or so will effect adequate pollination. Tomato plants in greenhouses, including those in Arizona and Sonora, were once hand-pollinated by workers with electric toothbrushes, a labor-intensive task. Today they are pollinated by commercially reared colonies of the common eastern U.S. bumble bee species (*Bombus impatiens*).

In the Sonoran Desert, we have many kinds of plants with these pored anthers. The most common ones are members of the legume family (e.g., *Senna covesii, S. armata,* and *S. wislizeni*). Their bright yellow blossoms are visited by carpenter bees and *Anthophora* digger bees. Many nightshades, including silverleaf nightshade and Sonoran nightshade, are visited by early morning bees. Look at the bright yellow anthers on the flowers; the dark brown marks you see are "bee kisses," where female bees bit into them while buzzing out the pollen. Higher up, in the Sky Islands, manzanita flowers are sonicated by bees (*Andrena, Bombus, Xylocopa*).

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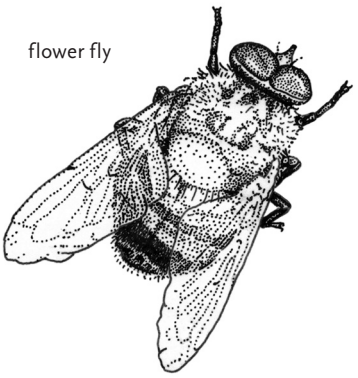
their fate to the breezes and rely on wind to move their pollen between plants. Jojoba, triangleleaf bursage, and canyon ragweed are all wind-pollinated.

Many of the adaptations between desert plants and their pollinators are unique, or are also found only farther south in the tropics of Mexico. Sonoran plants such as ratany and desert vine belong to families that offer chemically unique oils, in place of abundant pollen, as rewards for specialist bees in the genus *Centris*. The easy-to-miss, dark, ground-hugging blooms of Southwestern pipevine attract blood-sucking flies (see pipevine species account in

chapter 17). These "trap blossoms" hold the flies for a period and then release them, and the flies carry pollen to another flower. The flowers of Sonoran nightshade (a type of flower occurring on approximately 6–8 percent of flower species worldwide) have small pores at their anther tips. Female bees of some species cling to these flowers and vibrate with a specific frequency that propels the pollen out of the anther pores and onto the bee's body (see "Buzz Pollination" sidebar on page 125).

Flies and Beetles

Flies and beetles have been around since the origin of flowering plants (about 130 mya) and were some of the world's first pollinating animals. Beetles can commonly be observed feeding, mating, and defecating on composites (sunflower family) and other types of flowers. Wood-boring beetles in the family Buprestidae (e.g., *Acmaeodera*) are metallic and brightly colored, and they mimic bees in their behaviors and flight. They become dusted with pollen as they move from flower to flower. Small black rove beetles (Staphylinidae) are often found within the large blossoms of native and cultivated plants in the cucumber family.


flower fly

Flower flies, members of the large and diverse Syrphidae family, are bee mimics often found on desert flowers. Female flower flies (especially those in the genera *Copestylum, Palpada, Syrphus,* and *Sphaerophoria*) require the protein in pollen for their eggs, and they are frequently seen feeding on flowers. Their hairy bodies make them reliable pollinators since, like bees, the pollen gets caught between the hairs and is transported.

