POLLINATORS

OF THE SONORAN DESERT

A Field Guide

Pollinators of the Sonoran Desert

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Produced in partnership by the Arizona-Sonora Desert Museum, the International Sonoran Desert Alliance, and The Bee Works.

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Foreword

The incredible beauty of southwestern landscapes exists because of pollinators. Plants and their pollinators began evolving their intricate dance of codependency over 100 million years ago with the origin of the flowering plants (angiosperms). They fine-tuned it during the Cenozoic era (beginning 65 million years ago) as flowering plants began to dominate all the world's living landscapes. These millions of years of plant-pollinator coevolution have produced a world in which flowers have their anatomy and scents finely tuned to their pollinator partners. In exchange for pollination services, flowers provide food (nectar, pollen), shelter, and chemicals used by insects to produce such things as pheromones (chemicals produced by animals and released into the environment to stimulate a behavioral response from another animal). The relationship between flowering plants and their pollinators is so intimate that, should pollinator populations decline (or worse yet, go extinct), the impact on their plant associates would be immediate and profound. Because pollinators are species upon which the lives of so many other species depend, they are regarded as "keystone species." Pollinators are thus essential to the stability of the global ecosystem itself. In fact, without pollinators, life on planet Earth would be very different.

Not only are our native plants dependent upon pollinators for their continued existence, but so are our crops. Eighty percent of the world's crop species, including food, beverage, medicine, dye, and fiber crops, rely on animal pollinators. The critical importance of pollination has been recognized since humans first gave up nomadic lifestyles. That great symbol of human-pollinator partnering, beekeeping, began long ago, at least by 600 B.C. in the Nile Valley and probably well before that. The first beekeepers were most likely Egyptians who floated hives up and down the Nile to provide pollination services to floodplain farmers while simultaneously producing a honey crop. Domestic honey bees (*Apis mellifera*), introduced to North America from Europe in the mid-1600s, now play a role in pollinating 80 percent of the crop varieties grown in the United States. However, the story is complex. Because European honey bees have been introduced worldwide they now compete with native bees (and other native insects) around the world, and it is now virtually impossible to find an area free of managed or feral honey bees. Honey bees out-compete native insect pollinators by overwhelming them with their sheer numbers and superior ability to detect and direct one another to pollen and nectar sources. Further complicating the story, at the same time that the United States has allowed itself to become dependent on domestic honey bees, U.S. populations of these bees are beginning to plummet due to exotic (introduced) bee parasites (e.g., mites, beetles), loss of habitat, use of

pesticides, and the invasion by highly aggressive Africanized bees (*A. mellifera scutellata*) into the United States (since 1990). The aggressive Africanized bees out-compete the European honey bees but do not pollinate all the same plants and crops. The direct competition between European and Africanized honey bees with native species is reducing the numbers of native pollinators, and it is adding to the pollination crisis that the world faces today.

Like many other animals on Earth, pollinators today face growing threats of extinction. Disruption of habitat, widespread and often inappropriate use of pesticides, and the development of certain genetically engineered plants further add to the crisis, as pollinating insects are locally extirpated and native plant and domestic crop reproduction and fruit production plummet. It is suspected that many thousands of pollinator species have become extinct over the past century as a result of worldwide, rampant land-use change and deforestation. With accelerating global biodiversity losses, estimates of the number of insect species alone that will go extinct by the year 2050 range into the hundreds of thousands. The impact on native plants and on crops cannot be predicted in detail, but will surely be enormous.

What can you do to help slow the loss of pollinators? In this book you will find some answers. Remember: everything you do to help pollinators will also enhance the quality of your own living space. By adding native plants and flowers to your yard and garden, creating oases that will attract hummingbirds, butterflies, and other beautiful wildlife to your home, you will create a natural "outdoor classroom" for you and your family to enjoy and learn from. Join the growing number of people who are working to protect pollinators while at the same time improving our overall quality of life.

Richard C. Brusca
Executive Program Director
Arizona-Sonora Desert Museum

Introduction

The purpose of this field guide is to inform Sonoran Desert residents about a few of the most common pollinators likely to be seen in both urban and rural areas, and the importance of these pollinators to the ecology of this arid region.* Animal pollinators include birds (primarily hummingbirds), certain bats, butterflies, moths, bees, and other insects that carry pollen from one plant to another and in doing so allow plants to produce fruit and fertile seeds. Pollination is important not only for crop production, but also for desert plants and maintenance of natural ecosystems.

More than 218,000 of the world's flowering plants, including 80 percent of the world's species of food plants, rely on pollinators for reproduction. However, 200 vertebrate and 10,000 or so insect pollinators are now globally at risk—meaning their numbers are decreasing to the point that this important function may be seriously diminished. The threats that pollinators face include the loss of habitat and the widespread use of pesticides and other chemicals.

Pollinator habitats are being lost due to a number of reasons. Land conversion, or the shift from natural landscapes to agriculture, and from agriculture to residential subdivisions, is one of the main causes of habitat loss. The introduction of exotic species, particularly those with invasive properties, can result in the colonization of natural desert areas and endangers or crowds out native plants that provide food for pollinators. Large areas, particularly in Sonora, Mexico, have been converted to exotic grasslands (primarily buffelgrass) and have greatly decreased the availability of food plants for hummingbirds and other important pollinators. These introduced grasses also spread fire, which can kill native cacti and other desert plants.

While some pollinators are residents, others are migratory and travel long distances through areas with varied land uses and through both public and private lands. Their travel routes, or nectar corridors, are a distinctive type of migratory corridor that pollinators follow to take advantage of a sequence of plants coming into bloom along a south-to-north gradient in the spring, and reverse in the fall. These flowers provide nectar and pollen (for bats) that give them energy during their flight. Because of the fragmentation and loss of habitats, these migratory routes are becoming endangered.

Because pollinators feed from flowers and are attracted to agricultural plants and gardens, they are also susceptible to injury from pesticides and chemicals. Agricultural chemicals applied to kill pests also kill some

* Refer to the glossary for any unfamiliar terms.

insects necessary for crop production—the bees and other insects needed for pollination. In home gardens, too, people may not be aware that the chemicals they use to protect their plants and lawn may endanger the birds and insects attracted to their gardens.

In this guide, you will learn more about the pollinators of the Sonoran Desert and what you can do to protect—*and create*—their habitats. It is important for people to learn about pollinators and their habitat in order to protect the Sonoran Desert. There are easy things you can do: avoid using chemicals in your garden that are harmful to insects; and plant neighborhood parks, gardens, and roadways with native plants that attract pollinators and provide food for them. Some people may also choose to put out feeders and water to augment the natural habitat. Researchers believe that even small patches of native food plants, such as your garden, can make a tremendous difference to pollinators along their migratory route.

Creating Habitat with Pollinator Gardens

Pollinators have specific adaptations that make them highly effective in their work—such as brush-like tongues, long thin beaks, or tiny hairs on their bodies that collect pollen and allow it to be carried. Plants that need pollination are usually adapted to attract a narrow range of species that can pollinate them. Flowers attract pollinators (often with bright colors and sweet smells) and provide rewards (nectar or pollen) to those that visit them. Nectar is a high-energy, mostly sugar solution that provides energy for flight; pollen is rich in essential amino acids needed for maintaining animal tissues and raising young. Distinctive flower shapes make the nectar (which is expensive for the plant to produce) accessible only to those animals adapted to get it and to pollinate at the same time.

Although we have displaced some native Sonoran Desert habitats with cities, we can restore habitat by planting gardens around our homes and schools, and in our communities. The main elements of habitat are: food, water, shelter, and space—the territory needed to reproduce and raise young. The best gardens will include all these elements.

Food

Pollinators are best adapted to feeding from native plants. Plants that are native to the soils and climate of the Sonoran Desert provide the best overall food sources for native wildlife, require less fertilizer and water, and will usually be less affected by pests. Insects attracted to the garden also become food for other insects, birds, and insectivorous bats. Be sure not to use chemicals that can harm the creatures in the garden. It is best to provide as much food as possible through native vegetation in order to meet the year-round needs of pollinators.

Supplemental food, such as hummingbird feeders, can ensure hummingbirds will visit throughout the year. If you choose to use feeders, be sure to:

- *Use only sugar* and not honey or other sweeteners. The nectar mixture should be four parts water to one part sugar. Red food coloring is not necessary—and can even be harmful. Choose a feeder that has red or yellow parts to it, or tie strips of red cloth to attract hummingbirds.
- *Clean* feeders at least once a week, and at least twice a week in warm weather. Do not use ammonia-based cleaners, but soak them overnight in a mild detergent (or weak bleach solution). Rinse well.

Water
Every living thing needs clean water. Although Sonoran Desert pollinators are adapted to our dry climate, they still need water to drink and bathe. Drip irrigation or a patch of damp earth can provide water, salts, and other minerals for butterflies and bees. Hummingbirds sometimes bathe in moving water—water that drips or flows will attract them. If you water trees or shrubs high up so that their leaves drip, you might find hummingbirds "showering" under the falling drops or directly on the wet leaves.

Shelter
Just as people need a house to provide shelter and safety, pollinators also need shelter to protect them from predators and extreme weather. Often the same plants that provide food will provide shelter, though dead and dying plants or trees provide some of the best places for roosting and nesting. Trees, shrubs, and vines will provide shade, perching, roosting, and nesting sites. Constructed shelters, such as bee or bat houses, are also good additions to a garden; be sure to place them according to the species' needs.

Space
Territory is another important element for a complete habitat. Pollinators need a place to raise their young. Encourage nesting in your garden by ensuring the availability of nesting materials such as leaf litter on the ground, spider webs, downy plant fibers, or dead twigs and branches. Be sure to provide safe space for animals to hide from predators. Placing plants together creates overhanging branches and small refuges.

Photo by Charles Mann
Garden design by Carrie Nimmer, Phoenix

Planting a Pollinator Garden

Creating a pollinator garden can be lots of fun! Part of the fun is in enjoying its beauty and watching the animals it attracts, and part of the fun is in the planning and tending. To plan your garden, follow these steps:

1. ***Select a theme.*** What do you want to attract to your garden? Butterflies? Hummingbirds? A wide variety of animals? What you choose will ultimately guide your design and should be decided at the outset (see pages 14 and 15 for hints to attract hummingbirds and butterflies).

2. ***Select and inventory your garden site.*** Select a site that will be easy to see and enjoy. Take a good look at the site. Make a list of all the existing plants (including trees) in your garden that you want to include in your design. Make a note of where the shady parts are, and where the sun hits at different times of the day, or throughout the seasons. Look at physical attributes such as topography, fences, or rocks and think about how they might be incorporated into your design.

3. ***Select plants.*** Think about the kind of plants you want to use to attract pollinators and provide for their habitat needs—remember food for both adult butterflies and caterpillars (use the chart on pages 16 and 18 to assist you). Chose a variety of plants (preferably natives) that bloom at different times of the year and are of the colors and textures you enjoy. Next, think about the needs of those plants. Do they need sun or shade? How much water will they need? What kinds of soil do they need? You want to make sure that the site conditions match the plant needs. It is also a good idea to put plants with the same water requirements together so that you don't over- or underwater some. In this guide, we provide some ideas to help you choose plants, but there are many more available than what we have listed. Talk to experts at your local native plant nursery.

Hint: To be sure you get the plants you want, use the scientific name when buying or ordering from nurseries. Sometimes the same common name is used for different plants, and you may not get the one you want. ***Do not take plants from the wild!***

4. ***Design and refine.*** Once you have considered the above points, it is time to begin your design, and refine as needed. Assign each plant

the space it will need to grow; think about what plants to group together; and create a multi-storied habitat with trees, shrubs, and herbaceous plants. (If you have a very small space, a variety of low and tall plants can create a similar effect.) It may take some rearranging and refinement to get the elements balanced the way you want them.

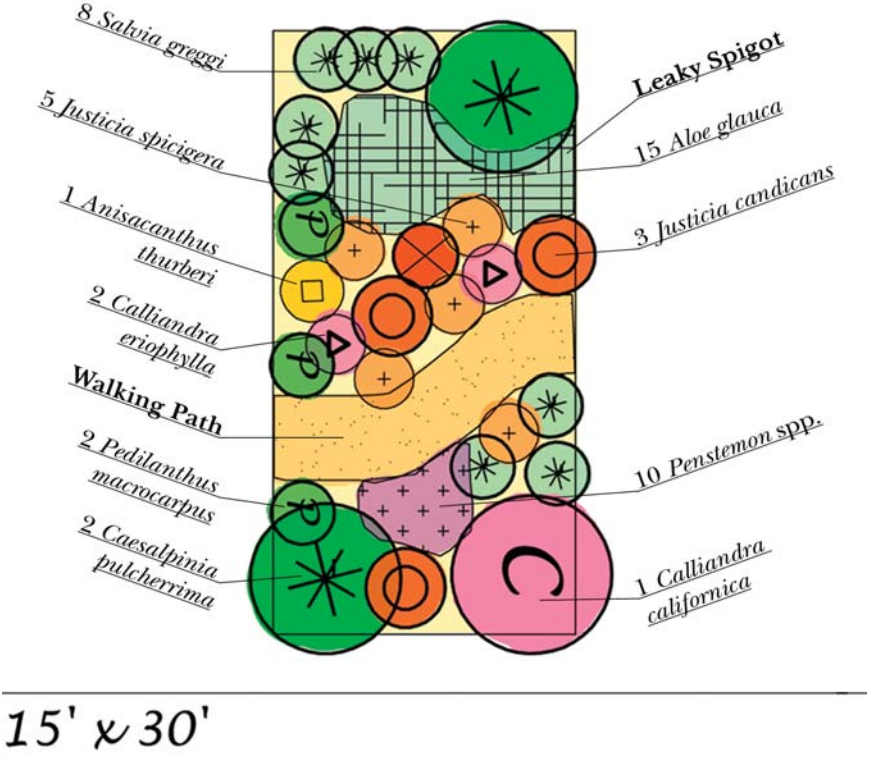
5. ***Final design and cost estimate.*** As you refine your design, be sure to think about the costs, including plants, decorative rock, stepping stones, water features, additional soil, or drip irrigation. To protect young plants, you may want to fence them with chicken wire to keep rabbits and other animals from eating them; this should figure into your cost estimate, too. Once you have done that, you can make any changes to your design or decide what features you want to add at a later time.

