

caterpillars may provide you with many virgin females and the means to conduct an interesting census of male moths in your area. Place female moths (usually distinguishable from males of the same species by having narrower, less comb-like antennae and larger, swollen abdomens) into small mesh or wire cages; position the cages along a trail, near a forest clearing, or on your porch; then observe. If males of this species are about, they should find their way to the cages in short order. When do they arrive? How abundant are they in suburban areas, as compared with rural habitats? Do males from more than one species arrive at the cages? If you are interested in moth breeding, this is an excellent way to attract wild mates and begin the life cycle anew.

BEES

Stephen L. Buchmann

Order: Hymenoptera

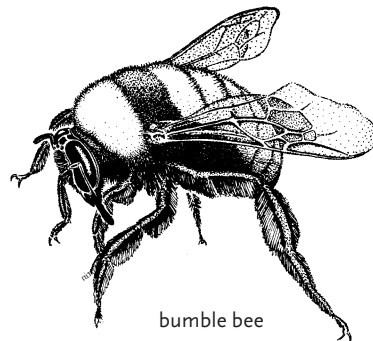
Families: Andrenidae, Apidae (includes all members of the former family Anthophoridae), Colletidae, Halictidae, Megachilidae, Melittidae, Oxaeidae

Common Sonoran Desert genera: *Agapostemon*, *Andrena*, *Anthidium*, *Anthophora*, *Apis*, *Ashmeadiella*, *Bombus*, *Centris*, *Coelioxys*, *Colletes*, *Diadasia*, *Epeolus*, *Exomalopsis*, *Halictus*, *Heriades*, *Heteranthidium*, *Hylaeus*, *Megachile*, *Melecta*, *Melissodes*, *Nomadopsis*, *Nomia*, *Osmia*, *Panurginus*, *Peponapis*, *Perdita*, *Psithyrus*, *Sphecodes*, *Stelis*, *Svastra*, *Tetraloniella*, *Triepeolus*, *Xenoglossa*, *Xeromelecta*, *Xylocopa*

Spanish names: abeja (bee), jicote, abejorro (bumble bee, carpenter bee)

Bees make up a highly diverse group in the Sonoran Desert Region. Superficially, bees (especially the parasitic bees known as cuckoo bees) resemble some wasps, except that bees are usually hairier and fatter, and they possess specialized structures for carrying pollen back to their nests. Bees also have branched (*plumose*) hairs on their bodies, which distinguishes them from wasps, which have unbranched

simple hairs (you need a hand lens to see this). Together with ants, bees and wasps form an evolutionary lineage referred to by taxonomists as the *aculeate*, or “stinging,” Hymenoptera; the stinger is called an *aculeus*. Among the aculeate hymenopterans, only females sting. The stinger evolved from the *ovipositor*, or egg-laying tube. Sonoran Desert bees range in size from the world’s smallest bee, *Perdita minima*, which is less than 0.08 inches (2 mm) long, to carpenter bees (genus *Xylocopa*), gentle giants with body lengths of almost 1 1/2 inches (40 mm) long that can weigh almost 0.04 ounces (1 g). Our native bees burrow into the ground, create nests, or use abandoned tunnels inside hollow, pithy, dried stems or abandoned tunnels left by wood-boring beetles. A few leafcutter bees (a grouping called *anthidiines*) construct small pebble and resin nests attached to twigs of creosotebushes and other plants. All bees are herbivorous except for parasitic forms that prey on other bees. Herbivorous bees feed on pollen, nectar, and oils offered as floral rewards by flowering plants. Bright metallic mason bees find unoccupied beetle burrows in dead trees and bring back mud to form partitioning cell walls between their larvae. Some bees are cleptoparasites on other bees; cuckoo bees, for instance, sneak into the nests of other bees to lay their eggs when the nesting female is away, similar to a cowbird laying an egg in another bird’s nest and letting the foster mom rear her chick. Most bees have solitary lifestyles in which females act alone to construct and provision nests, but there are also semi-social forms, such as the familiar large black carpenter bees (*Xylocopa vari-*



