A USDA Forest Service
and
Pollinator Partnership Publication

Bee Basics

An Introduction to Our Native Bees

By Beatriz Moisset, Ph.D.
and
Stephen Buchmann, Ph.D.

Cover Art:

Upper panel: The southeastern blueberry bee (*Habropoda laboriosa*) visiting blossoms of Rabbiteye blueberry (*Vaccinium virgatum*).

Lower panel: Female andrenid bees (*Andrena cornelli*) foraging for nectar on Azalea (*Rhododendron canescens*).

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United States Department of Agriculture

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*Worker honey bees (*Apis mellifera*) visiting almond blossoms (*Prunus dulcis*).*

Introduction

Native bees are a hidden treasure. From alpine meadows in the national forests of the Rocky Mountains to the Sonoran Desert in the Coronado National Forest in Arizona and from the boreal forests of the Tongass National Forest in Alaska to the Ocala National Forest in Florida, bees can be found anywhere in North America, where flowers bloom. From forests to farms, from cities to wildlands, there are 4,000 native bee species in the United States, from the tiny *Perdita minima* to large carpenter bees.

Most people do not realize that there were no honey bees in America before European settlers brought hives from Europe. These resourceful animals promptly managed to escape from domestication. As they had done for millennia in Europe and Asia, honey bees formed swarms and set up nests in hollow trees. Native pollinators, especially bees other than honey bees, have been pollinating the continent's flowering plants since long before the arrival of honey bees. Even in today's vastly altered landscapes, they continue to do the yeomen's share of pollination, especially when it comes to native plants.

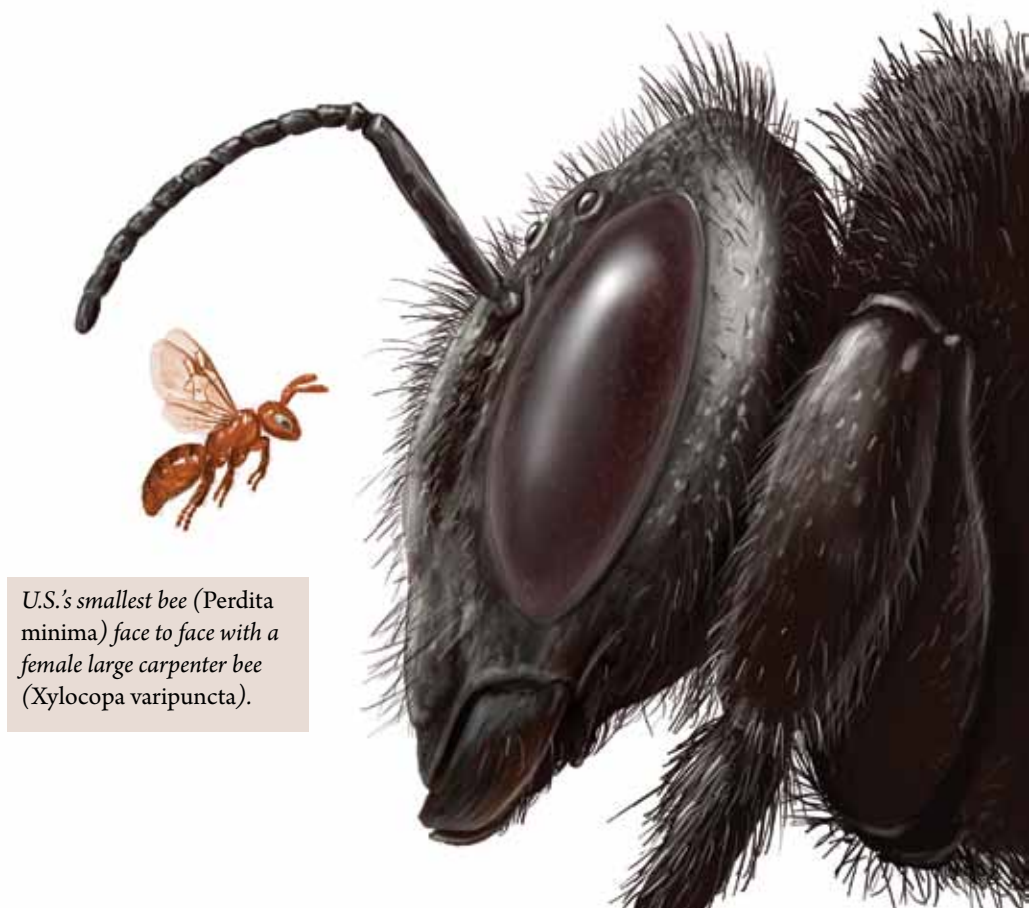
The honey bee, remarkable as it is, does not know how to pollinate tomato or eggplant flowers. It does very poorly compared to native bees when pollinating many native plants, such as pumpkins, cherries, blueberries, and cranberries.

Let us take a closer look at this forgotten treasure of native bees.

Native Bees: Varied and Valuable

Native bees come in a wide array of sizes, shapes, and colors. They are also varied in their life styles, the places they frequent, the nests they build, the flowers they visit, and their season of activity. They remain ignored or unknown by most of us. Yet, they provide an invaluable ecosystem service, *pollination*, to 80 percent of flowering plants. What would our world be like without the beauty of flowering trees, shrubs, and wildflowers? How many of us know that bees pollinate approximately 75 percent of the fruits, nuts, and vegetables grown in this country?

Bees are efficient foragers. One example is the southeastern blueberry bee, *Habropoda laboriosa,* a hard working little creature capable of visiting as many as 50,000 blueberry flowers in her short life and pollinating enough of them to produce more than 6,000 ripe blueberries. At market those 6,000 blueberries are worth approximately $20 or more. Not every bee that you see flitting about may be worth $20, but all of them combined keep the world of flowering plants going. The world as we know it would not exist if there were no bees to pollinate the earth's 250,000 flowering plants.



*U.S.'s smallest bee (*Perdita minima*) face to face with a female large carpenter bee (*Xylocopa varipuncta*).*

Bees or Wasps?
*Upper left: An eastern yellowjacket wasp (*Vespula maculifrons*)*
*Lower left: The familiar black and yellow mud dauber wasp (*Sceliphron caementarium*)*
Upper right: A digger bee, in the genus Diadasia
Lower right: The nomad bee, within the genus Nomada

From Whence They Came: Bees' Heritage

Bees are descended from wasps. Most wasps are carnivores; they either prey upon or parasitize other insects or spiders, and use this rich protein source to feed their young. About 125 million years ago, when the first flowering plants evolved, some wasps made a switch from hunting prey to gathering pollen for their brood. Perhaps they were hunting for insects that visited flowers and ate some of the pollen or drank the nectar along with their prey. It didn't take much to find the advantages of consuming pollen over hunting. Pollen is rich in proteins and doesn't fight back, so it is easy to imagine why the bees became vegetarians. Gathering pollen and nectar requires certain adaptations different from those of hunters, so they started to change, to evolve to meet these requirements and consequently became bees.