6. ***Plant the garden.*** Depending on the complexity of design and number of elements, you may want to divide construction into different tasks. Physical construction of beds, irrigation, pathways or other built features; planting and ensuring the establishment of new plants; and maintenance, such as watering, fertilizing, weeding, and pruning. Once your garden is established, observe what plants are used by pollinators and how. These observations will help you make revisions and improvements in your garden over time.

Photo by Charles Mann
Garden design by Carrie Nimmer, Phoenix

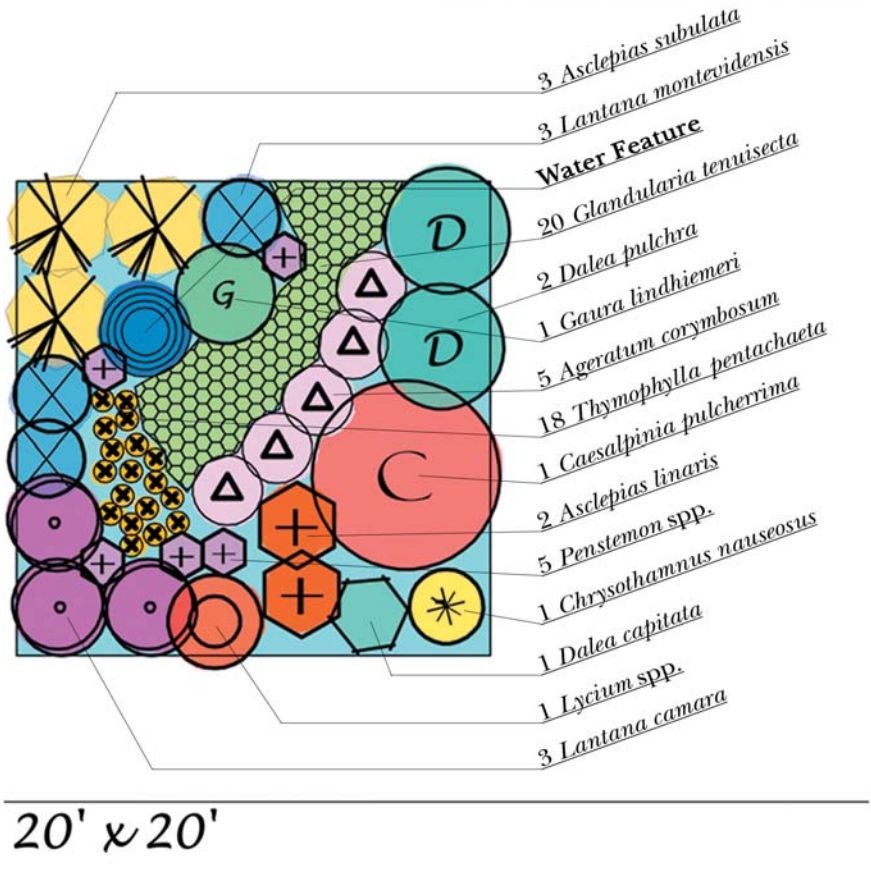
Hummingbird Gardens

- Allow open spaces for hummingbirds to view and defend their territory.
- Include moderately dense foliage for roosting and nesting, and horizontal branches for perches.
- Provide at least two widely separated areas where flowers will be in bloom at the same time—hummingbirds are very territorial and will defend food sites. The most aggressive bird will claim one territory, and the others will use the second.
- Be sure to plant a few nectar plants that will bloom in the winter, when Anna's and Costa's are nesting.
- Although water is important for birds, it is preferable not to have a fountain due to the high rate of evaporation—especially in the desert. Fountains and other permanent water sources use too much water and are labor intensive, needing almost daily cleaning to avoid parasites and disease.



Butterfly Gardens

- Butterflies prefer sunny areas protected from the wind.
- Select single flowers rather than double flowers; the nectar of single flowers is more accessible.
- Use large splashes of color in your design; butterflies are attracted to flowers by masses of color rather than by individual plants.
- Include host plants—these will attract female butterflies to lay their eggs and provide food for the caterpillars.
- Include damp areas or shallow puddles (from regular irrigation); butterflies cannot drink from open water.
- Place flat stones in the garden for butterflies to perch on, spread their wings, and bask in the sun.



Note: These pollinator gardens are hypothetical examples. You must verify the particular setting of your garden in order to make your own design.

Pollinator Garden Plants

Photos by Mark Dimmitt


desert willow


cosmos


desert milkweed


yellow evening primrose

Scientific Name	Common Name	Flower color	Type and Size
TREES			
Chilopsis linearis	desert willow		Tree to 25' tall x 25' wide
Pithecellobium flexicaule	Texas ebony		Tree to 30' tall x 30' wide
Prosopis velutina	velvet mesquite		Tree to 25' tall x 30' wide
SHRUBS			
Ageratum corymbosum	floss flower		Shrub to 3' tall x 3' wide
Anisacanthus thurberi	desert honeysuckle		Shrub to 6' tall x 4' wide
Antigonon leptopus	queen's wreath		Vine to 40'
Caesalpinia pulcherrima	Mexican red bird-of-paradise		Shrub to 8' tall x 8' wide
Calliandra californica	Baja fairyduster		Shrub to 7' tall x 7' wide
Calliandra eriophylla	fairyduster		Shrub to 3' tall x 3' wide
Gaura lindhiemeri	gaura		Perennial herb to 3' tall x 3' wide
Justicia candicans	red jacobinia		Shrub to 4' tall x 3' wide
Justicia spicigera	orange jacobinia		Shrub up to 3' tall x 3' wide
Lantana camara	lantana cultivars		Shrub to 3' tall x 8' wide
Lycium spp.	wolfberry		Shrub to 6' tall x 4' wide
Salvia greggii	autumn sage		Shrub to 3' tall x 3' wide
Sphaeralcea ambigua	globemallow		Shrub to 3' tall x 3' wide
Tecoma stans	yellow bells		Shrub to 12' tall x 8' wide
GROUNDCOVERS			
Calylophus hartwegii	yellow evening primrose		Groundcover to 2' tall x 2' wide
Glandularia tenuisecta	moss verbena		Groundcover to 1' tall x 3' wide
Lantana montevidensis	trailing lantana		Groundcover to 1' tall x 3' wide
Oenothera caespitosa	tufted evening primrose		Groundcover to 1' tall x 1' wide
Penstemon spp.	penstemon		Perennial herb to 1' tall x 1' wide
Thymophylla pentachaeta	golden fleece		Groundcover to 6" tall x 1' wide
ACCENT PLANTS			
Agave parryi huachucensis	Huachuca agave		Accent plant to 3' tall x 3' wide
Aloe spp.	aloe*		Accent plant to 3' tall x 3' wide
Asclepias subulata	leafless desert milkweed		Accent plant to 3' tall x 3' wide
Carnegiea gigantea	saguaro		Columnar cactus to 30' tall
Fouquieria splendens	ocotillo		Accent plant to 20' tall x 15' wide
Hesperaloe nocturna	night-blooming Hesperaloe		Accent plant to 4' tall x 4' wide
Hesperaloe parviflora	red flowered Hesperaloe		Accent plant to 3' tall x 3' wide
Mammillaria grahamii	pincushion cactus		Accent plant to .5' tall x .5' wide
Pedilanthus macrocarpus	slipper flower		Accent plant to 4' tall x 4' wide
Stenocereus thurberi	organ pipe cactus		Accent plant to 10' tall x 10' wide
ANNUAL PLANTS			
Cosmos sulfureus or cultivars	cosmos		Summer Annual from 2' to 7' tall
Glandularia gooddingii	Gooding's verbena		Winter Annual to 2' tall x 2' wide
Streptanthus carinatus	silverbells		Winter Annual to 2' tall x 1' wide

* Not native, but good food source

** In order of importance

organ pipe cactus

floss flower

penstemon

bird-of-paradise

	Water needs	Sunlight Needs	Flower Season	Pollinator (s)**
	Moderate	Full Sun	April to September	Bees, butterflies, hummingbirds
	Low to Moderate	Full Sun to Semi-Shade	Spring, Summer	Butterflies, bees
	Low to Moderate	Full Sun	Spring & late Summer	Bees
	Moderate	Sun or Filtered Shade	Spring, Fall	Butterflies, bees
	Low	Full Sun	Spring & sometimes Fall	Hummingbirds
	Low	Full Sun	Summer through Fall	Bees, butterflies, hummingbirds
	Moderate	Full Sun	Summer, Fall	Butterflies
	Low to Moderate	Full Sun	yearly unless affected by frost	Hummingbirds, bees, butterflies
	Low	Full Sun	Spring & sometimes Fall	Hummingbirds, bees
	Low	Full Sun to Part Shade	Spring, Fall	Moths, bees, butterflies
	Moderate	Full Sun to Part Shade	Fall, Winter, Spring	Hummingbirds
	Moderate	Sun or Filtered Shade	Fall through Spring	Hummingbirds, verdins
	Moderate	Full Sun	Spring, Fall	Butterflies, moths
	Low to Moderate	Full Sun	Fall through Spring	Bees, hummingbirds, butterflies
	Moderate	Full Sun to Light Shade	Spring, Fall	Hummingbirds, butterflies, bees
	Low	Full Sun	February, March, April	Bees
	Moderate	Full Sun	Spring to late Summer	Hummingbirds, bees
	Moderate	Full Sun	Spring & late Summer	Moths
	Low to Moderate	Full Sun or Part Shade	Spring through Fall	Butterflies, bees
	Moderate	Full Sun or Light Shade	Spring through Fall	Butterflies, moths
	Moderate	Full Sun	Spring & late Summer	Moths
	Low	Full Sun	Spring to early Summer	Hummingbirds, butterflies, bees
	Low	Full Sun or Light Shade	March through November	Bees, butterflies
	Low	Full Sun to Part Shade	Spring	Hummingbirds, bees, bats
	Low	Full Sun or Light Shade	Early Spring or Fall	Hummingbirds
	Low	Full Sun	Summer, Fall	Butterflies
	Low	Full Sun	May, June	Bats, white-winged doves, bees
	Low	Full Sun	March, April, May	Hummingbirds, carpenter bees, verdins
	Low	Full Sun	April, May	Moths, bats
	Low	Full Sun	Spring, Summer	Hummingbirds, butterflies
	Low	Full Sun to Light Shade	Summer rains	Bees
	Low	Full Sun to Part Shade	Summer	Hummingbirds
	Low	Full Sun	April through July	Bats, bees
	Moderate to High	Full Sun	May through November	Butterflies, bees
	Low to Moderate	Full Sun	Fall, Winter, Spring	Butterflies, moths
	Low to Moderate	Full Sun to Part Shade	Spring	Bees, flies

Larval Food Plants (Host Plants)

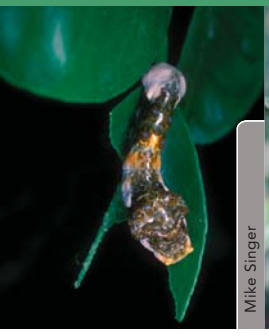
black swallowtail larva

sphinx moth larva

southern dogface larva

queen butterfly larva

Family	Subfamily	Butterflies Species
Papilionidae	**Papilioninae**	pipevine swallowtail (*Battus philenor*)
		giant swallowtail (*Papilio cresphontes*)
		black swallowtail (*Papilio polyxenes*)
Pieridae	**Pierinae**	checkered white (*Pontia protodice*)
	Coliadinae	cloudless sulphur (*Phoebis sennae*)
		southern dogface (*Colias (Zerene) cesonia*)
		Mexican yellow (*Eurema mexicana*)
Lycaenidae	**Theclinae**	gray hairstreak (*Strymon melinus*)
		great purple hairstreak (*Atlides halesus*)
	Polyommatinae	marine blue (*Leptotes marina*)
		western pygmy-blue (*Brephidium exile*)
Nymphalidae	**Heliconiinae**	gulf fritillary (*Agraulis vanillae*)
	Nymphalinae	painted lady (*Vanessa cardui*)
		American lady (*Vanessa virginiensis*)
		Texan crescent (*Phyciodes texana*)
	Danainae	queen (*Danaus gilippus*)
		monarch (*Danaus plexippus*)
Hesperiidae	**Pyrginae**	common checkered skipper (*Pyrgus communis*) white checkered skipper (*Pyrgus albescens*) desert checkered skipper (*Pyrgus philetas*)
	Hesperiinae	orange skipperling (*Copaeodes aurantiacus*)
		fiery skipper (*Hylephila phyleus*)
		eufala skipper (*Lerodea eufala*)



giant swallowtail larva

tomato hornworm larva

gulf fritillary larva

pipevine swallowtail larva

Larval food plants
pipevines (*Aristolochia* spp.), southwestern pipevine (*Aristolochia watsoni*)
citrus (Rutaceae), lime prickly-ash (*Zanthoxylum fagara*), Arizona star leaf (*Choisya arizonica*), common hoptree (*Ptelea trifoliata*)
parsley family (Apiaceae), *Apium leptophyllum*, and sometimes citrus (Rutaceae)
mustards (Brassicaceae), London rocket (*Sisymbrium irio*), sand peppergrass (*Lepidium* spp.), *Descurainia pinnata*
Fabaceae, such as *Senna* spp.
Fabaceae, false indigo (*Amorpha californica*), *Dalea* spp.
Fabaceae including *Acacia* spp. and *Senna* spp.
beans (*Phaseolus* spp.), mallow (*Malva* spp.), nolina, beargrass (*Nolina* spp.)
mistletoe (*Phoradendron* spp.), especially on cottonwoods (*Populus* spp.)
a wide variety of legumes (Fabaceae), fairydusters (*Calliandra* spp.), mesquite (*Prosopis* spp.)
saltbush (*Atriplex* spp.), lamb's quarters (*Chenopodium* spp.)
passion vines (*Passiflora* spp.)
many species; mallows, composites, legumes. Borages (*Amsinckia* sp.), thistle (*Cirsium* spp.) (Asteraceae)
pearly everlastings (*Anaphalis* spp.), plants in the aster family (Asteraceae)
small plants in the Acanthus family (Acanthaceae), chuparosa (*Justicia californica*), orange jacobina (*Justicia spicigera*), *Dicliptera resupinata*
milkweed plants (*Asclepias* spp.) and milkweed vines (*Sarcostemma* spp.)
milkweed plants (*Asclepias* spp.)
globemallow (*Sphaeralcea ambigua*) and other mallows (*Malva* spp., *Sida* spp.)
grasses (Poaceae), including side oats grama (*Bouteloua curtipendula*)
weedy grasses, especially crab grass (*Digitaria* spp.)
grasses (Poaceae)