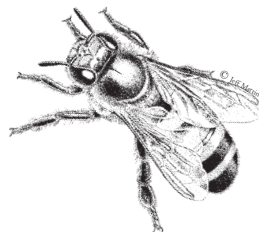
bumble bee

Africanized Bees

The infamous Africanized honey bee (sometimes erroneously called “killer bee”) closely resembles other North American honey bees; even experts have to examine them carefully to tell them apart. Africanized honey bees are about 10 to 15 percent smaller than other subspecies and races of *Apis mellifera*. They are called “Africanized” because they are the hybrid progeny resulting from the release of pure *A. m. scutellata* (the African honey bee) into the forests near São Paulo, Brazil, in 1956. They arrived in southern Arizona from Mexico in the early 1990s and quickly established feral colonies in rock outcrops, tree hollows, and saguaro boots. In cities, Africanized bees preferentially nest under sheds and in streetside concrete water-meter boxes.

Africanized or not, a few foraging honey bees are usually no cause for alarm. The only true danger is encountering an Africanized colony and provoking it. Stimuli that alert and engage the defensive guard bees are ground vibration, rapid movement, dark clothing, and the carbon dioxide in exhaled breath. If a colony is apt to be provoked, stay clear of it and contact a beekeeper

or pest control company. Often, a guard bee will bounce off your head without stinging. This is a warning that more bees and stings may follow. Do not swat at the bees. Walk calmly out of the area. If you are attacked by numerous Africanized bees and are being stung, pull your shirt or blouse over your face to protect your eyes. Hold your breath if you can and get out of the area. Unfortunately,



Africanized bees may continue to follow and try to sting you for up to ¼ mile (0.4 km). Do not jump into a swimming pool or lake to escape them. Get indoors as quickly as possible; an automobile is a safe retreat. Don't worry about bringing in a few bees with you; they will soon disperse and fly toward a lighted window.

puncta) and the truly social, bright yellow and black Sonoran bumble bees (*Bombus pennsylvanicus*) of lower desert elevations.

DISTRIBUTION

There are at least 45 genera in 7 families, and likely 700 to 800 species of bees, distributed within the Sonoran Desert Region. We do not know the exact number because many bee genera are in need of taxonomic revision, numerous new species are being described, and bee surveys in many counties and for Sonora, Mexico, are incomplete. The region around Tucson, Arizona, is thought to host more kinds of bees than anywhere else in the world, with the possible exception of some deserts in Israel. The state of Arizona has 1300 native bee species. In the United States, there are about 3500 species of bees. On a global scale, there are approximately 20,000 named species, but it is likely

that another 5,000 or more or so still remain undescribed and unnamed by taxonomists.

ECOLOGY

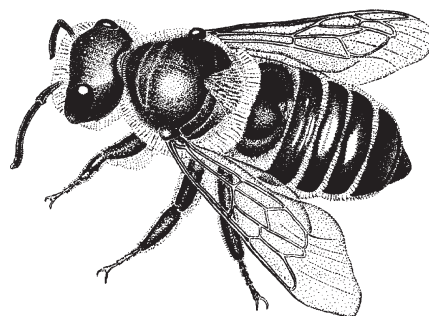
Bees are a highly successful group that evolved from wasps; they live in almost all terrestrial habitats within our region. Except for the parasitic cuckoo bees (including *Ericrocis*, *Xeromelecta*, and *Triepeolus* spp.), all female bees make their living by foraging in search of protein-rich pollen and sugary nectar from flowering plants. By moving pollen from flower to flower and plant to plant, bees perform vital and often underappreciated roles as the most important group of pollinating animals on Earth. Bees are an excellent example of the evolutionary fine-tuning of insect-plant symbioses: they are not out to “help” flowers; they simply collect pollen and nectar to feed themselves and their larvae and, in the process, facilitate pollination.

Of the approximately 640 flowering plant taxa growing in the Tucson Mountains near the Desert Museum, approximately 80 percent have flowers adapted for bee pollination. Similarly, at least 80 percent of agricultural crops, globally, require bees to move pollen between flowers. Many table foods—like those in the broccoli family, as well as carrots, squashes, onions, melons, cucumbers, peppers, eggplants, tomatoes, avocados, coffee, and many fruits and nuts, to name just a few—are pollinated by bees. But we depend on these “forgotten pollinators” not only for about a third of our global food crops (many are wind-pollinated), but for other products as well. Cotton cloth is one eventual product of bee pollination, as are many beverages and medicines made from fruits and seeds.