Bees, Wasps, and Ants

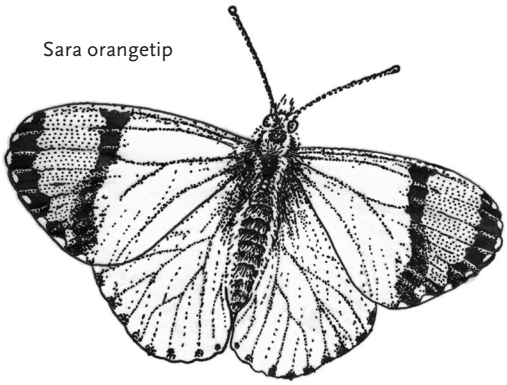
The insect order Hymenoptera (bees, wasps, and ants) contains the most insect pollinators. Bees are the dominant group of pollinators, and except for a few wasps, they are the only pollinators that actively collect pollen to feed to their broods. The state of Arizona has 1300 species of bees, more than a third of the total bee species (~3500) in the continental United States, and more than any other state. The Sonoran Desert Region probably has more native bee species than any other region in the world. Many of our bees are specialists, narrowly focused on feeding from the flowers of a single species or genus of plants. Cactus bees (*Diadasia*) are specialists on prickly pear cacti, globemallows, and sunflowers. The genus *Perdita* contains over 600 species of fruit fly–sized generalists and specialists, and they are commonly seen in large numbers on mesquite flowers. The large gray and black *Centris pallida* is a common visitor to palo verdes.

Tarantula hawks and other wasps are important pollinators of some desert plants, especially milkweeds. *Masarid* wasps (those relatively few wasp species that stock their nest cells with pollen and nectar) visit and pollinate *Phacelia* flowers, but with the exception of the masarids, wasps visit flowers for nectar only. They feed their offspring caterpillars, flies, and beetles, not pollen.

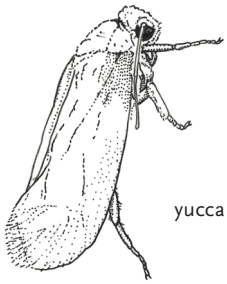
It is estimated that the Sonoran Desert Region has about 500 species of native ants; Arizona alone has recorded 335 species, more than any other state of the United States. Ants, especially *Crematogaster, Forelius,* and native fire ants (*Solenopsis*), are commonly seen visiting the extrafloral nectaries of barrel cactus and other plants. But these ants are defending the plants from their enemies, not pollinating them. Most desert ants are insignificant pollinators, because pollen sticks poorly to their smooth bodies.

Butterflies and Moths

August and September are the peak months for butterfly abundance in the Sonoran Desert, although there are common spring species like Sara orangetip butterfly. There are over 250 species of butterflies in the Sonoran Desert, and nectar is a critically important food for desert butterflies, but as pollinators, butterflies are not as efficient as bees and some other insects. They have long legs and their bodies don't acquire much pollen, although some pollen lands on their "tongues" (proboscides), and thus some transfer between flowers does occur.


Sara orangetip

Of the several thousand moth species in the Sonoran Desert, the large hawk moths (Sphingidae), including the hornworms (*Manduca sexta, M. quinquemaculata, M. rustica,* and *Hyles lineata*), are excellent pollinators of night-blooming plants like sacred datura and desert night-blooming cereus. The hawk moth diversity in southeastern Arizona is the highest in North America. Small moths are the pollinators of desert tobacco. Small moths in the family Prodoxidae (especially *Tegeticula*) are obligate pollinators of yucca flowers. These female moths actually gather pollen and place it on the floral stigmas. They lay their eggs in yucca ovaries and their caterpillars feed on the yucca seeds. Farther south, in Sonora, Mexico, the senita moth has a similar obligate pollination relationship with the senita cactus.


yucca moth

Hummingbirds and Bats

A remarkable 17 species of hummingbirds have been recorded in Arizona, more than in any other U.S. state. Some hummingbirds, like the rufous, are long-distance migrants between Alaska and southern Mexico. These hummingbirds follow the seasonal waves of flowering, tracking, feeding at, and pollinating their favorite red, yellow, or orange tubular blossoms (e.g., ocotillo, chuparosa, honeysuckle [*Anisacanthus*], fairy duster, and coral bean) along their north–south migratory corridors. Feisty male hummingbirds set up their territories near these blooming plants.

Although bats have learned to take advantage of our hummingbird feeders, their more natural resource is nocturnal blooms. The lesser long-nosed bat and the Mexican long-tongued bat are long-distance migrants, following the bloom of columnar cacti (cardón, organ pipe, and saguaros), agaves, and kapok trees from Sonora into Arizona and New Mexico. They make a significant contribution to the pollination of these plants (and you can thank them for your mescal). Several citizen science programs are now monitoring these nectar bats at flowers and bird feeders.