Hummingbirds

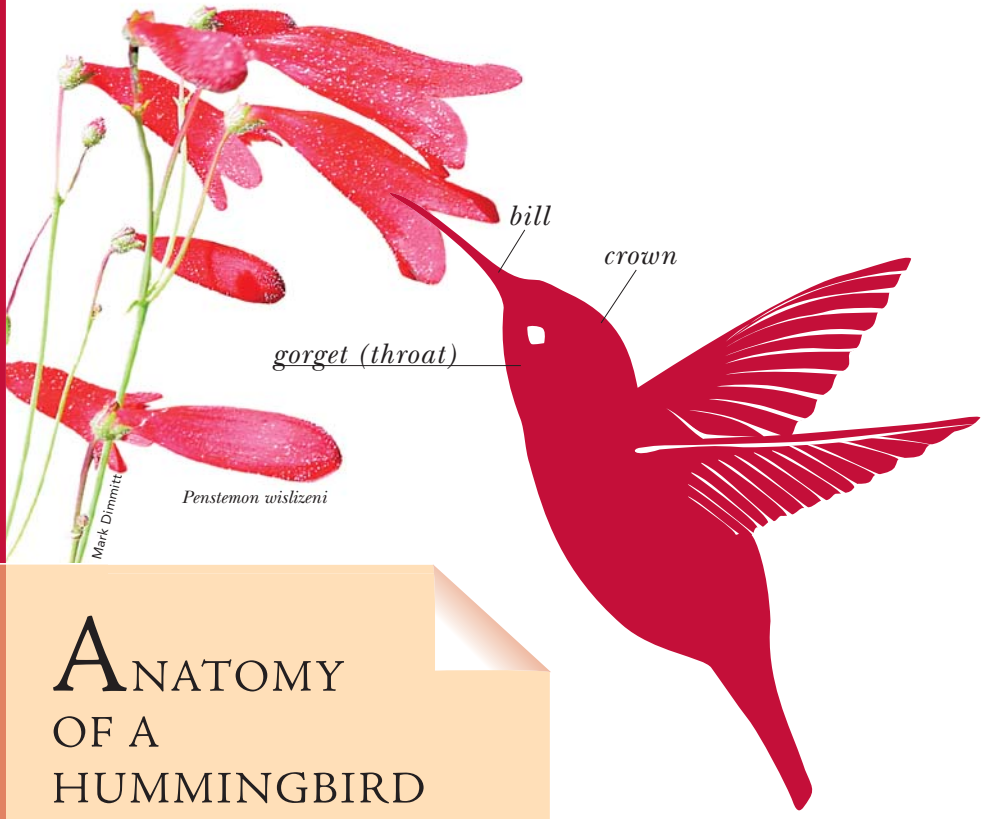
Family Trochilidae

Of all New World birds, hummingbirds are the most efficient pollinators. Their long beaks and long, bristled tongues work perfectly for harvesting nectar from tubular blossoms. Some types of sticky pollen adhere to and are carried on the bill between flowers, while others are carried on the feathers of the head. Hummingbirds feed during the daytime and while hovering. They have a poor sense of smell but excellent color vision. Flowers that attract hummingbirds tend to be long, tubular, non-fragrant flowers that are oriented sideways or down facing and are brightly colored (usually pink, orange, or red). You have probably noticed that hummingbirds are attracted to red and other warm colors, though they will also feed from blue flowers; actually, hummingbirds will visit almost any flower that produces nectar! Besides feeding on nectar, hummingbirds also eat small insects, which provide protein and extra energy.

Some other birds, such as the white-winged dove, (*Zenaida asiatica*), are also pollinators. White-winged doves visit saguaro flowers and pollinate them while feeding on the flower's pollen; they also eat saguaro fruit and are effective seed dispersers. White-winged doves in southwestern deserts are called saguaro specialists, meaning they rely on saguaros almost entirely for nutrients and water during the breeding season, and, naturally, their breeding season is synchronized to the flowering of the saguaro.

Carnegiea gigantea

Stephen Buchmann



Penstemon wislizeni

Mark Dimmitt

Anatomy of a Hummingbird

Selasphorus rufus

Karen Krebbs

Hummingbird Watching Tip

Hummingbirds (particularly the males) have iridescent feathers that appear to be different colors in different kinds of light, or viewed from different angles. When watching hummingbirds, take a good look—from different angles, if possible—as you try to identify them. Sometimes cloudy days are better to see the coloration because the light is diffused and shows the colors from more angles. To complicate identification, female and immature male hummingbirds are often subdued in coloration and difficult to tell apart. If you want to learn more, use other birding field guides that have more detailed descriptions, and practice! It's fun!

adult female Anna's hummingbird

Karen Krebbs

Anna's Hummingbird

(Calypte anna)

Identification

Anna's hummingbirds are rather stocky, and are one of the larger hummingbirds you will see in the Sonoran Desert. One characteristic to watch for is that Anna's hold their tails relatively still while hovering.

Adult Males

- crimson-rose crown and gorget with moderately elongated corners

Adult Females

- green above and gray below, with a green wash on the sides
- frequently, the throat has a rosy patch or rosy flecks

adult male Anna's hummingbird

Jim Flynn

Range

Anna's hummingbirds are present year-round in the Sonoran Desert where they nest in urban and suburban areas. They nest from late fall to early summer (mostly January through April) and wander widely in the Southwest and Pacific Coast regions from summer through fall, with many individuals migrating to the Sonoran Desert.

Conservation Status

Anna's hummingbirds have benefited from human activities; the replacement of native desert with irrigated gardens and parks has allowed them to expand their range. They are well-adapted to urban areas and tend to displace Costa's hummingbirds in areas where natural desert gives way to residential areas.

Did You Know?

Hummingbirds generally construct their nests by weaving together plant fibers, feathers, grasses, and animal hair held together with spider web. The outside of the nest is often camouflaged with shreds of bark, dried flowers, and lichen. Anna's hummingbirds, and other hummingbirds adapted to urban environments, may use artificial materials such as scraps of paper, filter fibers from cigarette butts, and paint chips in nest construction.

adult male black-chinned hummingbird

Jim Flynn

Black-chinned Hummingbird

(*Archilochus alexandri*)

Identification

Black-chinned hummingbirds are medium-sized, but slim and sleek with long black bills. They usually wag their tails when hovering.

Adult Males

- velvety-black gorget with broad violet band
- white "collar" contrasts strongly with dark head

Adult Females

- dull green above and gray below
- forecrown dull gray to grayish-tan

adult female black-chinned hummingbird

Jim Flynn

Range

Black-chinned hummingbirds are summer residents of the higher regions of the Sonoran Desert and adjacent mountain habitats; some may nest in lower riparian areas, as in the Yuma area and along the Colorado River. In spring, some migrate as far north as British Columbia and can be found throughout the western U.S.—as far east as central Texas and west to southern California. They return south in fall to winter in central and southwestern Mexico.

Conservation Status

Black-chinned hummingbirds breed and nest throughout much of the interior West—from Texas to Idaho—including the Sonoran Desert. This species is well-adapted to human environments and seems tolerant of altered habitats, although threatened habitat along the Colorado River is a concern for breeding and nesting.

Did You Know?

Hummingbirds have adaptations for flight that set them apart from other birds. Their unique flight mechanisms allow them to hover in front of flowers when feeding, move in any direction (even backward), and dive at over 60 miles per hour. Their wings beat up to 80 beats per second—the most rapid of any bird. Their flight muscles account for 25 to 30 percent of their body weight, compared to 15 to 25 percent in other birds. To fuel these muscles, hummingbirds have larger hearts in proportion to their body size than do other warm-blooded animals. Their heart rates are also more rapid than other birds—up to 500 beats per minute resting and 1,260 beats per minute during activity.

adult female broad-billed hummingbird

Karen Krebbs

Broad-billed Hummingbird

(*Cynanthus latirostris*)

Identification

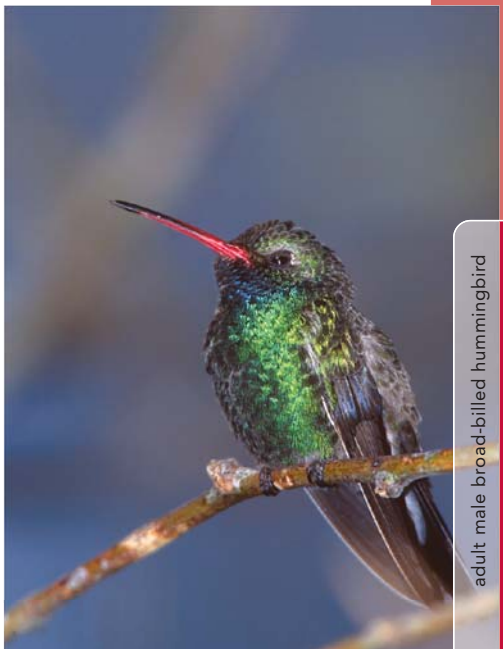
Broad-bills are medium-sized hummingbirds with distinctive red-orange on their bills. Their broad tails wag in flight and often quiver when perched.

Adult Males

- dark in appearance, iridescent blue-green all over
- blue throat
- red-orange bill with a black tip

Adult Females

- red-orange at the base of the bill only
- white stripe behind the eye



adult male broad-billed hummingbird

Jim Flynn

Range

Broad-billed hummingbirds can be found from March to September in southern Arizona, the northernmost extent of their range. They winter in Mexico or occasionally in southern Arizona. Wanderers are sometimes seen in California, New Mexico, and Texas. Their spring migration peaks in March, and the southbound migration to central Mexico is generally over by November.

Conservation Status

Broad-billed hummingbirds are summer residents and breed in the eastern portion of the Sonoran Desert, though they occasionally are found in the western region as well. Grazing, residential and recreational development, and loss of riparian habitat due to ground water pumping threaten broad-billed hummingbirds habitat. The conversion of natural desert to exotic grasslands (buffelgrass) for livestock grazing in Mexico has affected the nectar sources needed for migration of this species between Mexico and Arizona.

Did You Know?

All hummingbirds can be aggressive when defending food sources and territory. Aggressive behavior includes tail-fanning displays, sharp calls, and diving attacks. Their aggression is not just aimed at other hummingbirds, but against potential nectar competitors such as bees and small songbirds, and potential predators such as hawks, jays, cats, and even snakes.

adult male Costa's hummingbird

Jim Flynn

Costa's Hummingbird

(*Calypte costae*)

Identification

Costa's hummingbird is the smallest hummingbird regularly found in the Sonoran Desert.

Adult Males

- amethyst-purple crown and flared gorget
- green wash on sides

Adult Females

- dull green above, off-white below

adult female Costa's hummingbird

Jim Flynn

Range

Costa's hummingbird is primarily found in the southwest deserts of Arizona, California, and northwest Mexico. Many are all-season residents but are found in greatest numbers in the Sonoran Desert in February through April when they nest; by May or June some leave the desert for locations to the south or interior mountains. Costa's spring migration is associated with the timing of ocotillos blooming in the Sonoran and Mohave Deserts, but they also depend on early-blooming chuparosa (*Justicia californica*) and desert honeysuckle (*Anisacanthus thurberi*).

Conservation Status

Costa's is a year-round resident that breeds and nests in the Sonoran Desert. Urbanization, agriculture, and fire suppression are changing the character of its habitat. Some of the main areas of habitat destruction include the nearly total destruction of coastal scrub habitat in California, and the conversion of native desert scrub to buffelgrass pastures in Sonora. Costa's seems to be less adaptable than other hummingbirds to feeding stations and urban habitats.

Did You Know?

Nectar provides energy-rich sugars (such as sucrose) to fuel the high metabolic rates for hovering and migration. In general, a hummingbird will consume about one and a half times its body weight in nectar each day, and over three times its body weight when bulking up for migration.

When hummingbirds are stressed, and need to conserve calories and energy, they can go into a state of torpor—or temporary hibernation. In this state, their heart rate drops, breathing is greatly reduced, and energy needs are minimized. In the morning, they power up their metabolism and warm up to normal body temperature.

adult male rufous hummingbird

Karen Krebbs

Rufous Hummingbird

(Selasphorus rufus)

Identification

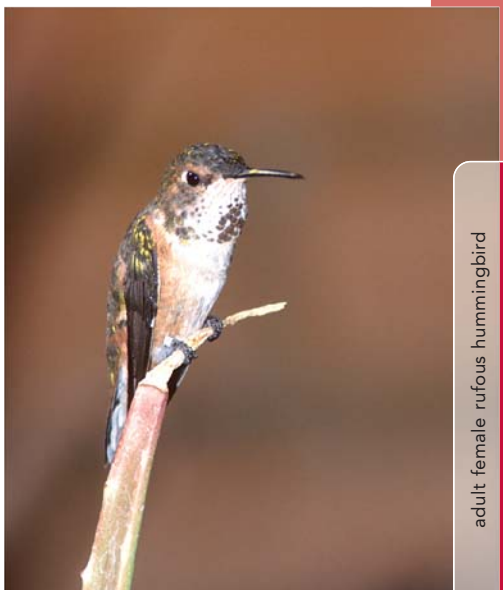
The rufous hummingbird is very difficult to distinguish from Allen's hummingbird, and while the rufous is more common in the Sonoran Desert, Allen's may also be seen here. The females and immature males of the two species are virtually indistinguishable from one another.