Without the pollination services bees provide, many plants would not produce seed-bearing fruits from which the next generation of plants would grow. Without bees, there would be few or no fleshy berries or fruits to sustain birds, mammals, and other wildlife. The tunneling activity (*bioturbation*) of bees helps aerate the soil and allows water to quickly penetrate and reach plant roots. Larval bees’ nitrogen-rich feces fertilize the soil. The bees are themselves food for lizards, mammals, birds, insects, spiders, and other arachnids.

In their daily foraging, bees harvest food-stuffs from flowers for themselves and their larvae. Pollen is a rich source of amino acids, proteins, fatty acids, vitamins, minerals, and carbohydrates. Nectar provides sugars for the energy boost that bees need to fly. Some desert bees (such as *Centris* spp.) have specialized scrapers on their legs for harvesting oils from glands on the undersides of specialized flowers (such as *Krameria* spp. and *Janusia* spp.). These energy-rich oils are mixed with pollen as larval food and are also used to help construct brood cells. Other bees collect small pebbles, plant hairs, or floral resins for use as building materials. Some bees, such as mason bees in the genus *Osmia*, also require water and mud, with which they construct their adobe-like nests.

Leafcutter bees (*Megachile* spp.) remove circular pieces of leaves to fashion into cell walls. Resin bees (*Heriades* and some *Megachile* spp.) collect resins from creosotebush and brittlebush to seal their linear nests in former beetle tunnels in dead tree branches.



leafcutter bee

LIFE HISTORY

Almost 80 percent of our native Sonoran Desert bees excavate burrows in the ground for their brood cells. Cells can be placed a few inches (5 cm) deep or 6 feet (2 m) or more in sandy soils. Many species line their burrows or cells with waxy secretions produced from the Dufour’s glands within their abdomens. This lining waterproofs the cells, maintains humidity, and keeps organisms like fungi from destroying the food and the developing larvae. Most bees are solitary and do not help one another. The life history for social bees, such as bumble bees, is very different.

Each female of the solitary kinds selects a site for her nest, excavates the tunnels, and forms and provisions the rounded cells with pollen and nectar. Usually the pollen balls are shaped by the female, and she lays a small white egg on the provision mass. She can make about one cell every day of her life. Most ground-nesting bees seal their brood cells with a spiral mud closure. This behavior is called *mass provisioning*, since the mother bee collects and prepares at one time all the pollen and nectar food each developing larva will need to complete its life cycle from larval stages to newly emerged adult. Not all bee larvae spin a silken cocoon, but

some do. After laying an egg in each cell, the solitary female has no further contact with her progeny. She dies and will never see her brood. Although solitary, many of our Sonoran Desert bees routinely nest with other females in very large aggregated nest sites. Among them is our common cactus bee (*Diadasia rinconis*), which pollinates prickly pear, cholla, and saguaro cacti. During the spring cactus bloom there may be thousands to hundreds of thousands of aggregated nests over an area the size of a tennis court.

Other native desert bees don't go to the bother of excavating their own nests. Instead, they seek the abandoned exit holes and tunnels of wood-boring beetles (usually buprestids and cerambycids) in dead limbs or standing dead trees. These bees are known by their common names of leafcutter (*Chalicodoma* and *Megachile*) and mason bees (*Osmia*). Once a beetle burrow is located, these females bring back cut pieces of leaves, resins, and pebbles or mud balls with which to fashion cells and their thick, protective capping plugs.

Most of our Sonoran Desert bees have a single generation per year, the adults typically emerging with the spring or summer wildflower blooms. Some species, however, have two or three generations per year. In a typical life history, adult males and females mate soon after emergence from their brood cells. Females construct and provision nests and lay eggs, and the larvae develop rapidly underground. During cooler months the larvae usually stay in a resting condition, or *diapause*, at either the *pre-pupal* or the *pharate* adult stage (the pupal stage just prior to the final molt and emergence as an active adult) until the following spring or summer, when they complete their metamorphoses and emerge as adults.