Even today, there are bees that appear very similar to wasps. Like wasps, some bees are also nearly hairless; and like female wasps, only female bees have stingers.

The similarities do not stop with physical appearance. Both bees and wasps have species that are solitary (living and raising their brood alone) or social (living together and sharing the rearing and provisioning). For example, bumble bees and yellow jacket wasps are social and have an annual colony. In both, an over-wintering queen emerges in the spring. The queen builds a nest, collects food, and lays eggs. The female workers hatch and work together to feed and care for the colony until fall when new queens emerge, mate, and hibernate until the following spring when the cycle begins anew.

Bee Anatomy or Morphology

Like all insects, bee bodies are comprised of a head, thorax, and abdomen. They also have six legs and two pairs of wings.

The head features:

- two antennae that are used to touch and "smell";
- two compound eyes and three simple eyes;
- mandibles or jaws used for biting, working wax and pollen "loaves," and digging.

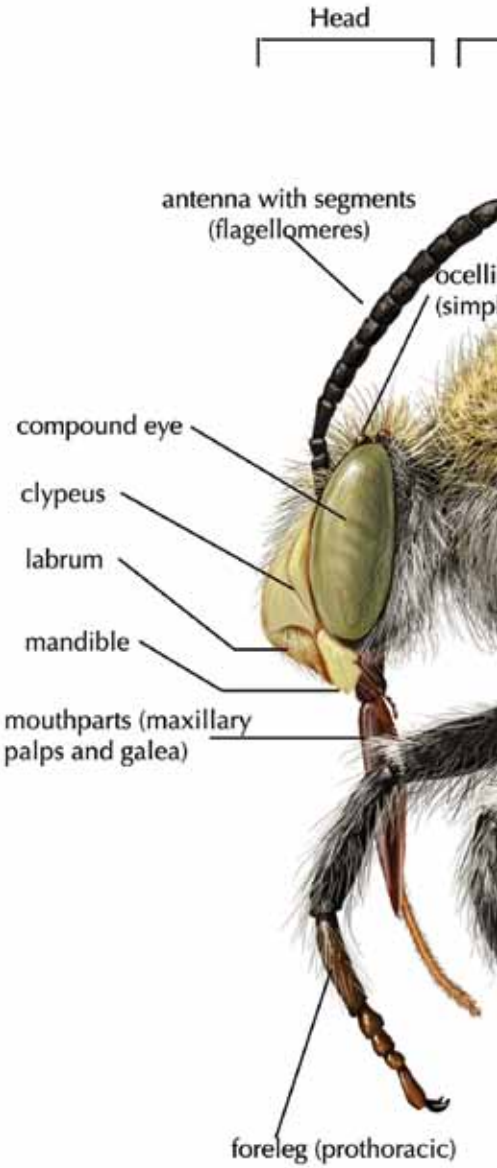
The thorax features:

- two pairs of membranous wings, linked in flight by minute hooks;
- three pair of legs.

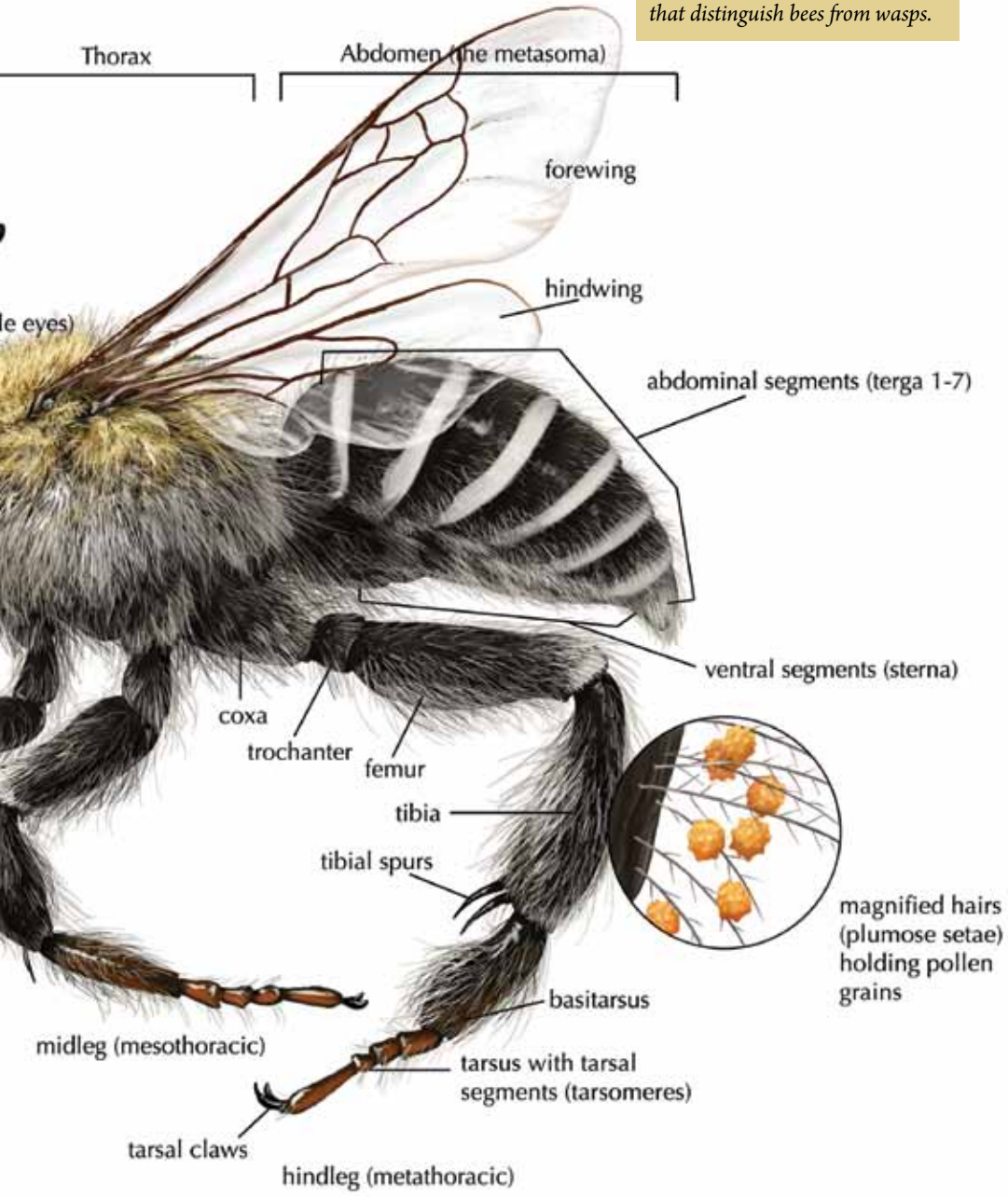
The abdomen features:

- six segments in females, seven segments in males;
- internal wax glands (only in honey bees and bumble bees);
- a stinger (modified ovipositor) at the tip (females only);
- branched hairs (plumose) SOMEWHERE on the body.