Adult Males

- orange-red gorget
- rufous back, sides, and tail, sometimes with extensive green on the back
- green crown

Adult Females

- green back, rufous wash on sides
- may have orange flecks on throat



adult female rufous hummingbird

Jim Flynn

Range

Rufous hummingbirds have one of the longest migrations of any animal relative to their body size. Some may travel over 4,000 miles (round trip) every year! Some individuals fly as far north as southeast Alaska—through western Canada and the western U.S.—and return south to central Mexico for the winter. Fall migration through Arizona and Sonora, Mexico begins in late June, peaks in early September, and is over by late October. Spring migrants travel north between January and May (with most traveling mid-February to the end of March).

Conservation Status

Rufous hummingbirds breed and nest far north of the Sonoran Desert. Population declines have been noted over parts of the breeding range, though the reasons for this are not clear. It could be that their short nesting season and long migration may limit their ability to sustain or rebound population sizes that are negatively affected by habitat destruction.

Allen's Hummingbird (*Selasphorus sasin*)

Allen's hummingbird is a transient in the Sonoran Desert. It is primarily found in California, but occasionally is seen in southern Arizona and eastern Sonora in July and August during the fall migration to central Mexico.

Allen's has one of the most restricted breeding ranges among northern hummingbirds—largely confined to California coastal habitats where they are particularly adapted to endemic plants. Despite threats to these habitats, Allen's seems to be expanding its range southward.

Bats

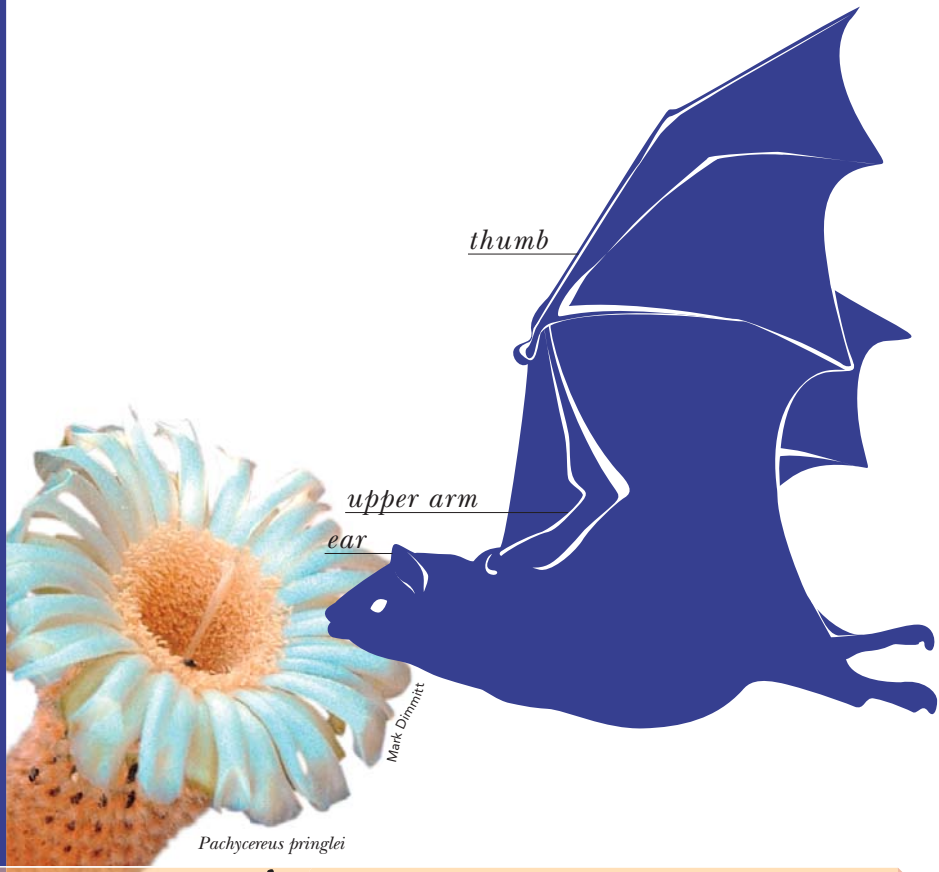
Family Phyllostomidae


Merlin Tuttle

People living in temperate regions may not think about bats as pollinators; but the lesser long-nosed bat (which is a federally listed endangered species) and the Mexican long-tongued bat are subtropical species specially adapted as pollinators with their long muzzles and brush-tipped tongues. These nectar-feeding bats migrate north from Mexico and depend on agave and columnar cactus nectar and fruit for most of the year, and switch to nectar of certain tropical trees and shrubs in the fall and winter. They time their migration to the flowering or fruiting of the major food plants (using the nectar corridor), which must be found in high concentrations or densities in order to sustain them. The flowers that attract them are pale green or white, night blooming, and produce a strong rotting fruit or musky scent. The main species of plants they feed on include saguaro (*Carnegiea gigantea*), organ pipe cactus (*Stenocereus thurberi*), and cardón (*Pachycereus pringlei*) in the spring and early summer, and agaves (*Agave* spp.) in the fall.


Carnegiea gigantea

Stephen Buchmann



Pachycereus pringlei

ANATOMY OF A BAT

Identification

Members of this family of bats are called the leaf-nosed bats because of the distinctive leaf-like flap of skin at the base of their long noses. Only three species in this family are found in the Sonoran Desert and two of them play a role in pollination—the lesser long-nosed bat and the Mexican long-tongued bat. They are about the same size (wingspan between 13 and 16 inches) and roost in caves and abandoned mines. To feed on pollen and nectar, these bats have long tongues covered with tiny hair-like structures toward the tip. They also stick their long snouts into the flower blossoms and the pollen that sticks to their fur is transferred from flower to flower.

lesser long-nosed bat
Merlin Tuttle

Lesser long-nosed bat
(*Leptonycteris curasoae*)

Lesser long-nosed bats feed on pollen, nectar, and fruit of agaves (*Agave* spp.), saguaro (*Carnegiea gigantea*), cardón (*Pachycereus pringlei*), and organ pipe cactus (*Stenocereus thurberi*). Females arrive in Arizona from south-central Mexico by mid-April already pregnant, and they soon form maternity colonies of up to thousands of females. The young are born in late May or June. By late September or October they return to Mexico for the winter. Their flight is rapid (up to 14 miles per hour) and direct, but they can also hover and maneuver well. The subspecies found in Arizona (*Leptonycteris curasoae yerbabuenae*) is considered an endangered species. The greater long-nosed bat (*Leptonycteris nivalis*) is also an endangered species; it is found only in southwest Texas and central northern Mexico.

- body grayish to reddish-brown above and brown below
- small ears
- no visible tail

lesser long-nosed bat
Merlin Tuttle

Mexican long-tongued bat
(*Choeronycteris mexicana*)

Mexican long-tongued bats are primarily found in oak-pine habitats at elevations between 4,000 and 6,000 feet, but have occasionally been found in saguaro-palo verde desert habitats. They roost in relatively small colonies with no other bats, and are very wary and will leave their roost if disturbed. Young are born in June or July, and occasionally as late as September in Mexico. While they feed on pollen and nectar from agave flowers (*Agave* spp.), and cactus flowers and fruit (particularly columnar cacti such as saguaro and cardón), they also use hummingbird feeders effectively.

- body buffy-brown to dark or sooty grayish-brown above and paler below
- medium-sized ears
- tiny tail

Mexican long-tongued bat
Merlin Tuttle

Butterflies

Order Lepidoptera

Butterflies are important pollinators and good indicators of the ecological quality of habitat because they are important components of the food chain. That is, other animals—primarily birds—feed on them, particularly as larvae (caterpillars). Flowers that attract butterflies tend to be brightly colored red, pink, yellow, purple, blue, or orange; have a sweet scent; and are flat and easy to land and walk on, although some tubular flowers also attract butterflies. You are likely to see butterflies gather on patches of mud or along shallow puddles to drink and take in minerals and salts (a behavior called puddling). Male butterflies are often found in greater numbers on hilltops and ridges, this is a habit called hilltopping.

It takes three to five weeks for most butterflies to go from egg to emerged adult; some overwinter as pupae. Remember, the larvae you see in your garden are butterflies waiting to mature! Be careful not to poison them with chemicals (which can also harm the birds that eat them), and be sure to include host plants in your garden on which they can feed; caterpillars are voracious eaters.

Photos by Stephen Buchmann

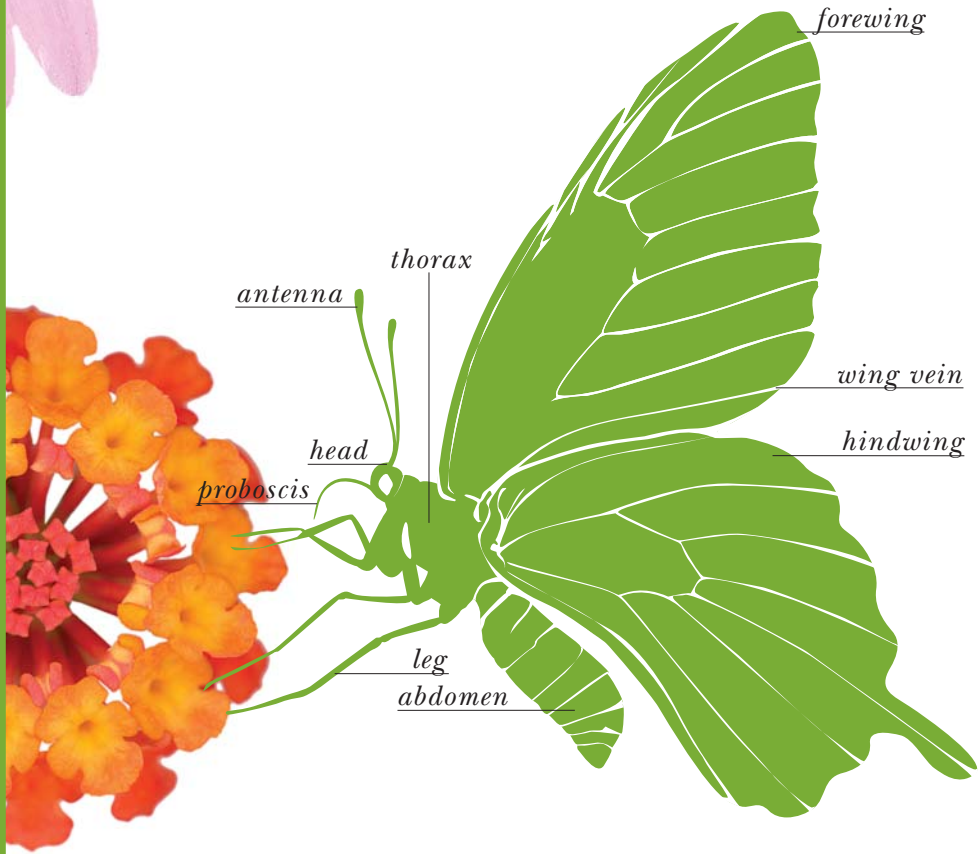
Erigeron sp.

Battus philenor

Papilio sp.

Lycaenidae

Anatomy of a Butterfly



Lantana sp.

pipevine swallowtail butterfly

Mike Singer

Swallowtail Butterflies

Family Papilionidae

Identification

Swallowtails are some of the largest and most beautiful butterflies in the world. They have bright patterns on their wings, and the "tail" extending from each hindwing is what gives them their name. Species in North America have wingspans reaching 5.5 inches. Their flight is strong, swift, and stately. Larvae (caterpillars) have a red, orange, or yellow forked structure (scent gland) behind the head that gives off a disagreeable odor when they are disturbed. Chrysalids resemble brown or green twigs or leaves hanging from plants by a silk girdle.

Pipevine swallowtail (*Battus philenor*)

Pipevine swallowtails are found in the Sonoran Desert primarily between February and October. Like the milkweed butterflies, caterpillars of pipevine swallowtails feed on plants that provide noxious chemicals to the adults and this protects them from predation.

- strongly iridescent blue with white spots on the hindwings
- brilliant metallic blue on the lower margin of the darker forewings
- seven prominent red spots on underside of hindwings

Host plants: pipevines (*Aristolochia* spp.), southwestern pipevine (*Aristolochia watsoni*)

Giant swallowtail
(*Papilio cresphontes* = *Heraclides cresphontes*)

The giant swallowtail is a very large butterfly (wingspan to 5 inches) with bold black and yellow markings. It is found in the Sonoran Desert primarily between March and October. Giant swallowtail caterpillars mimic bird droppings with their mottled white and brown-black patterns. Look for the cleverly disguised larvae (caterpillars) on citrus leaves, and don't be surprised if that bird dropping moves.

Mike Singer

giant swallowtail butterfly

- long, dark, spoon-shaped tails with yellow centers
- cream-colored body
- prominent orange spots on the underwings

Host plants: citrus (Rutaceae), lime prickly-ash (*Zanthoxylum fagara*), Arizona star leaf (*Choisya arizonica*), common hoptree (*Ptelea trifoliata*)

Black swallowtail
(*Papilio polyxenes*)

Black swallowtails are found in the Sonoran Desert from February through October. A subspecies, the desert black swallowtail (*Papilio polyxenes coloro*), difficult to distinguish from regular black swallowtails, is also found in the Sonoran Desert, particularly in the western Sonoran Desert. You may often find the desert black swallowtail on turpentine-broom (*Thamnosoma montana*) or chuparosa (*Justicia californica*).

Host plants: parsley family (Apiaceae), *Apium leptophyllum*, and sometimes citrus (Rutaceae)

Mark Muegge

black swallowtail butterfly

- abdomen with three rows of yellow spots

cloudless sulphur butterfly

Danforth/Honcoop

White and Sulphur Butterflies

Family Pieridae

Identification

Most of the butterflies in this family are medium sized (wingspan from 1.5 to 2 inches) and white or yellow with black or orange markings on their wings. Chrysalids are elongate and narrow and are attached by a silken girdle around the middle. Over 1,000 species have been described worldwide, about 60 of which occur in North America.

Whites (Subfamily Pierinae)

Checkered white (*Pontia protodice*)

Checkered white butterflies are widespread throughout the West and the Sonoran Desert lowlands, particularly from February to November.