SOCIAL BEHAVIOR

A relatively small number of our desert bees are truly social. In the case of some sweat bees (Halictidae), a queen looks like other females in the colony, although she differs in having highly developed ovaries. She may or may not secrete

pheromones that elicit feeding and grooming behavior in her daughters. The queen lays all the eggs within the colony. Sweat bee colonies are usually small, consisting of a few dozen or at most a few hundred individuals.

Highly social bees in our region include the introduced European honey bee (*Apis mellifera*) and the native black and yellow bumble bees in the genus *Bombus*. Bumble bee colonies are annual, established by an inseminated queen that emerges from her winter retreat in spring and finds a suitable mouse nest or other underground cavity in which to nest. The queen is larger than her daughters and lays all the eggs after she has produced an initial small brood of workers. Males and queens are produced late in the season. They mate, the males die, and the inseminated queens spend the fall and winter "hibernating" below ground until the next spring.

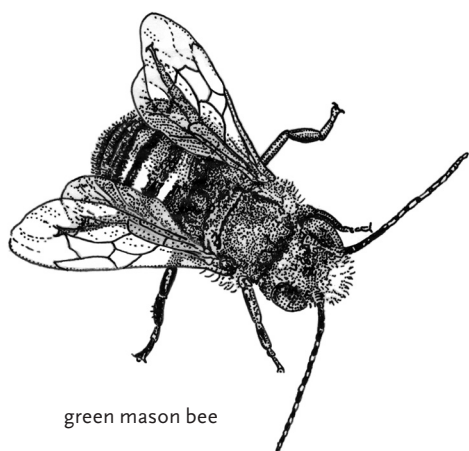
In Sonora, Mexico (near Alamos), and farther south, extremely social bees called "stingless bees" (*Melipona* and *Trigona* spp.) live in colonies with many thousands of individuals. (Although these bees do not sting, they can bite, and will, if their nest is disturbed.) These queens are *physogastric*, with abdomens swollen full of eggs. They are not able to fly once they begin laying eggs, and they will never leave the colony again. Thus, these social bees represent a still greater caste differentiation between queens and workers. Stingless bees store as much as several quarts (liters) of honey in waxen storage pots that look like clusters of grapes. Indigenous peoples, including the Mayans of the Yucatán Peninsula, find these nests in hollow trees and transport the log hives back to their villages, where they tend the bees and periodically harvest their honey and beeswax.

We can explore bee diversity by examining where bees live and which flowering plants they visit to collect food (pollen and nectar) and nesting materials (leaves, resins).

leafcutter and mason bees

Leafcutter bees and mason bees (the common names for many genera of bees in the family

Megachilidae) make up about 10 percent of our 1300 native Arizona bees species. Both groups of bees typically nest in abandoned tunnels in dead trees and limbs left by emerging beetles, although a few are ground-nesting. Female leafcutter bees do not eat, but cut elliptical pieces from thin leaves, including those of rosebushes

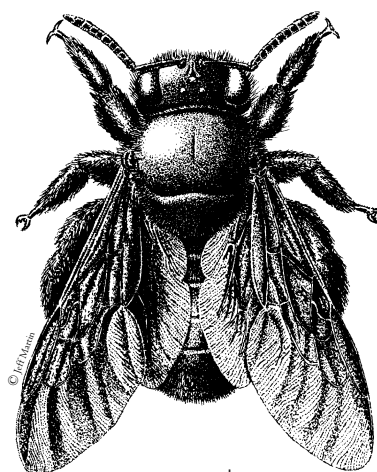


green mason bee

and other garden plants. They carry these back to their tunnel nests to serve as a protective lining for their brood cells and help maintain a constant humidity. Chemicals in the leaves help protect the eggs and developing bee larvae from microbial attack. Leafcutter bees are generally all black, often with faint white stripes on their abdomens. Species of the genus *Megachile* are the most common in our deserts, and they can be found visiting mesquite and palo verde trees. Females in the subgenus *Chelostomoides* can be recognized by their massive mandibles, with sharp cusps, which they use not only for cutting leaves but also for collecting plant resins from brittlebush and creosotebush. The resins are used to top off their nests as a deterrent for marauding ants. In the Sky Islands, shiny metallic green mason bees (e.g., *Osmia ribifloris*, which pollinates manzanita flowers) nest in abandoned beetle burrows and, as their name suggests, use mud to construct cell wall partitions. Leafcutter and mason bees generally have one or two generations per year in our area.