Some females have pollen transport structures, called scopae, made of stiff hairs located on the hind legs or under the abdomen. Bees frequently brush themselves, gathering pollen grains from their body's feathery hairs and transferring the pollen grains to their transport structure.

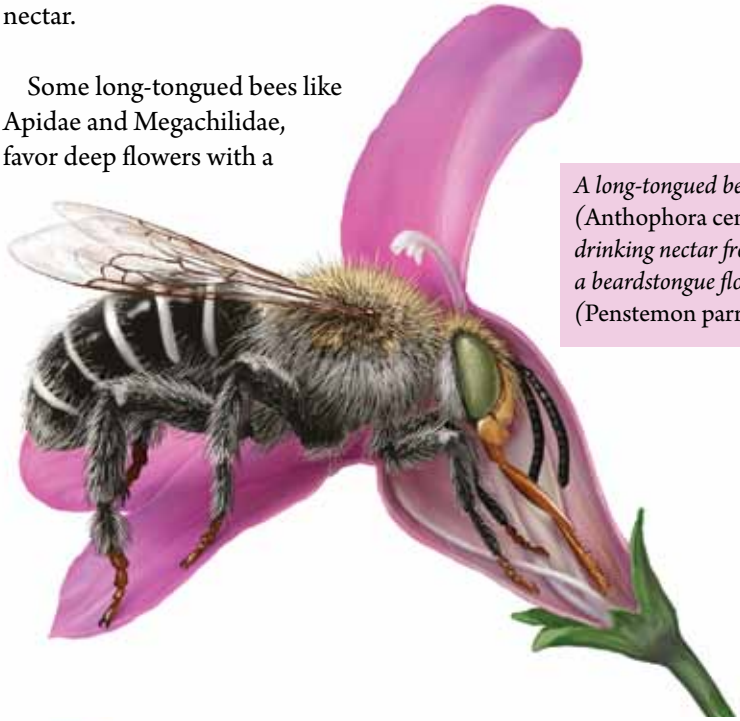


*A male digger bee (*Anthophora centriformis*) with major body parts labeled. Inset shows pollen grains caught in the branched hairs that distinguish bees from wasps.*

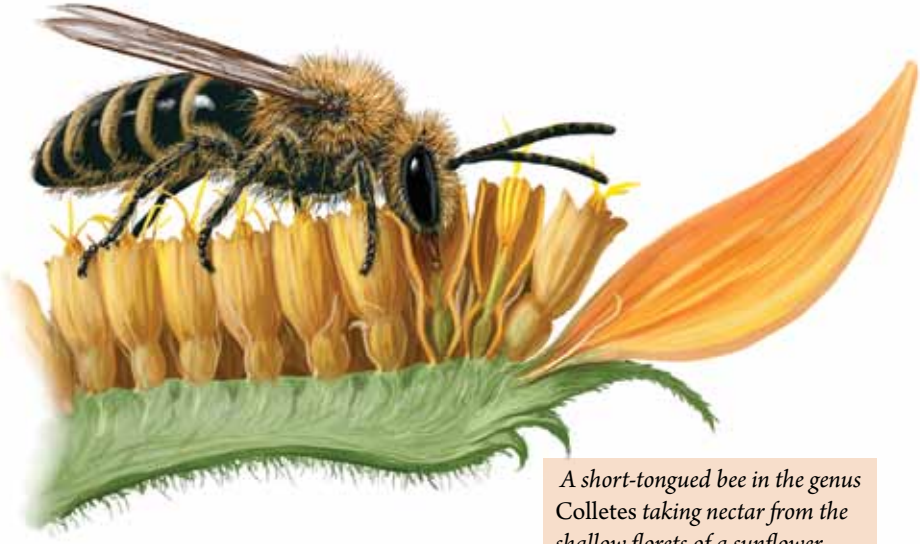


Ecologically, bees can be separated into two groups based on the relative length of mouthpart segments within their tongues, called proboscides. The long and short tongues are used to gather nectar.

Some long-tongued bees like Apidae and Megachilidae, favor deep flowers with a



*A long-tongued bee (*Anthophora centriformis*) drinking nectar from a beardstongue flower (*Penstemon parryi*).*



A short-tongued bee in the genus Colletes *taking nectar from the shallow florets of a sunflower (*Helianthus annuus*)*

longer throat; they are not averse to collecting nectar from open flat flowers. The remaining families are made up of short-tongued bees and are more limited in their floral choices. They are only able to take advantage of shallow flowers, such as those of the daisy or aster family and those of the carrot family.

Generally, females are larger than male bees, although there may be some overlap in size.

Nesting

All bee families have species that take care of their young, by building nests and providing food for them. But several families, Apidae, Halictidae, and Megachilidae, have some species that take advantage of their relatives. They have become "cuckoos," just like there are cuckoos among birds. As with cuckoo birds (like cowbirds), cuckoo bees lay their eggs in the nests of others. Most species of cuckoo bees only lay their eggs in the nests of a few bee species. There are cuckoo bee species that only parasitize the nests of a single species. In some species of cuckoo bees, the female kills the host's larva before laying her egg. However, the majority of cuckoo bee larvae feed on the stored food and the larvae of the unfortunate hosts. Cuckoo bees do not gather pollen and have lost their pollen baskets and much of their hair. In fact, at first glance some cuckoo bees are often mistaken for wasps. Cuckoo bees do visit flowers to feed on the flower's nectar.