- primarily white with dark markings—colors on females are more pronounced than males

checkered white butterfly

Steven J. Prchal

Host plants: mustards (*Brassicaceae*), sand peppergrass (*Lepidium* spp.), *Descurainia pinnata*

Sulphurs (Subfamily Coliadinae)

Cloudless sulphur
(*Phoebis sennae*)

The cloudless sulphur is a relatively large butterfly, widespread and common in the Sonoran Desert, particularly between April and October. Similar sulphurs that are widespread in the West include the orange sulphur (*Colias eurytheme*) and the clouded sulphur (*Colias philodice*), which hybridize in some areas.

- upper wings are solid yellow

Host plants: Fabaceae, such as *Senna* spp.

Southern dogface
(*Colias cesonia* = *Zerene cesonia*)

Southern dogface sulphurs are large and bright yellow, and are year-round residents of the Sonoran Desert.

- black margin on the forewings
- dog profile (French poodle) in the pattern on the forewings


Steven J. Prchal
southern dogface butterfly

Host plants: Fabaceae, false indigo (*Amorpha californica*), *Dalea* spp.

Mexican yellow
(*Eurema mexicana*)

The Mexican yellow is a year-round resident, but most prevalent in the fall.

- cut-out, angled hindwings

Host plants: Fabaceae including *Acacia* spp. and *Senna* spp.


Danforth/Honcoop
Mexican yellow butterfly

gray hairstreak butterfly
Mike Singer

Gossamer-winged Butterflies

(Coppers, Blues, and Hairstreaks)

Family Lycaenidae

Identification

Butterflies in this family (Lycaenidae) are typically small (wingspan generally less than 2 inches), brightly colored, and have iridescent markings. They have thin bodies and their eyes and antennae are usually ringed with white. Hairstreaks are recognized by their small "tails" and eyespots on their hind wings that create a false head that confuses predators.

great purple hairstreak butterfly
Mike Singer

Hairstreaks (Subfamily Theclinae)

Gray hairstreak
(*Strymon melinus*)

The gray hairstreak is common throughout the West and is variable in its appearance. It is found all year, but mostly between March and October in the Sonoran Desert.

Danforth/Honcoop
gray hairstreak butterfly

- the last third of the male's abdomen is orange
- both males and females have characteristic orange spots on the hindwings
- wingspan to 1.25 inches

Host plants: beans (*Phaseolus* spp.), mallow (*Malva* spp.), nolina beargrass (*Nolina* spp.)

Great purple hairstreak
(*Atlides halesus*)

The great purple is a very large and dramatic hairstreak. It is found in the Sonoran Desert lowlands all year, but mostly between March and October, particularly in canyons or near streams with mistletoe-covered trees.

- flash of iridescent blue
- striking blue and orange abdomen
- wingspan to 1.5 inches

Host plants: mistletoe (*Phoradendron* spp.), especially on cottonwoods (*Populus* spp.)

marine blue butterfly

Danforth/Honcoop

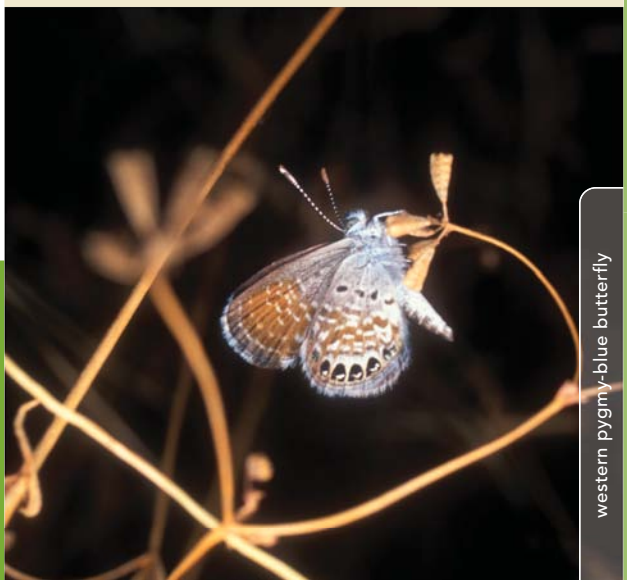
Blues (Subfamily Polyommatinae)

Western pygmy-blue
(Brephidium exile)

The western pygmy blue is one of the world's smallest butterflies, with a wingspan of just half an inch. It may be found all year in the Sonoran Desert, but is most abundant between March and October.

- copper colored forewings
- four prominent eye spots on the underside of the hindwings

Host plants: saltbush (*Atriplex* spp.), lamb's quarters (*Chenopodium* spp.)



western pygmy-blue butterfly

Mike Singer

Marine blue
(*Leptotes marina*)

Marine blues are year-round residents of the Sonoran Desert, but they are found primarily between March and October and in abundance in southern Arizona along the U.S.-Mexico border. This species is similar to the **ceraunus blue** (*Hemiargus ceraunus*), which is another resident of low deserts along the Mexico border in southern Arizona.

Danforth/Honcoop
marine blue butterfly

- eyes and antennae ringed with white
- males are bluer than females, which are more brown
- females have a pattern of irregular concentric circles (or an appearance of faint stripes) on the wings; this pattern is particularly evident in the underneath part of the wings
- males have pronounced blue venation and are blue to purplish near the base of the wings, fading outward

Danforth/Honcoop
ceraunus blue butterfly

Host plants: a wide variety of legumes (Fabaceae), fairy-dusters (*Calliandra* spp.), mesquite (*Prosopis* spp.)

gulf fritillary butterfly

Danforth/Honcoop

Brushfoot Butterflies

Family Nymphalidae

Identification

There is a great deal of morphological variation within this large family (upwards of 3,000 species, 140 of which are found in North America). Brushfoots are distinguished by their prominent wing venation, often bright colors, and the appearance of only four legs because the front pair of legs is reduced and held tightly against the body. Only the second and third pairs of legs are used for walking. Brushfoot butterflies are swift and strong in flight, and most are territorial. Chrysalids usually hang from silken pads attached to plants.

Heliconians and Fritillaries

(Subfamily Heliconiinae)

Gulf fritillary

(*Agraulis vanillae*)

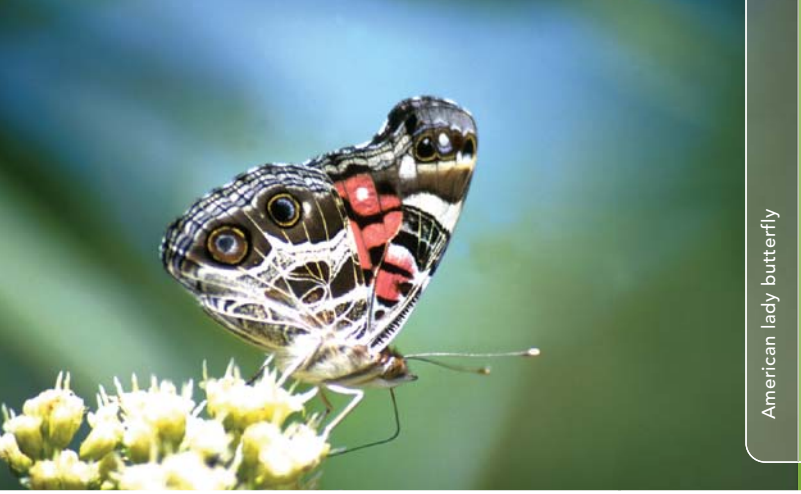
The gulf fritillary is a year-round resident of the Sonoran Desert, though most commonly seen between May and October. It prefers thorn scrub and open woodland habitats, but is quite common in Tucson because of the use of passion vine (*Passiflora* spp.) in landscaping.

- metallic silver spots on the underwings
- black-ringed silver spots on the top of the brilliant red-orange forewings
- one of the larger brushfoots, with a wingspan to nearly 3 inches

Host plants: passion vines (*Passiflora* spp.)

gulf fritillary butterfly

Danforth/Honcoop



American lady butterfly

Danforth/Honcoop

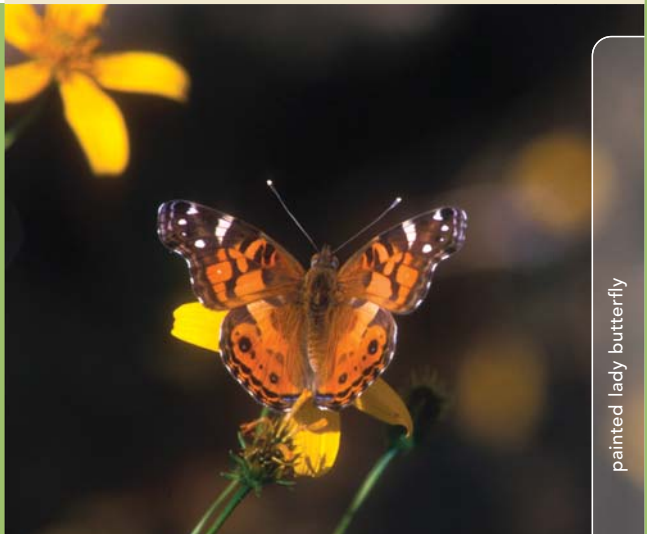
True Brushfoots (Subfamily Nymphalinae)

Painted lady
(Vanessa cardui)

The painted lady is one of the most widespread butterflies in the world. It can be found year-round in the Sonoran Desert, in any open habitat, and is most abundant between March and October.

- four small black eye spots on the hindwings

Host plants: many species; mallows (*Malva* spp.), composites (Asteraceae), and legumes; borages (*Amsinckia* spp.), thistles (*Cirsium* spp.)



painted lady butterfly

Danforth/Honcoop

American lady

(*Vanessa virginiensis*)

American ladies are year-round residents of the Sonoran Desert, most likely to be seen from March to November.

- two large blue-centered eye spots on the hindwings

Host plants: pearly everlastings (*Anaphalis* spp.), plants in the aster family (Asteraceae)

Danforth/Honcoop

Texan crescent butterfly

Texan crescent

(*Phyciodes texana* = *Anthanassa texana*)

Texan crescents can occur year round in the Sonoran Desert, but they are most likely seen between March and October.

- underside of forewings with orange base and prominent black patch
- one of the smaller brushfoots found in the Sonoran Desert, with a wingspan to 1.5 inches

Host plants: small plants in the Acanthus family (Acanthacea), chuparosa (*Justicia californica*), orange jacobina (*Justicia spicigera*), *Dicliptera resupinata*

queen butterfly

Danforth/Honcoop

Milkweed Butterflies

Family Nymphalidae
Subfamily Danainae

Identification

Butterflies in this subfamily are large, brightly colored, and slow and graceful in flight. They are named for their larval food plants—milkweeds. Although 300 species occur worldwide, only 4 are found in North America. Like the true brushfoots, milkweed butterflies have greatly reduced forelegs. The caterpillars are brightly striped and have pairs of long filaments at the head and rear.

Queen
(*Danaus gilippus*)

The queen is a very common butterfly in the Sonoran Desert. Queens are similar to monarchs, but are darker orange, have white spots on the outer half of the forewings, and do not have prominent venation on the upper wing surface. Queen butterflies are non-migratory.

- weak venation on upper wing surfaces
- black wing margins
- white spots on outer half of the forewings

Host plants: milkweed plants (*Asclepias* spp.) and milkweed vines (*Sarcostemma* spp.)

Monarch
(*Danaus plexippus*)

Monarch butterflies are uncommon in the Sonoran Desert, but they may occasionally be seen in late summer and early fall. It takes two generations of monarch butterflies to migrate from Mexico to Canada, a trip of nearly 2,000 miles, between March and November. They migrate in large numbers, though these mass migrations are not seen in the Sonoran Desert because it is not part of their main migration route.

Danforth/Honcoop

monarch butterfly

- prominent black wing venation on both upper and lower wing surfaces
- white spots restricted to wing margins

Host plants: milkweed plants (*Asclepias* spp.)

Did You Know?

Many milkweed plants contain poisonous chemicals (alkaloids that are heart poisons for vertebrates), which are ingested by milkweed caterpillars, stored in their bodies, and carried into the adult stage. While this doesn't hurt the caterpillars, it makes the adult butterflies distasteful to predators. The bold markings of the caterpillars and adult butterflies warn predators of their toxicity. Such markings, usually contrasting colors of white, black, red, and orange, are found in many animals as warning colors.

common checkered skipper butterfly
Danforth/Honcoop

Eufala skipper butterfly
Steven J. Prchal

Skipper Butterflies

Family Hesperiidae

Identification

Skippers are small (wingspan 0.5 to 2.5 inches), heavy-bodied butterflies known for their fast, "skipping" flight. They usually have a curved, slender hook at the end of their antennae. When at rest, skippers assume an unusual posture with the forewings and hindwings held at different angles, rather than together. About 3,000 species occur worldwide, 250 of which are found in North America.

Spread-wing Skippers (Subfamily Pyrginae)

Common checkered skippers (*Pyrgus communis*)

Common checkered skippers (*Pyrgus communis*) and white checkered skippers (*Pyrgus albescens*) are both found in the Sonoran Desert. Both species are morphologically variable and difficult to tell apart. The white checkered skipper is found along the Arizona-Sonora border and is a bit whiter and with fewer markings than the common checkered skipper. Both species occur in the Sonoran Desert, mainly from May through September. The desert checkered skipper (*Pyrgus philetas*) is a year-round resident in the eastern Sonoran Desert and darker than the common and white checkered skippers.

- extensive white spots on dark background
- blue-tinged hairs on the body, extending onto the wings

Host plants: globemallow (*Sphaeralcea ambigua*) and other mallows (*Malva* spp., *Sida* spp.)

Eufala skipper
(*Lerodea eufala*)

Eufala skippers are found in the Sonoran Desert almost year round, but are most abundant from June to October. They are very similar to violet-clouded skippers (*Lerodea arabus*), which are also found in the Sonoran Desert. Violet-clouded skippers are larger, stronger flyers, and have a dark blotch on the central part of the hindwings.

- pale body and nearly uniform gray-colored wings

Host plants: grasses (Poaceae)

Orange skipperling
(*Copaeodes aurantiaca*)

Orange skipperlings are very small with angular wings. They are found all year in the lowland deserts.

- a jet-plane position is typical


Steven J. Prchal
orange skipperling butterfly

Host plants: grasses (Poacea), including side-oats grama (*Bouteloua curtipendula*)

Fiery skipper
(*Hylephila phyleus*)

The fiery skipper can be found in the Sonoran Desert year round, but is most abundant between March and September.