carpenter bees

Exceeded in size only by queen bumble bees, these large, mostly black bees have massive mandibles and excavate tunnels dime- to nickel-sized in diameter in sound but dead wood. Our most common low-elevation carpenter bee, *Xylocopa californica arizonensis*, nests in one- to two-year-old dead fruiting stalks of agave, sotol, and yucca. Females save some of the excavated sawdust from their linear galleries to form concave, spiral, “particleboard” cell partitions between their young. They lay a long egg on a pillow-like provision mass, and the larva consumes the entire mass before finally defecating and becoming a pupa. The pupae wait in their cells until the next spring, although in some cases a generation matures faster and a second generation is produced in the same year. These bees cause little damage to structural timbers (although they will burrow into large household wood structures). Females have short mouthparts and are often seen slitting the bases of flowers, including those of *Chilopsis* and *Tecoma*, to steal nectar without pollinating these flowers. The larger *Xylocopa varipuncta* nests in dead logs of sycamore and poplar, along with chinaberry trees in urban environments. Its golden males establish *leks* (communal mating sites) on hilltops. The males produce rose-like scents that attract females for mating.



carpenter bee

sweat bees

Sweat bees (Halictidae) are some of our smallest bees. These ground-nesting bees are black or bronze in color and visit a wide variety of flowering plants. *Halictus* and *Dialictus* are two of our most common genera. Attracted by salts, the tiny *Dialictus* species often land on the sweaty skin of hikers, drinking their perspiration. (If you don't notice them and flex your arm, you might be stung, but the stings are not very painful.) Bright metallic green bees (*Agapostemon* and *Augochlorella* spp.) are also common desert bees.



sweat bee

bumble bees

Arizona has far fewer native bumble bees than California and states farther north into the Rocky Mountains. Our most common low-elevation bumble bee, *Bombus pennsylvanicus* (formerly *B. sonorus*), is a large, brilliant black and yellow bee, with a broad black band across a yellow thorax. It is often seen visiting thistle flowers. Bumble bees are truly social, with a queen and a worker caste. They preferentially nest underground in rodent burrows or mouse nests. In urban areas, they often nest in abandoned human articles, in upholstery, or under discarded boards or utility sheds. Colonies are found in the spring and are annual, living only until the first frosts of the fall.

digger bees

Bees known as digger bees are ground nesters, or kleptoparasites. Common genera are the fast-flying, robust *Anthophora* and *Centris*. Squash and gourd bees (*Peponapis* and *Xenoglossa* spp.) are commonly found nesting in pumpkin and gourd patches, and these bees

Honey Bee or Bumble Bee Stings

If you are stung by a honey bee or bumble bee, remove the stinger immediately (with fingers or teeth, by scraping off with a fingernail, etc.) to prevent more venom from being delivered. (Don't take time to look for tweezers or other instruments.) Be alert in the first several minutes to an hour to any unusual symptoms that may represent a life-threatening situation. Difficulty breathing, dizziness, nausea, body rash, or intense itching are warning signs of a potential systemic allergic reaction in your body that, left untreated, could lead to anaphylactic shock and possible death. If you or someone you are with is stung and shows any of these symptoms, get yourself or them to an emergency room and medical treatment immediately (but don't drive recklessly). With anaphylactic reactions, prompt action is crucial. If you know you are allergic, you may already be carrying an EpiPen auto injector (epinephrine) and know how to use it. It should only be used in an emergency based on some or all of the above warning symptoms. The vast majority of people can easily withstand one or a few honey bee or other bee stings and only have minor discomfort. If, for example, you are stung on a finger or hand, you might experience pain for the first few minutes and, over a period of hours to days, intense itching, redness, and swelling (edema). You might even have swelling all the way up your arm. While uncomfortable, this swelling is not a life-threatening condition. Most people see their doctor and just take some pain-killer and perhaps Benadryl tablets for the itching. A simple home remedy for immediate sting pain is application of a paste of moistened table salt.