Beyond Pollination

Pollinators do much more for desert ecosystems than pollinate. For example, most of our native bees are ground nesters, excavating burrows in the soil and stocking their brood cells with pollen. Bee biomass is large in the Sonoran Desert,

per unit area, and bees' bioturbation aerates the soil and augments rainwater penetration. Female bees bring pollen and floral nectar into their nests as food for their offspring. The nitrogen-rich feces of the larval bees remain in the soil and nourish plants. Not only do their food and wastes improve desert soils, but the bodies of bees, flies, wasps, butterflies, moths, beetles, and others feed a variety of hungry vertebrates (birds, lizards, and mammals), as well as spiders and other invertebrates.

It is difficult to estimate the total value of pollination and other ecosystem services to wildflowers and other animals. For agricultural crops grown in the United States, however, the pollination services of native bees, other insects, and honey bees contribute at least $8 to $10 billion to the U.S. economy each year. In the Sonoran Desert Region, watermelons, cantaloupe, citrus, alfalfa, and various vegetables are among the important crops pollinated by bees. But honey bees and some native pollinators are on the decline.

In the Sonoran Desert, as elsewhere, human activities (such as agriculture, mining, and house and road building) take up the living, nesting, and feeding areas of many pollinators. Long migrations like those of the monarch butterfly are epiphenomena at risk. Tens of millions of these butterflies fly south from Canada and the northern United States to overwinter in oyamel fir forests in Michoacan, Mexico. (It takes three to five generations to migrate northward each spring and summer, but much of a single generation migrates all the way south into Mexico, starting the journey northward again in late February to reproduce.) However, early southbound monarchs sometimes pause in September to produce a new generation of monarchs in the Sonoran Desert, feeding on about 20 species of milkweeds. Their September–October newly hatched offspring will then fly on to the Mexican overwintering sites. (Some monarchs overwinter in coastal central California in Monterey pines and exotic eucalyptus trees; some also overwinter at the Rio Salado Audubon Center in Phoenix and at sites along the lower Colorado River.) Efforts to eradicate milkweeds are endangering this beautiful insect, whose populations have declined by 90 percent in the past decade. Pesticide and fungicide use in agriculture can also spill over to hurt pollinators (see chapter 13). Invasive plants and animals (including some exotic bees), along with introduced diseases and parasites, threaten other pollinators.

While urban and residential landscapes provide some habitats and floral resources, they do not entirely replace the richness and diversity of habitats for insect and vertebrate pollinators. Nevertheless, using native plants in a residential pollinator garden can provide great opportunities to enjoy these fascinating animals. There are many online resources for learning about Sonoran Desert pollinators and which plants to provide for them.

With the advent of close-focusing binoculars, many people now enjoy going "butterflying," identifying butterflies from a distance. The same thing is happening with some nonpollinators, such as the dragonflies. The Audubon Society, local chapters of the North American Butterfly Association—including Southeast Arizona Butterfly Association (SEABA) and Central Arizona Butterflies (CAzBA)—and other groups take members and guests on hikes to look for butterflies and other pollinators. Similarly, Feeder Watch is a citizen science program that monitors migrant and resident hummingbirds within Arizona and other states. The USA National Phenology Network, based at the University of Arizona, has volunteer observers in the Southwest and across the United States. From their data, and from scientists elsewhere, we know that many flowering plants now bloom one or more weeks earlier than ever before, presumably due to climate change. Shifts in bloom times by their flowering host plants may adversely affect pollinating animals.

Resources include (search for these online): the Pollinator Partnership; the North American

Pollinator Protection Campaign; the Xerces Society; Monarch Watch; Make Way for Monarchs, A Milkweed-Butterfly Recovery Alliance; the North American Butterfly Association; and USA National Phenology Network.

ADDITIONAL READINGS

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