- many small, faint dark spots on the underwings

Host plants: weedy grasses, especially crab grass (*Digitaria* spp.)


Danforth/Honcoop
fiery skipper butterfly

Datura wrightii

Moths

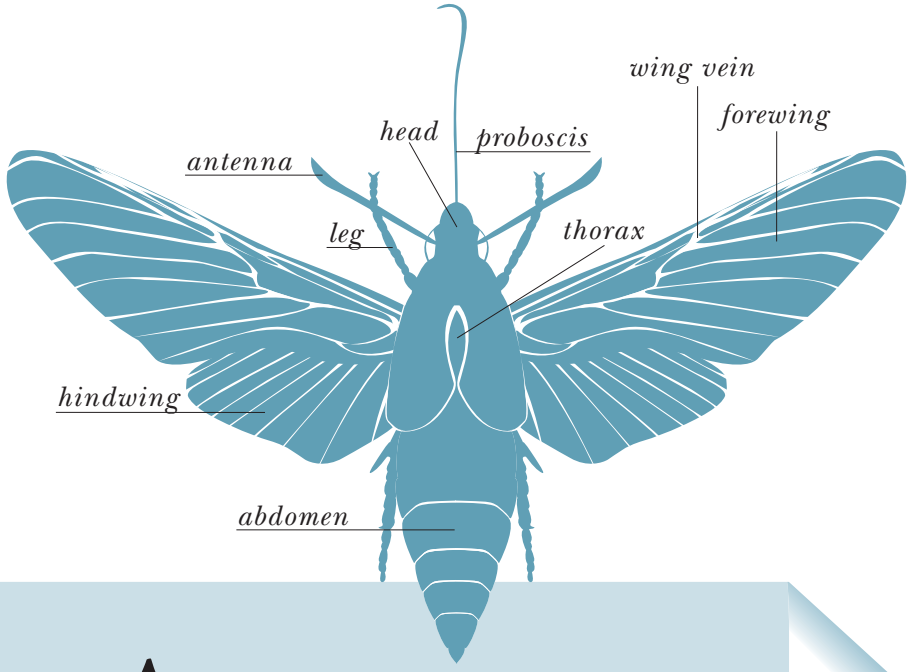
Order Lepidoptera

Most moths are active at twilight and are attracted to lights or to the sweet fragrances of moth-pollinated blossoms. Sphinx moths prefer white tubular flowers for their dilute nectar. Concentrated nectar is more difficult for sphinx moths to drink through their long proboscides. They usually have robust bodies, often with feathery antennae, unlike butterflies, which are day fliers and have delicate bodies and club-shaped antennae.

Stephen Buchmann

Manduca rustica

Stephen Buchmann



Anatomy of a Moth

Sphinx Moths or Hawk Moths
Family Sphingidae

Hyles lineata

Identification

Sphinx moths are large moths and common in the Sonoran Desert during the spring and summer months. They are strong and agile fliers, with long narrow wings. Their long proboscis allows them to feed on nectar from flowers much like hummingbirds. In fact, some sphinx moths do fly during the day and are often mistaken for hummingbirds.

Hornworm caterpillars turn into these nectar-feeding moths (sphinx moths or hawk moths). They visit many night-blooming plant species, especially in grasslands and dune areas. Adults of desert sphinx moths take nectar from the fragrant white tubular blossoms of sacred datura (*Datura wrightii*) and other *Datura* spp., evening primrose (*Oenothera* spp.), sweet four o'clocks (*Mirabilis longiflora*), and several introduced night-blooming ornamentals.

tomato sphinx moth
Mark Dimmitt

White-lined sphinx
(*Hyles lineata*)

The white-lined sphinx is the most common sphinx moth in the Sonoran Desert. Its larvae occasionally form massive migrations of green and black striped hornworm caterpillars, especially noticeable crossing roadways, as they search for food or seek out areas to pupate underground.

- black and white forewings and dash of pink on the hindwings

Host plants: spiderlings (*Boerhavia* spp.)

white-lined sphinx moth
Jim Honcoop

Tomato sphinx
(*Manduca quinquemaculata*)

Caterpillars of tomato sphinx moths are called tomato hornworms. The caterpillars bury themselves in the soil and emerge in the spring as sphinx moths. They are common garden guests that feed on the foliage of tomato, potato, and chile plants. The tongues (proboscides) of this species can reach a length of six inches.

- brown, black, and white patterned wings
- paired orange spots down the broad abdomen

Host plants: tomato (*Lycopersicon esculentum*), eggplant (*Solanum melongena*), and pepper (*Capsicum annuum*) plants

yucca moth
Mark Meugge

Yucca moths
Family Prodoxidae
(*Tegiticula* spp. and *Parategiticula* spp.)

Yucca moths are small white moths associated with the blooms of yuccas. The larvae eat their way through the centers of the triangular black seeds, breaking the seed coats thus allowing them to germinate. The female moths have nonfunctional mouthparts called tentacles. They gather up yucca pollen and are one of only a few pollinators that "purposely" gather up pollen and place it on the receptive female stigmas. This pollinates the yucca flowers and ensures food for its hungry caterpillars. Yucca moths and yucca plants are dependent upon one another for their coexistence.

Bees

Superfamily Apoidea

Bees are the most important and diverse pollinators on earth. In addition to providing a service to the plant, they need pollen and nectar to feed themselves and their larvae. The southwest has over 1,000 species of bees, and more species are still being discovered! Approximately 4,000 species of native ground and twig-nesting bees are known in the United States, and over 20,000 occur throughout the world. Included here are descriptions of some kinds of bees you are likely to see.

Bees see colors in the ultraviolet range, and those colors complementary; therefore, flowers that attract bees are blue, purple, and yellow. Bees cannot easily land on hanging flowers and cannot reach the nectar at the base of long tubes, so hummingbirds pollinate those flowers.

Hibiscus coulteri

Stephen Buchmann

Centris pallida

Echinocereus triglochidiatus

Stephen Buchmann

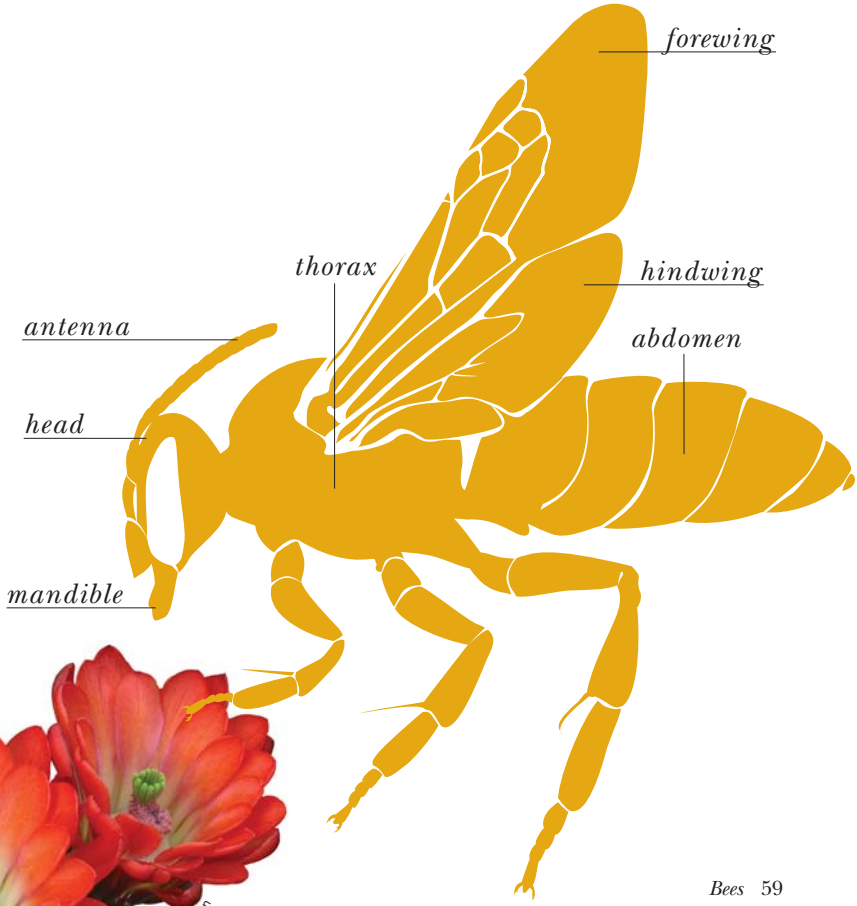
Megachile sp.

Parkinsonia microphyllum

Stephen Buchmann

Brian Anderson

ANATOMY OF A BEE



Brian Anderson

sweat bee

Jim Cane

Sweat bees

(Family Halictidae)
(*Agapostmon* spp., *Lasioglossum* spp., *Dialictus* spp., *Evylaeus* spp.)

Sweat bees are very small bees active much of the year—from February to October. They sometimes land on people's arms or legs to lick the salty perspiration. They are important pollinators for chiles, tomatoes, and many crops with small flowers. They build their nests in sunny locations in the ground.

- metallic green or black
- some males have yellow and black striped abdomens

Squash and gourd bees

(*Peponapis* spp., *Xenoglossa* spp.)

Squash and gourd bees are small to medium sized and are active in the summer when squashes and gourds are flowering. Around mid-day, look in the wilted squash flowers and you may find male squash bees sleeping inside. They nest in farm fields and adjacent roadsides.

- *Peponapis* spp. are mostly brown with very long mouthparts
- *Xenoglossa angustior* is more robust and has a shiny orange abdomen

squash and gourd bee

Jim Cane

cactus bee

Mark Singer

Cactus bees
(*Diadasia* spp.)

Cactus bees are small and active between April and June—the prime time to pollinate prickly pears and chollas (*Opuntia* spp.) and saguaros (*Carnegiea gigantea*). Females will nest together in the ground, sometimes forming groups of hundreds or thousands of nests. Some species specialize in the pollen and nectar of mallows and plants in the sunflower family. The most common species is the common cactus bee (*Diadasia rinconis*).

- fuzzy and brown, about the size of a honey bee, with strong light-colored bands on the abdomen

common cactus bee

Stephen Buchmann

Steven J. Prchal

leafcutter bee

Leafcutter and mason bees

(Family Megachilidae)
(*Megachile* spp., *Osmia* spp.)

Many species in this family are commonly found throughout the Sonoran Desert. Leafcutter bees are small to medium sized and active throughout the spring and summer. Leafcutter bees get their name because they line their nests with pieces cut from leaves; you may notice small circles cut out of leaves on your garden plants. They are important pollinators of many cacti, as well as sunflowers and legumes. They nest in dead branches or in dead trees in the tunnels made by wood-boring beetles, though a few will make their nests in the soil.

Mason bees (*Osmia* spp.) use their mandibles to carry mud they use in constructing partition walls between the cells in their nests.

- long black or black and white-striped abdomen
- may have large mandibles

Stephen Buchmann

mason bee

digger bees

Stephen Buchmann

Digger bees

(Family Anthophoridae)
(*Centris* spp., *Anthophora* spp.)

Digger bees are medium sized, and active between April and September. They construct single-cell, shallow nests in the ground, which helps aerate the soil. Palo verdes (*Cercidium* spp.), creosote (*Larrea tridentata*), nightshades (Solanaceae), and legumes (Fabaceae) are pollinated by digger bees. Common in the Sonoran Desert are species of *Anthophora* that typically have a brown thorax and a vividly black and white-striped abdomen. Many *Centris* species are also common—they appear to be a gray blur flying around palo verde flowers. There is a beautiful black and lemon yellow species, the yellow-banded digger bee (*Centris eisenii*), that has been expanding its range north from Hermosillo, Sonora due to nurseries promoting yellow orchid-vine (*Mascagnia macroptera*), which have specialized oil glands that these bees collect for larval food.

- fast flying, and colored gray, brown, and black, sometimes with bold yellow markings

digger bees

Stephen Buchmann

Carpenter bees
(Subfamily Xylocopinae)
(*Xylocopa* spp.)

Carpenter bees are so named for their habit of excavating nests in dead wood—particularly cottonwood and sycamore—some smaller species (e.g., *Xylocopa californica*) also nest in dead *Sotol*, *Agave*, and *Yucca* stalks. Most carpenter bees are large. The largest bee in the Sonoran Desert, *Xylocopa varipuncta*, is active between late February and early October and pollinates squash (*Cucurbita* spp.), eggplant (*Solanum melongena*), cotton (*Gossypium* spp.), tomatoes (*Lycopersicon esculentum*), mesquite (*Prosopis* spp.), prickly pears (*Opuntia* spp.), poppies (*Kallstroemia grandiflora, Eschscholtzia mexicana*), and palo verdes (*Cercidium* spp.).

- females are completely shiny black and shine almost blue
- males (of some species) are golden colored with bright green eyes

carpenter bee

Steven J. Prchal

honey bee
Brian Anderson

Bumble Bees and Honey Bees

(Family Apidae)

Bumble bees
(Subfamily Bombinae)
(*Bombus* spp.)

Bumble bees are medium-sized, active between March and October, and pollinate tomatoes (*Lycopersicon esculentum*), squash and gourds (*Cucurbita* spp.), sunflowers (*Helianthus annuus*), and legumes (Fabaceae). They nest in abandoned rodent burrows or under rocks. The Sonoran bumble bee (*Bombus sonorus*) has a broad black band between the wings across the thorax. At higher elevations you might see a beautiful bee that is nearly all yellow—Morrison's bumble bee (*Bombus morrisoni*).

- very fuzzy, yellow with black bands, some higher elevation species have a reddish tipped abdomen

bumble bee
Jim Honcoop

Honey bees and *Africanized bees* (Subfamily Apinae)

(both are subspecies of *Apis mellifera*)

Did you know honey bees are not native to North America? The Jamestown colonists introduced them from Europe almost 400 years ago. Today, there are no areas in the Sonoran Desert where they cannot live. While excellent pollinators, honey bees are invasive aliens that may compete for habitat and floral resources with our native bees.

In addition, European honey bees are impossible to distinguish from Africanized bees just by looking at them; in fact, Africanized bees are a subspecies of the honey bee from Africa. They have a dark brown head and thorax, and a brown and black-banded abdomen with a black tip. If bees act aggressively and nest in cavities at or near ground level, they may be Africanized and should be treated with caution. They are sensitive to ground-borne vibrations, rapid movements, dark clothing, and exhaled breath.