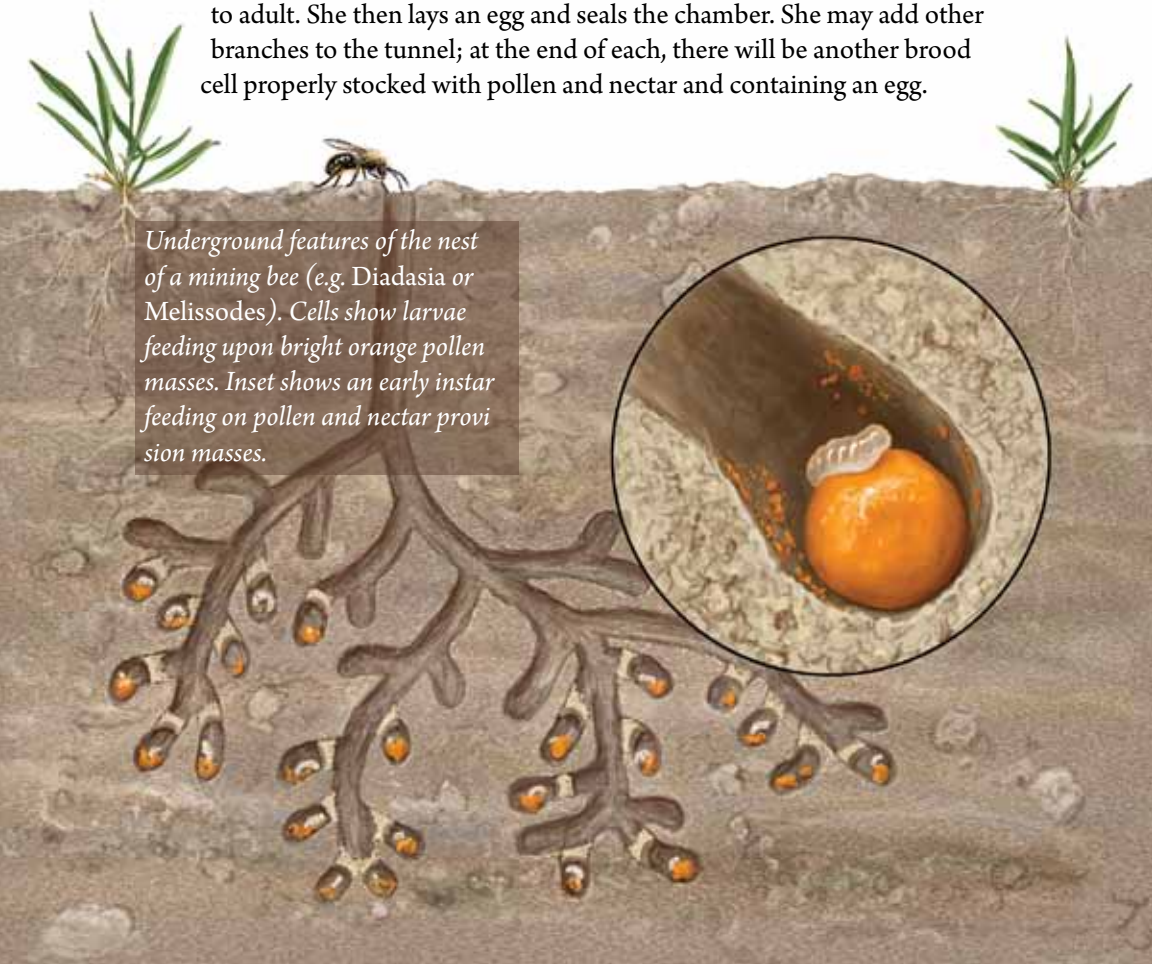
Aside from cuckoo bees, all bees build nests, stocking them with a nutritious mixture of pollen, nectar, and saliva before laying their eggs, and sealing them so the larvae remain safe. They generally mix the dry pollen with some nectar, kneading it into a pollen loaf used to feed their young. They add their own saliva to this mixture. The saliva is thought to be an important ingredient that provides protection against bacterial and fungal infections.

Some native bees build their nests underground; others use hollow stems or holes in trees, usually left by beetles; and some use their powerful jaws to make holes in wood. Whatever their method, they start the job of nest building by carefully choosing the best real estate; if conditions are not right, they continue their search. It would not do to have their homes flooded or lacking enough sunshine, or being too large or too small for their needs. Except for honey bees and bumble bees, females of solitary bees provide in one cell all the food required by their larvae to become an adult. This is called mass provisioning.

Nesting Practices Differ

Miners

Some members of the larger families, Apidae, Andrenidae, Halictidae, Megachilidae, and Colletidae, are ground nesters. They choose a bare, sunny spot with little likelihood of flooding and start the task of digging, which may take several days. They excavate a long tunnel slightly wider than their own bodies. Some don't tolerate any neighbors around; others prefer the company of their own species (who may or may not be relatives). These groups may aggregate their nests, but they still remain solitary in the sense that each bee digs her own nest and provisions her own brood. Still other bees show different levels of cooperation, sharing the tasks of nest building and food provisioning. The underground burrow can be a foot long or even deeper. It may twist halfway or take a turn near the end. At the end of the tunnel, the female bee builds a chamber (called a brood cell) a little wider than the tunnel. A brood cell will be the nursery for just one baby, called a larva. The mother bee fills the brood cell with enough pollen and nectar for just one bee to grow from egg to adult. She then lays an egg and seals the chamber. She may add other branches to the tunnel; at the end of each, there will be another brood cell properly stocked with pollen and nectar and containing an egg.



Underground features of the nest of a mining bee (e.g. Diadasia *or* Melissodes*). Cells show larvae feeding upon bright orange pollen masses. Inset shows an early instar feeding on pollen and nectar provi sion masses.*

Imagine a bunch of grapes; that is what some of the underground solitary mining bee nests look like.

Hole-Nesters: Masons and Leafcutters

Members of several families take advantage of already existing holes. These bees use hollow stems or holes made by beetles or other insects in dead wood. Still other bees locate and use rock crevices or surfaces to form their nests. There, they construct brood cells, usually lined up end-to-end in a row, which they individually stock one by one to serve as nurseries and growth chambers for the larvae, pupae, and young adults.

Most members of the family Megachilidae, mason and leafcutter bees, are hole (rarely ground) nesters who use certain materials to modify their nest chambers. Some use mud to construct partition walls between adjacent cells and a thicker plug to seal the nest entrance from parasites. These bees are called mason bees. Others cut rounded leaf pieces for the same purpose, to line the inner walls of the nest burrow; they are called leafcutter bees. You may have seen those nearly perfect circles neatly clipped from the leaves of your prize rose bushes. Please, don't begrudge this housing material to such hard working mothers. Bees require more than pollen and nectar; and like birds, they depend upon collecting nest-building materials and finding suitable habitats in which to forage and live.