are specialist pollinators of these gourd plants (Cucurbitaceae). A large local bee, the gray and black *Centris pallida*, is a common visitor to palo verde flowers. Other members of the genus *Centris* are specialists, harvesting floral oils (as brood food) from plants including *Krameria* and *Janusia*.

honey bees

Honey bees (*Apis mellifera*) are not native to the Sonoran Desert but were purposely introduced into the United States (from Europe) over 400 years ago by the Plymouth colonists. These are truly social bees, with large colonies of up to 50,000 bees, headed by a single queen and with worker and drone castes. Honey bee colonies are managed by beekeepers and are our single most important pollinator of agricultural crops. In the Sonoran Desert, since about 1990, the Africanized race (hybrids of some subspecies of European honeybees with the African honey bee *Apis mellifera scutellata*) has established large feral populations within cities and in rocky desert outcrops. Most of the honey bees you see on flowering plants are Africanized honey bees.

WASPS

Justin O. Schmidt

Order: Hymenoptera

Suborder: Apocrita

Division: Aculeata

Families: Pompilidae, Mutillidae, Crabronidae, Sphecidae, Vespidae, Scolidae

Sonoran Desert genera: *Pepsis*, *Dasymutilla*, *Sphecius*, *Sceliphron*, *Polistes*, *Triscolia*

Spanish name: avispa

Wasps comprise an enormous and diverse assemblage of insects ranging from the smallest known insects—tiny parasites of insect eggs—to immense cicada killers and tarantula hawks. Most wasps are predators whose young feed on other insects or arthropods, but a few groups have become vegetarians, similar to bees, and collect pollen to feed to their larvae. Both sexes of wasps are typically strong fliers, but some species are flightless; in others, one sex, usually the male, is an excellent flier while the other sex is flightless.

Perhaps the most conspicuous and commonly seen wasps in the Sonoran Desert are the paper wasps (*Polistes* spp.). Paper wasps

are large (about 1 in/20–25 mm) social wasps that build paper honeycomb-style nests. Paper wasps and other wasps in Arizona don't produce honey, but the honey wasp in Sonora (*Brachygastra mellifica*) does store some honey in the combs. Paper wasps are longer, thinner, smoother, and shinier than honey bees and have longer, narrower waists (called *petioles*) than do bees. Common paper wasps include the yellow paper wasp (*P. flavus*), whose color is true to the name; the Navajo paper wasp (*P. comanchus navajoe*), which is deep chocolate brown with the end of the abdomen yellowish; and the Arizona paper wasp (*P. arizonensis*), which is slightly smaller and more spindle-shaped than the other two and is brownish-red with thin yellow cross bands on the abdomen.

Some of the most impressive insects in the Sonoran Desert are the enormous tarantula hawks (*Pepsis* spp.). These 1- to 1 3/4-inch (25–45-mm) wasps sport brilliant gunmetal, blue-black bodies carried by fiery orange or jet black wings. The desert contains about a dozen species.

Flightless female velvet “ants” (*Dasymutilla* spp.) are among the most colorful of all organisms in the desert. More than three dozen species live in the Sonoran Desert. They range in size from tiny, 1/8-inch (4-mm) species to huge, nearly 1-inch (25-mm) giants. Most are clothed in red, orange, yellow, or silver coats of hair-like *setae* (bristles) and look like moving fuzzy cotton balls. Particularly large velvet ants include the black and red magnificent velvet ant (*D. magnifica*) and Satan's velvet ant (*D. satanus*), which is black with a yellowish-white furry abdomen. The glorious velvet ant (*D. gloriosa*) is a long-haired, totally white velvet ant that looks like a creosotebush seed on legs.

Cicada killers (*Sphecius grandis*) superficially resemble huge yellowjackets or hornets. Yellow with tan patches, they are 1 to 1 1/2 inches (25–40 mm) long. These powerful fliers have large compound eyes.

Mud daubers (*Sceliphron caementarium*), sometimes called “dirt daubers” or “mud wasps,” are thin, 1-inch-long (25-mm) black