Did You Know?

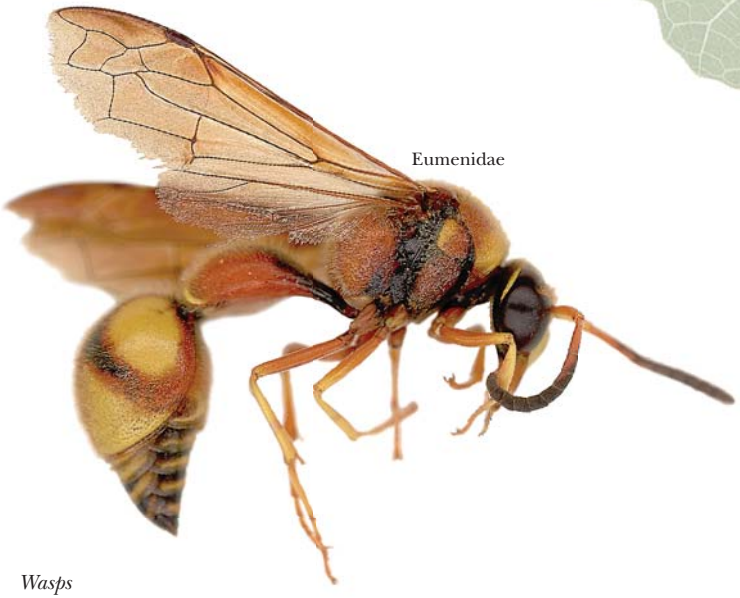
If you get up early in the morning and sit near a patch of *Solanum* flowers (such as deadly nightshade), *Cassia* spp. (= *Senna* spp.) blossoms, you could be in for a real treat! About 8% of the world's flowering plants have anthers with two tiny pores at their tips. Native bees—but not honey bees—sonicate the pollen out of these flowers! That is, bees (*Bombus* spp., *Centris* spp., and *Anthophora* spp.) turn themselves into living tuning forks to get the protein-rich pollen out of these colorful blooms. This has been called "buzz pollination." The sounds they make are quite loud and comical. By buzzing the flowers, bumble bees can harvest pollen hundreds of times faster than honey bees.

Wasps

Order Hymenoptera

Wasps are less effective pollinators than bees, flies, or beetles. This is because they typically have smooth, shiny bodies, and they don't pick up or carry pollen around from flower to flower very efficiently. In the Sonoran Desert, the masarid wasps are the only ones that actively collect pollen and nectar to feed their young. Fig wasps pollinate figs, and without them we would have no edible figs.

Some wasps have yellow and black coloring, visit flowers, and might be confused with bees. One way to tell the difference is bees generally have a more robust and fuzzy body, and wasps are generally sleek with narrow abdomens. Another way to tell the difference between bees and wasps is to look at their hairs under a hand lens. Bees have branched hairs that help them carry pollen, and wasps have simple, unbranched hairs.



Eumenidae

Photos by Stephen Buchmann

Asclepias subulata

Ficus carica

Anatomy of a Wasp

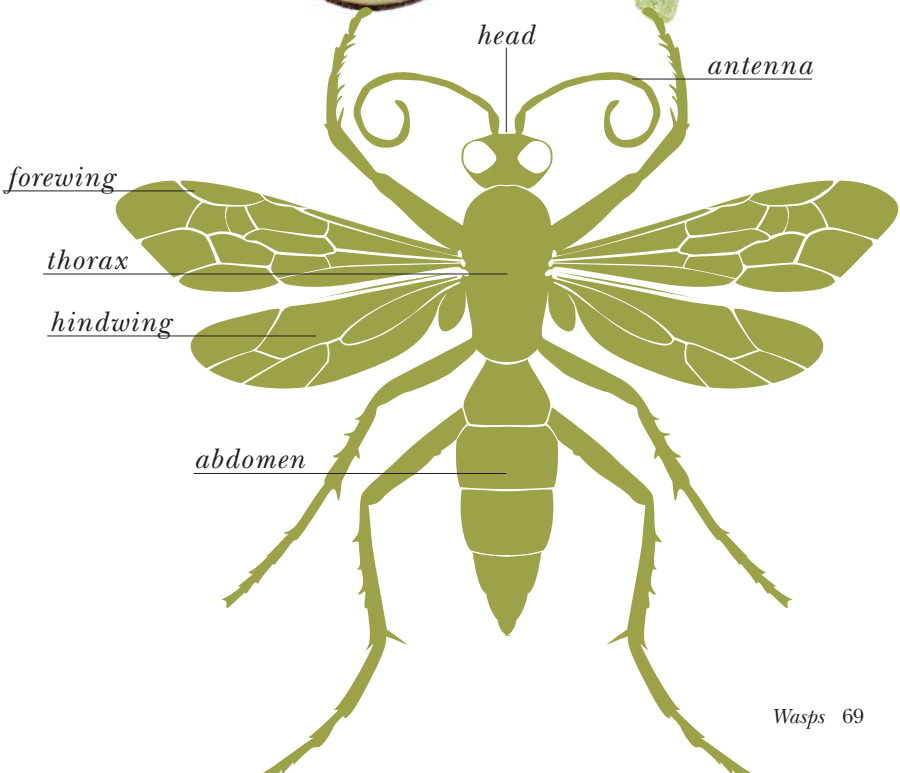


Fig wasps
(Family Agaonidae)

There are two species of fig wasps in the United States, and one (*Blastophaga psenes*) is found in Arizona and California. It was introduced to this region specifically to make possible the cultivation of figs. The male wasp has little other purpose than to mate with the female; it is the female that pollinates the fig flowers.

fig wasps
fig wasps: Carlos Machado

Sand wasps
(Family Sphecidae)

There are over 1,200 species in this large family, worldwide. They occur in various shapes, colors, and sizes and often are found on flowers, though they feed on insects found in the flowers rather than pollen. The earliest bees evolved from these wasps.

sand wasp
B.M. Drees

spider wasp
Jim Honcoop

Spider wasps
(Family Pompilidae)

These are slender wasps with long spiny legs. Most spider wasps are dark colored with smoky or yellowish wings, although a few species are brightly colored. The adults are usually found on flowers or on the ground searching for insects to eat. The larvae of most species in this group feed on spiders. Some of the most conspicuous spider wasps in the Southwest are the tarantula wasps (*Pepsis* spp. and *Hemipepsis* spp.).

scoliid wasp
Steven J. Prchal

pollen wasp
Jim Honcoop

Scoliid wasps
(Family Scoliidae)

These are large, hairy wasps, often with black and yellow bands on the abdomen; some have a red body. The adults are commonly found on flowers searching for food. Females prey on grubs (beetle larvae), which they sting, pull into an underground nest, and lay eggs on them so the larvae have food.

Pollen wasps
(Family Vespidae, Subfamily Masarinae)

Pollen wasps are usually black and yellow (though some are brownish) and have clubbed antennae. They often visit caterpillar weed (*Phacelia* spp.) flowers and provision their nests with pollen and nectar, like bees.

tarantula wasp
Mark Dimmitt

Tarantula wasps
(Family Pompilidae)
(*Pepsis* spp. and *Hemipepsis* spp.)

There are more than 12 species of tarantula wasps in the Sonoran Desert. They are up to 1.75 inches long, brilliant blue-black bodies with fiery orange wings (though some species have black wings). As their name suggests, the females hunt tarantula spiders. Once a tarantula is located, the female wasp stings the spider at the base of one of the legs. The paralyzed, but alive, spider is dragged to a hole—sometimes the tarantula's own burrow—where the wasp lays a single egg on the spider. The wasp seals the burrow, and when her egg hatches the larva will consume the tarantula. Male tarantula wasps do not hunt, but are frequently seen visiting flowers. They carry pollen on their legs and can be good pollinators of milkweeds (*Asclepias* spp.), soapberry trees (Sapindaceae), or mesquites (*Prosopis* spp.).

Flies

Order Diptera


Mike Singer

Bombyliidae

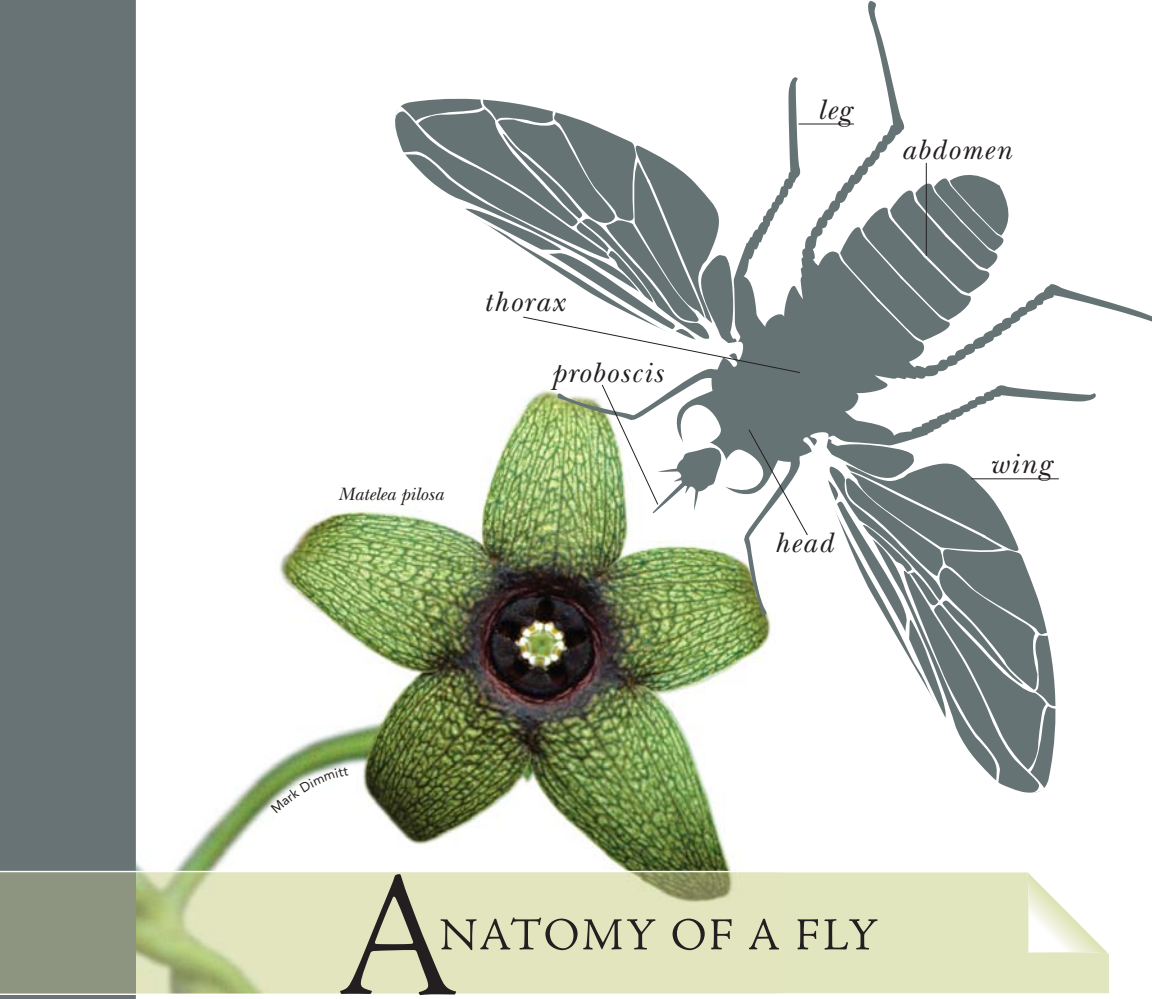
Other insects, such as flies and beetles are also important pollinators. Flies and beetles are generalist pollinators and typically visit open shallow flowers where they can easily reach nectar and pollen to feed. Plants in the carrot family (Apiaceae) and sunflower family (Asteraceae) often attract flies and beetles—especially at high elevations where there may be fewer bees.

There are three main families of flies (Bombyliidae, Syrphidae, and Tachinidae) that feed on nectar and pollen and pollinate Sonoran Desert plants. Flower flies (Syrphidae) are especially abundant and valuable pollinators in the Sonoran Desert.

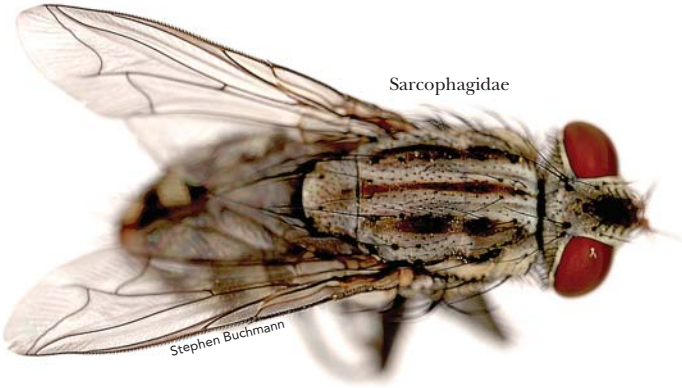
Although some flies look like bees, flies have one pair of wings, whereas bees have two pairs of wings. The adult drone fly (*Eristalis tenax*) is sometimes called the "H bee" because it closely resembles a honey bee. Large black bee flies (*Volucella* spp.) mimic carpenter bees, and some even use "buzz pollination" when feeding (see the description of "buzz pollination" on page 67).


Zephyranthes sp.