*A female leafcutter bee (*Megachile *sp.) transports a cut leaf she will use as liner for her brood cells. Characteristic cuts made by these bees in leaf margins are shown behind.*

*Excavated nest with branched tunnels made by the eastern carpenter bee (*Xylocopa virginica*) inside wood of a dead log.*

Carpenters

Some bees create burrows, or holes, of their own making. They have powerful jaws called mandibles with which they can excavate tunnels in wood. Fortunately they prefer soft wood and dislike paint or other finishing materials. It is possible to prevent them from doing serious damage to wood structures by taking simple precautions, such as painting or staining the wood. These gentle giants are called carpenter bees, and very likely you have seen some of them and their handiwork. There is usually a pile of sawdust below the opening of the hole during the early nesting and burrow excavation season. These bees create "particle board" spiral partitions between adjacent cells. Most bees construct spiral partition cell closures, a trademark of bees rather than wasps.

Foraging Needs and Floral Specialization

Some bees are generalists and will use pollen from a wide variety of flowering plants. Bumble bees are generalists as they depend upon a

succession of plants flowering from early spring when the queen emerges to late summer – early fall when the colony dies. Other bees have some degree of specialization in foraging; they resort to using pollen from only one or two families of flowering plants. Fortunately plant reproduction has redundancy in floral visitation already built in. Each flowering plant species usually has a small guild of bees and other pollinators which coevolved with them to ensure their pollination. Typically, bees collect nectar from a wider range of blossoms than they visit for pollen.

One example of floral specialization is squash bees which are efficient visitors and pollinators of cucurbit plants (squash, pumpkin, and zucchini). Blueberry bees, globe mallow bees, and cactus bees are also floral specialists. Some bee species are active only for a few weeks during the growing season and depend on just a few families of flowering plants for their foraging needs. Bees in the genus *Macropis* depend only on loosestrife flowers (*Lysimachia*) from which they collect oil and pollen for their larvae's food. Loosestrife flowers however, have no nectar available so bees in the genus *Macropis* must visit other flowers for their nectar needs. One highly specialized bee is *Anthemurgus passiflorae.* This bee is only known to forage on yellow passionflower (*Passiflora lutea)*.

Female Macropis nuda *bees collect floral oils from specialized glands of the spotted loosestrife (*Lysimachia punctata*).*

Most flowering plants bloom during the day. It is during these hours that they produce the most nectar. It is therefore not surprising that most species of bees keep the same schedule. However, there are a few bee species in each of the main bee families that become active foragers only at dawn or dusk. Naturally they are pollinating plants that bloom at such times. They are called matinal or crepuscular bees. In the tropics there are even strictly nocturnal bees that navigate by moonlight!

Females and Males

In general, when not working, female bees rest inside their nests. The male bees, on the other hand, have nothing to do with nest building or provisioning, so they find other places to rest and sleep. Occasionally, it is possible to find a cluster of male bees, clinging by their mandibles to flowers, stems, or twigs. Male squash and gourd bees are frequently found sleeping inside squash blossoms. Look for them in your garden once the sun's heat wilts the squash blossoms.

Male vs. Female?
Above: A female digger bee, Centris pallida, *from the southwestern deserts.*
Below: A male of the same species. Note the color differences and the slender hind legs of the male with no pollen transporting hairs (scopa).

Families of Bees

There are 4,000 species of native bees in the United States. The members of the five most common families, Apidae, Halictidae, Andrenidae, Megachilidae, and Colletidae, can be found throughout the North American continent from Canada and Alaska to warm and sunny Florida and Mexico; from forests to deserts; from remote wildernesses to gardens and backyards; even the National Mall in the heart of our Nation's capital sports a native bee fauna. Perhaps the only places where bees are absent are the high mountains.

*The colorful green-eyed male of a large carpenter bee (*Xylocopa varipuncta*).*

There is even a hardy little bee, the arctic bumble bee, which lives within the Arctic Circle. The young queen begins raising her first brood while there is still frost on the ground. Sometimes she spends hours vibrating her flight muscles while pressed against her brood cells, covering and providing heat for her young. She even has a brood patch, a bare spot on her abdomen, to transfer heat to her babies, just like many birds do. This physical activity and the heat it produces warm the waxen brood cells, speeding the development of the larvae.

Bumble bees and a few other insects are like warm-blooded animals. They can be powerhouses producing energy by rapidly flexing their flight muscles. This intense effort requires a lot of fuel so they depend upon the early-flowering willows and maples to provide plentiful amounts of nectar. Finally, after spending long hours taking care of her initial brood, the busy young queen has to leave the nest in search of supplies for the family.

Apidae (honey bees, bumble bees, carpenter bees, squash bees, southeastern blueberry bees, and cuckoo bees)

The family Apidae is the largest bee family and includes a wide variety of native bee species, and also the nonnative honey bee. In fact, the name of the family comes from the Latin name for the honey bee, *Apis*. It includes all the bumble bees, carpenter bees, and some species of cuckoo bees. Stingless bees and orchid bees that are found in the tropics also belong to this family.

Bumble bees

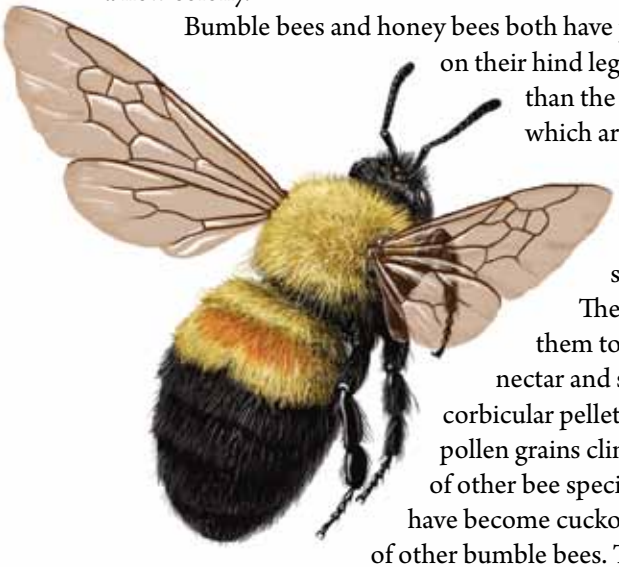
There are about 50 species of North American bumble bees. Many people are familiar with bumble bees. They are large, furry, and mostly black with stripes of yellow, white, or even bright orange. Bumble bees have some things in common with honey bees; they are more sociable than most other native bees, forming colonies with one queen and many workers. However, bumble bee colonies are never as big or as long lived as those of honey bees.