Jim Honcoop



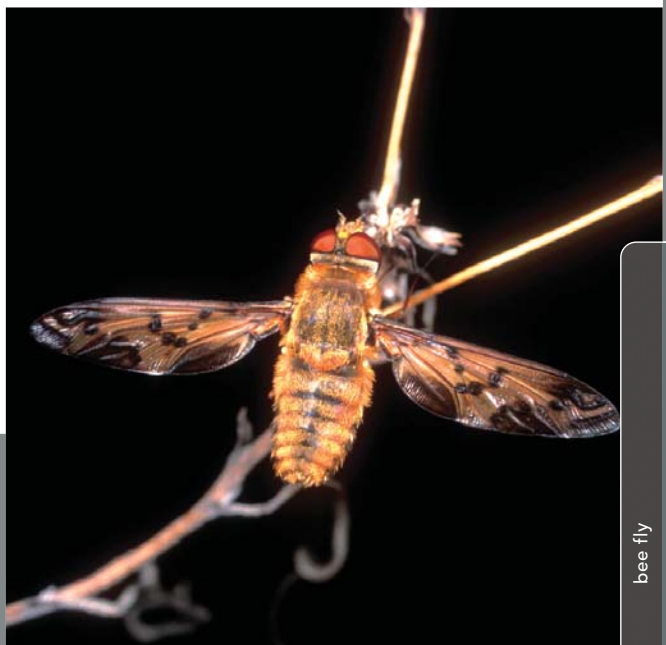
Anatomy of a Fly



syrphid fly
Mike Singer

Bee flies
(Family Bombyliidae)

Bee flies are a large family of flies, numbering more than 800 species in North America and commonly seen at desert wildflowers and around water holes. They have extremely hairy, stout bodies, long legs, and an unmistakably long stiletto-like proboscis that they use to probe flowers for nectar. They even buzz much like bees. As larvae, all bee flies are parasites on true bees, grasshopper eggs, and larvae of various insects, including caterpillars.



bee fly
Mike Singer

Flower, hover, or syrphid flies
(Family Syrphidae)

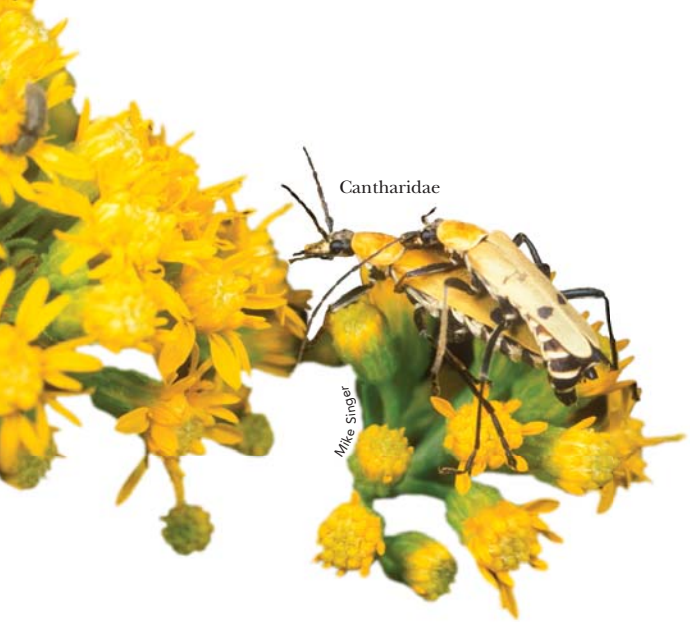
This is another large family of flies, including nearly 1,000 species in North America alone. They can be found almost anywhere, but they spend a lot of time hovering near flowers and feeding on pollen. Most are brightly colored, with yellow and black markings, which creates a resemblance to bees and wasps (but none bite or sting).

Tachinid flies
(Family Tachinidae)

Tachinids are one of the largest fly families with about 1,300 North American species. Many are large, bristly, and look like bees or wasps. They are often very colorful, sometimes with an orange abdomen. These flies are predators or parasites on other insect larvae (mainly butterflies and beetles). The female flies lay their eggs directly on the host larvae (caterpillars); when the eggs hatch, they burrow into the flesh of the caterpillar and feed internally. Some species lay their eggs on foliage, which when ingested by caterpillars, cause the eggs to hatch whereupon they feed on the internal organs of the caterpillar. An insect attacked by these flies is nearly always killed.

tachinid fly

Mark Singer



Cantharidae

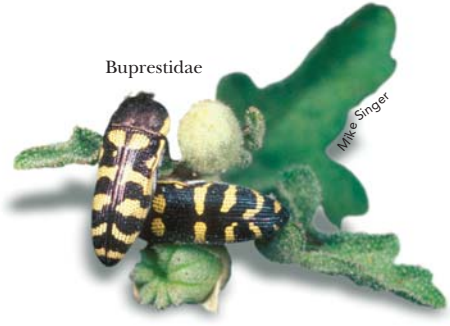
Mike Singer

Stephen Buchmann

Beetles

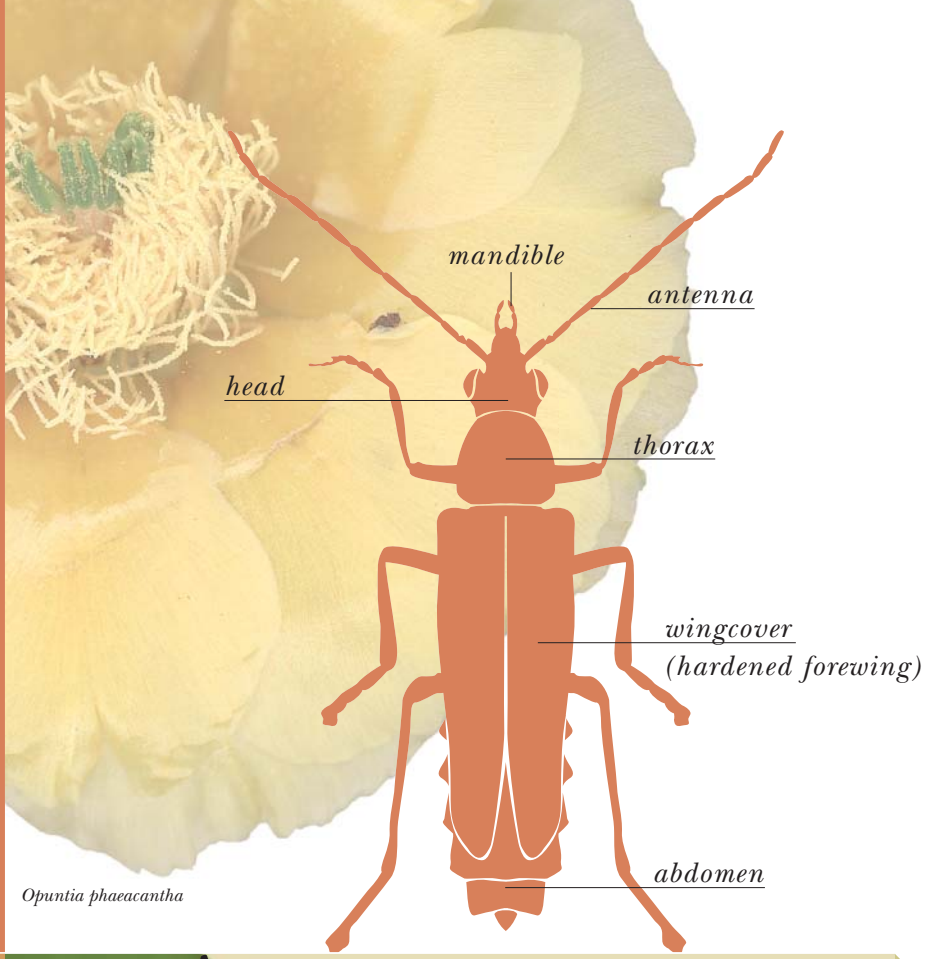
Order Coleoptera

Beetles are the most common and diverse group of animals in the world, with over 30,000 species in the United States, and over 300,000 worldwide. Beetles are characterized by the presence of hard wing coverings. Many are common on flowers where they feed on pollen and nectar while searching for mates. Beetles typically damage some of the flower parts by feeding on them, and they often defecate on the flowers; for these reasons, they are sometimes known as "mess and soil" pollinators.



Buprestidae

Mike Singer



Opuntia phaeacantha

ANATOMY OF A BEETLE

Cleridae

Troy Bartlett

Soldier beetles
(Family Cantharidae)

Soldier beetles are boldly colored with contrasting yellow, orange, or red against black. They are commonly seen on flowers in the Sonoran Desert. They resemble lightning bugs, but do not have light-producing organs. The larvae of soldier beetles are predators on other insects.


soldier beetle
Mike Singer

Checkered beetles
(Family Cleridae)

Checkered beetles are hairy, elongate, and often brightly colored. Most beetles in this family are predaceous (as both larvae and adults), although some are pollen feeders as adults (and sometimes as larvae).


checkered beetle
Troy Bartlett


sap beetle
B.M. Drees

Sap beetles
(Family Nitidulidae)

Sap beetles are often found where plant fluids are fermenting or souring, for example around decaying fruits or melons, flowing sap, and some types of fungi. Some species (such as *Conotelus mexicanus*) are commonly found inside squash blossoms. They are long, thin, black beetles and, unlike most beetles, their wing covers are short and don't cover the entire abdomen.


metallic wood-boring beetle
Mike Singer


tumbling flower beetle
Troy Bartlett

Metallic wood-boring beetles
(Family Buprestidae)

These beetles are metallic copper, green, blue, or black in color—particularly on their underside and on the upper side of their abdomens. They are compactly built and have a characteristic, elongated body. Metallic wood-boring beetles may be seen on fruit trees and shrubs where they bore into wood and under the bark. One species also forms galls on ironwood trees (*Olneya tesota*). Most wood-boring beetles fly when disturbed, but leaf-mining species (*Brachys* spp.) draw their legs up and "play dead," and fall off the foliage onto the ground when disturbed.

Tumbling flower beetles
(Family Mordelidae)

Tumbling flower beetles have a characteristic "swept back" oval look (like a VW beetle) and a very pointed abdomen. Most tumbling flower beetles are dark—black or mottled gray—with a soft fuzz covering. They are commonly found on flowers, especially on composites. They are very active and run or fly when disturbed; their name comes from tumbling movements they make to escape being captured.

Did You Know?

Beetles are the largest group of animals, making up 25% of the animal kingdom. Many beetles perform essential pollination services, but are known as "mess and soil" pollinators. Beetles take their time when they "check in" at floral hotels, and like some rock stars, leave the room a mess. They chew on tender petals, chomp pollen and drink nectar, mate, rest, and defecate within the blossoms.

Glossary

Chrysalis (plural, ***chrysalides***)**.** The pupa stage of butterflies.

Complete metamorphosis. Metamorphosis is the process of change from one life stage to another. Complete metamorphosis occurs in insects that have four stages of change: egg, larvae, pupae, and adult. Insects that undergo complete metamorphosis include butterflies.

Crown. Refers to the top of the head; in hummingbirds, this is often a region of distinct coloration.

Ecosystems. The combined living organisms and non-living physical components of the environment and their relationships in any given area.

Exotic. Not naturally found in a particular place or region; foreign; non-native.

Gall. An abnormal growth of plant tissues (often forming round balls), caused by the stimulus of a microbe, an animal, or another plant.

Gorget. The throat area of many hummingbirds, particularly in males, where the brightest colors are often most concentrated.

Habitat. The combination of food, water, shelter, and space (territory to reproduce and raise young) needed by all animals (and plants) to live; often characterized by a dominant plant form or physical characteristic (e.g., desert habitats, mountain woodland habitats).

Hilltopping. A habit of butterflies, primarily males, to travel along hilltops and ridges where they seek out mates.

Host plants. Host plants are the plants butterfly and moth larvae (caterpillars) feed on.

Invasive. Characterized by the ability to rapidly colonize diverse environments and geographic sites.

Larva (plural, ***larvae***)**.** The immature stage (between egg and pupa) of insects having complete metamorphosis; such as caterpillars of butterflies and moths, larvae are known for their voracious eating.

Legumes. Plants in the bean (pea) family, most of which produce seed pods; there are many in the Sonoran Desert, such as acacias (*Acacia* spp.), fairy duster (*Calliandra eriophylla*), palo verdes (for example, *Cercidium* spp.), mesquites (*Prosopis* spp.), and many others.

Mandibles. The "jaws" of insects and other arthropods.

Native. Naturally occurring in a particular place or region; natives may be endemic, meaning they occur only in that region and nowhere else.

Nectar corridors. Diffuse habitats (or sometimes linear—especially along rivers or washes) that produce flushes of blooms, especially in the spring and summer months; hummingbirds, bats, and some butterflies travel along these habitats to take advantage of the nectar.

Pollen. Male gene-bearing cells; they are rich in proteins essential for maintaining animal tissues and for raising young.

Pollination. The transfer of pollen from anther to stigma, on the same or a different plant. Pollination can occur by wind, or even humans; animals that transfer pollen from one flower to another are called pollinators.

Proboscis (plural, ***proboscides***). Nectar-imbibing "tongues" of many insects, including bees, butterflies, and moths; they can be unusually long, and are often coiled in butterflies.

Puddling. A habit of butterflies, primarily males, to gather around shallow puddles or wet soil to extract moisture and minerals.

Pupa (plural, ***pupae***; v. ***pupate***,). The resting stage following the larva and from which the adult insect emerges; this sequence is found in insects that go through complete metamorphosis (such as beetles, butterflies, moths, flies, wasps, ants, and bees); it is the pupal stage that is most resistant and helps get the species through times of drought or over winter.

Stigma. The part of the pistil (female organ of a flower, that receives pollen). When pollen reaches the stigma, it grows a tube that penetrates down the style to the ovary to fertilize the ovules.

Sp. (plural, ***spp.***). Abbreviation in scientific nomenclature for species.

Thorax. The middle part of an insect body to which the wings and legs are attached, located between the head and abdomen.

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Additional resources

American Field Guide: http://www.pbs.org/americanfieldguide/teachers

Arizona Native Plant Society: http://aznps.org/

Arizona-Sonora Desert Museum: http://www.desertmuseum.org

Center for Insect Science: http://cis.arl.arizona.edu/

Center for Insect Science Education Outreach: http://insected.arizona.edu/home.htm

Herbario Universidad de Sonora: http://148.225.52.2/cdrom.htm

International Sonoran Desert Alliance: http://www.isdanet.org

National Gardening Association: http://www.kidsgardening.com

North America Pollinator Protection Campaign: http://www.nappc.org/

Sonoran Arthropod Studies Institute: http://www.sasionline.org

The Bee Works: http://thebeeworks.com

The Pollination Home Page: http://www.pollinator.com

Tucson Botanical Gardens: http://www.tucsonbotanical.org