Bumble bees are ground nesters with most making their nests in an underground cavity or in rare cases, above ground partly covered by thatch. The cavities they need for their nests are larger than those of solitary bees, so the first thing that a young queen does in the spring is to find an abandoned mouse nest or a similar burrow. Then she starts preparing it for her brood. She builds a few wax pots that she fills up with pollen and honey, and a larger cell for her brood. Once provisioned the queen lays her eggs, laying no more than half a dozen at first. These eldest offspring are all sterile female workers. Once this brood is fully grown, the queen rarely leaves the nest again and spends all her time laying more eggs while the workers take care of all the activities in and out of the nest.

*A female Morrison's bumble bee (*Bombus morrisoni*) from the western States.*

The colony grows rapidly, and it can reach a population of a few hundred workers. The workers are usually smaller than the queen. It is after her first brood emerges that you will seldom observe large bumble bees foraging. Near the end of the summer, the queen lays male eggs in addition to female ones. The females emerging at this time become queens, not sterile workers, and they soon mate with the males after emerging from the nest.

All workers, male bumble bees, and the old queen die at the end of summer. The only survivors are the new queens, which have already mated. They find a secluded hideaway to spend the winter and go to sleep. Then as winter gives way to spring and the willows begin to flower, the queens emerge and each will found a new colony.



Bumble bees and honey bees both have pollen baskets, called *corbiculae*, on their hind legs. They are more specialized than the pollen baskets of other bees, which are called *scopae*. In honey bees and bumble bees, the tibial segment of the hind leg is flattened, with rows of long, strong hairs along the edges. The shape of these baskets allows them to pack pollen, mixed with some nectar and saliva, into a tight mass called a corbicular pellet rather than the loose mass of pollen grains clinging to the hairs of the scopae of other bee species. A few species of bumble bee have become cuckoos, laying their eggs in the nests of other bumble bees. They have no need for workers or for pollen baskets.

*Above: The pale-colored "impatient" bumble bee (*Bombus impatiens*) from the eastern United States. This is the most common bumble used as a pollinator of greenhouse tomatoes. Below: Female of the rusty-patched bumble bee (*Bombus affinis*). Populations of this species have steeply declined in its eastern and midwestern U.S. habitats.*

Bumble bees are so effective at pollinating tomatoes that their buzz pollination services are put to good use in large greenhouses that grow tomatoes year round. All that is needed is a queen, a box for the nest, and a supply of sugar water because tomatoes produce abundant pollen but no nectar. The bumble bees are free to come and go but remain inside the greenhouse most of the time.

Bumble bees and their pollination services are a key component in agriculture. They are important pollinators of some clovers, a forage crop for cattle.

Carpenter bees

Carpenter bees are typically large and black. You may have trouble telling them apart from bumble bees except for one very distinctive feature: bumble bees are fuzzy all over, while the upper abdomen of carpenter bees is almost hairless, appearing glossy. Early in the spring, males prospect for promising courtship and mating sites, not because they plan to set up housekeeping, but because they know that such places will attract females. They patrol the territory zealously chasing away other males that venture too close. In fact, sometimes they chase away almost anything that moves, including surprised human gardeners. Fortunately, they cannot sting (only females have stingers), so there is nothing to fear and you can let them be. Females have powerful mandibles and use them

Above: Female of the Yellow-faced bumble bee (Bombus vosnesenskii) *in flight. Below: Female of the widespread bumble bee* Bombus pensylvanicus.

to excavate wide tunnel systems in which they build their nests, hence their common name of carpenter bee.

Carpenter bees are not always well-behaved pollinators. Occasionally, when a flower has a long throat that places the nectar out of reach of its tongue, the carpenter bee uses her sharp mouth parts to cut a slit at the base of the flower where the nectar is stored. She then drinks the nectar without coming near the pollen dispensing anthers or stigma of the flower. Thus, carpenter bees can be nectar robbers that cheat the flower instead of doing it a service in return for its nectar. Bumble bees are also capable of floral larceny. Look at the trumpet honeysuckles, horse mints, or abelias in your garden. You may find the telltale signs of these attacks, flowers with their throats slit by thirsty carpenter bees.

Small carpenter bees in the genus *Ceratina* are related to the larger carpenter bees, although you would never mistake them because of the size difference. They nest in pithy stems, such as blackberry brambles or roses rather than digging their own..

*A female large carpenter bee (*Xylocopa virginica*) slits the corolla base of a trumpet vine (*Tecoma stans*) gaining access to nectar otherwise unavailable with its relatively short mouthparts.*

Squash bees

Squash bees (*Peponapis* and *Xenoglossa)* pollinate flowers of squash, pumpkins, melons, and other cucurbits. *Peponapis* squash bees are dependent only on the pollen cucurbits. Squash bees are about the same size and brownish coloration of honey bees. You can easily tell them apart by their behaviors when they are near flowers of these crops. Squash bees are fine-tuned to the daily rhythms of cucurbit flowers. They begin their work shift at or before dawn when the flowers of these valuable crop plants are opening.

They show no hesitation when approaching a squash flower, plunging right in, gathering pollen and/or nectar and quickly leaving. Honey bees, on the other hand, arrive later in the day once the flowers are past their prime. They also take extra time hovering over flowers and visiting them with a slower foraging tempo. Even with honey bee hives nearby, it is estimated that squash bees do many times more pollination per flower per unit time than honey bees. Cucurbit crop growers are very aware of their value as pollinators. These bees often nest underground beneath the very plants they will pollinate. If you are one of those who pick up your own pumpkin to make a Jack-o-lantern, you will be walking over nests full of developing young squash bees.

Females of the common squash bee (Peponapis pruinosa) *visiting a female pumpkin blossom* (Cucurbita pepo *or* C. mixta).

*Females of the southeastern blueberry bee (*Habropoda laboriosa*) visiting and buzz pollinating the flowers of Rabbiteye blueberry (*Vaccinium virgatum*).*

Southeastern Blueberry Bees

The southeastern blueberry bee (*Habropoda laboriosa*) gets its common name from the fact that it forages primarily on blueberries (*Vaccinium* spp). Its native range is the southeastern United States. Southeastern blueberry bees are only active for a few weeks each year. It just so happens that their active season coincides with when blueberries are in flower. Compared to honey bees, blueberry bees are faster and more efficient pollinators of blueberry flowers. The reason for this is that the anthers of the blueberry flower are tubular with an opening pore only at one end. The southeastern blueberry bee attaches herself to the blueberry flower and vibrates her flight muscles very rapidly. Like shaking a salt shaker, pollen comes out of the opening of the anther and is collected by the southeastern blueberry bee. When she moves on to the next blueberry flower, her buzz pollination not only shakes out the pollen but causes pollen clinging to her body to attach to the stigma and pollinates the flower.

What is Buzz Pollination or as pollination ecologists call it, sonication?

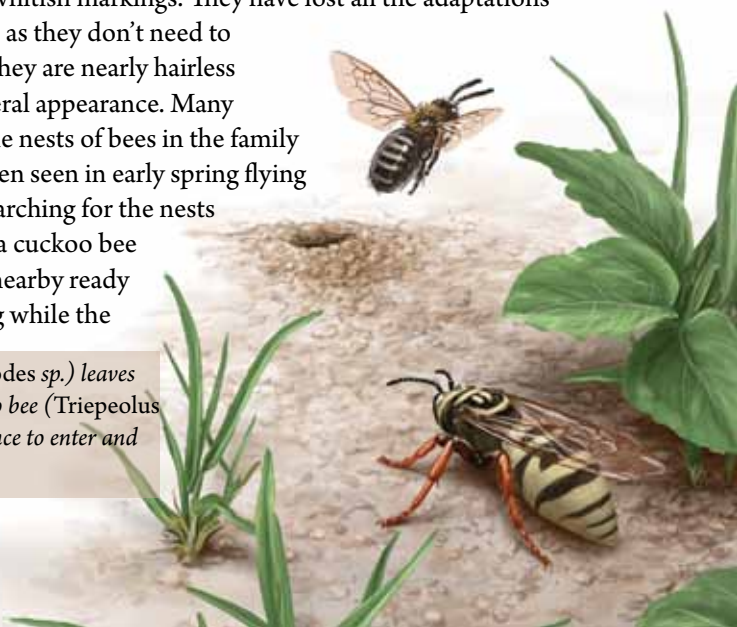
Buzz pollination is the process where a bee attaches itself to a flower and rapidily vibrates its flight muscles. This rapid movement causes the entire flower to vibrate and loosens the pollen so as to flow out the openings in the anthers.

Bumble bees use buzz pollination when pollinating tomato flowers. Other flowering plants that require buzz pollination include cranberries and blueberries, eggplants, and other plant species in the family Solanaceae. Honey bees do not buzz pollinate flowers.

*Two female Morrison's bumble bees (*Bombus morrisoni*) sonicate the pollen from pored-anthers of a garden tomato.*

Cuckoo Bees

One large group within the Apidae family, the Nomadinae, is made up exclusively of parasitic bees, the cuckoo bees. Nomada bees are usually red or yellow, sometimes with whitish markings. They have lost all the adaptations that serve to carry pollen as they don't need to provision their young. They are nearly hairless and are wasp-like in general appearance. Many cuckoo bees parasitize the nests of bees in the family Andrenidae. They are often seen in early spring flying low over bare ground, searching for the nests of potential hosts. Once a cuckoo bee locates a nest, she waits nearby ready to sneak in and lay an egg while the



*A female digger bee (*Melissodes *sp.) leaves her nest unguarded. A cuckoo bee (*Triepeolus *sp.) waits nearby for the chance to enter and lay her own eggs.*

*Females of the brightly-colored Blue Orchard Bee (*Osmia lignaria*) visit and pollinate the blossoms of sweet cherry (*Prunus avium*).*

busy female and rightful owner of the nest leaves in search of food. In some species of cuckoo bees, the female kills the larva as part of the process of parasitizing the nest. The egg of the cuckoo bee develops rapidly and grows into a larva that kills and eats the resident host larva in addition to the pollen and nectar food reserves inside the host cell.

Megachilidae

This family contains mason bees and leaf-cutter bees. The females use leaves and/or mud in their nest construction. Most of these bees nest in holes, either in wood or hollow twigs, but there are also a few that nest in the ground. There are a few species within this family that are not native to the United States, but that have been introduced either intentionally or unintentionally in this country. An interesting characteristic of the bees of this family is that they don't carry the pollen on their back legs but on the underside of their abdomens.

If you happen to see a bee, about the size of a honey bee, with a yellow belly dusted with pollen, you can be sure that it is a megachilid bee (although sometimes the color of the pollen it is carrying may be white). However, some megachilid bees carry such large yellow/orange loads of pollen that they look like flying "cheetos" snacks coming in for a landing at their nests.

The blue orchard bee, *Osmia lignaria,* of the western United States is being managed for the pollination of fruit trees (especially sweet cherries and almonds). Farmers are providing drilled boards as nesting sites. Already it is proving to be an excellent replacement for the beleaguered honey bee on a local, though not national, level. Much remains to be learned about convenient rearing and use of this beautiful blue bee.

Halictidae (sweat bees)

Some of the most beautiful bees belong to this family. With their shiny metallic-colored bodies, these bees will capture your heart. Many are metallic green, but others have shades of color from blue to copper or gold, and sometimes even black. Most nest in the ground. Some are solitary while others share the entrance to their nests. In most cases, that is all they share and are not truly social. However, a few sweat bee species go a step further and show some division of labor in guarding the entrance to their homes and rearing their young. Usually they are sisters that originated from the same nest. Some species of sweat bees can be considered truly social; with a division of labor in which the mother and founder of the colony lays eggs while the daughters do all the other work.

Some unusually attractive halictids (green, yellow and black-striped *Agapostemon* species) are found throughout North America. One of the prettiest halictid bees is *Augochlora pura* (the name means the pure magnificent green bee) found in the eastern United States. It has the peculiar habit of building her nest under the bark of a rotted log. She takes advantage of the

A colorful sweat bee, a male Augochlorella pomoniella *from the western States.*

Another gorgeous sweat bee, a male Agapostemon texanus.

loose, half-rotted material to make the housing, adding her own saliva and secretions to build an envelope for her eggs and accumulated pollen. She kneads the pollen into a number of little loaves shaped like tiles, which she then plasters on the inner wall of the brood chamber and then lays an egg before sealing the cell completely. This precaution is necessary due to foraging ants and other predators that abound under loose bark.

One interesting and commercially valuable halictid bee is the alkali bee, *Nomia melanderi*, of the western United States. As its name suggests, the alkali bee prefers to build its nest in alkaline soils. It often lives in dense aggregations (up to tens or hundreds of thousands of individuals). However, it is not social since each female constructs her own burrows and tends to her own brood, but lives compatibly with and in close proximity to other alkali bees. The alkali bee is a very good pollinator of alfalfa, and some growers take advantage of its nesting habits to manage this species to a limited extent. They supply the appropriate terrain for the alkali bee's needs near alfalfa crops. The farmers even go so far as creating it artificially by using a tarp, covering it with clay, and watering it as needed to create nesting beds. Once established, these alkali bee beds can remain active for decades.

There are also some cuckoo bee species in this family, and just like the other cuckoo bees, they are almost hairless and somewhat wasp-like. Some have a bright red abdomen.

Andrenidae (miner bees)

The andrenid bees are all ground nesters and thus the common name miner bees. They are mostly dark, black, or reddish, but they can be metallic blue, yellow, or red and yellow. They are often shy, medium- to large-sized bees. They can be distinguished from other bees by the velvety patches (foveae) on their faces, between the eyes and the base of the antennae, though these patches are often visible only under a microscope. Many are active only in the early spring. The next generation remains underground developing through the summer, fall, and winter only to emerge the next spring when their favorite flowers are in bloom.

What would eastern forests be without azaleas? Their flowers are one of our native flowering plants that honey bees cannot pollinate. They don't release

*Female andrena (*Andrena cornelli*) visit an eastern Azalea (*Rhododendron canescens*).*

their pollen like most flowers, but hold it inside the anthers waiting for a skillful bee that knows how to shake it, just like a saltshaker. Further the pollen clumps are tied together with sticky threads. Bumble bees and a number of solitary bees are good at pollinating azalea flowers. The Cornell azalea bee (*Andrena cornelli*) is one of them, a dark-colored, slender bee that is found in the eastern United States. It is never too far from azaleas because their pollen is its favorite food. Her pollen baskets have long, widely spaced hairs that are especially adapted to the texture and size of these flowers' pollen clumps.

Andrenids are among the earliest bees to emerge in the spring. You will observe them visiting willows, maples, violets, and other early blooming spring wildflowers. Some andrenid bees are very good pollinators of apple blossoms.

*A male yellow-faced bee (*Hylaeus *sp.) in flight.*

Colletidae

This is a small family of solitary bees which is considered more primitive than other families of bees. Some of them such as the yellow-masked bees, *Hylaeus*, do not have baskets in which to carry pollen. Instead, these bees carry pollen inside their crops. They are not as hairy as other bees and can easily be mistaken for wasps. They all nest in pithy stems. Sometimes they form large aggregations of closely spaced nests. They use a cellophane-like material exuded from glands to line the brood cells where they lay their eggs; so sometimes they are called cellophane bees.

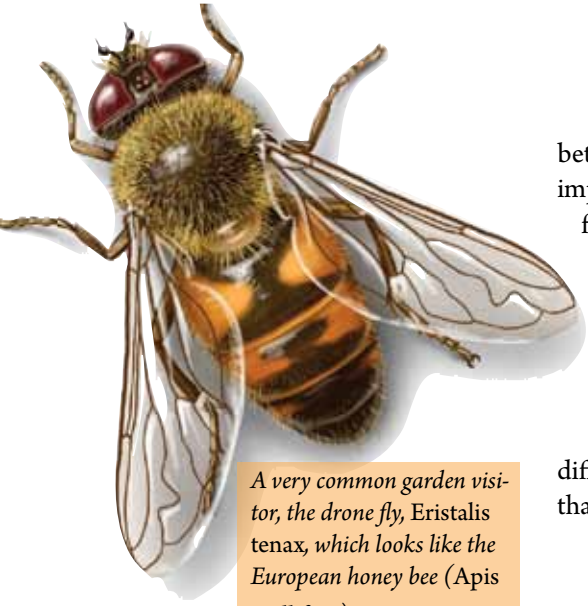
Bee Mimics

Last but not least, there are superb impersonators of bees, the flower flies or syrphids. Don't be fooled by them. Despite their appearance, they are not bees but flies. They are frequent flower visitors, and they don't have a stinger like most bees. They masquerade as bees to fool hungry birds.

*A bee-mimicking fly (*Eupeodes *sp.).*

Often they succeed in fooling the inexperienced observer of bees, as well. Bee-flies, another family of bee mimics, are parasites of many bee species. All flies have only one pair of wings as compared to the two pair of wings possessed by bees This is a significant difference between flies and bees, but it is nearly impossible to notice when they are flying about. Part of the reason for this difficulty is that bees' wings have tiny hooks that lock the front and hind wings together making them appear as just one on each side. There are several other differences that would be more helpful to the observer of these flower visitors. Bee-flies and syrphid flies have huge eyes, very short antennae, and skinny legs when compared to bees.

Another bee-mimicking (possibly bumble bee mimic) flower fly (Mallota posticata).



A very common garden visitor, the drone fly, Eristalis tenax*, which looks like the European honey bee* (Apis mellifera*).*

Another syrphid, or flower fly wasp mimic (Heliophilus pendulus*).*

Conservation

In recent years the general public has become aware that honey bees are in serious trouble. Honey bee colonies have been mysteriously dwindling in what has been called "Colony Collapse Disorder." The cause is unknown, but may be due to a combination of factors including diseases, nutrition, stress, and pesticides. This is just the most recent of several honey bee die-offs over the past century. What most people don't know is that it's not just honey bees that are declining. Some native bees and other pollinators are experiencing population declines and range reductions. Many of the same factors affecting honey bee health are also affecting native bee species health as well.

Several bumble bee species on the east and west coasts of the United States have been declining precipitously. One hypothesis is that these bees may have become infected with a microsporidian fungal parasite from infected greenhouse bumble bees used to pollinate hothouse tomatoes that have escaped from their greenhouses. In the Pacific Northwest, Franklin's bumble bee appears to be on the verge of extinction. Unfortunately, we know so little about most of these bees that it is difficult to fully assess the situation and determine the causes for their declines. Buchmann and Nabhan called attention to this problem as early as 1996 in their book, *The Forgotten Pollinators*. They emphasized the urgent need to learn more about our native pollinators and to take steps toward conserving and sustaining their populations.

It may seem strange, but honey bees may be contributing to the extinction of some native bees. Honey bees can out-compete many native bees and extract vast amounts of pollen and nectar from every habitat in which they live. We can only speculate what the impact of the arrival of honey bees has had on the populations of native bees in the 400 years since they were brought to North America by European colonists.

Habitat loss and fragmentation are adversely affecting populations of native bees. Pesticides may also have an impact on many species including native bees. This became dramatically apparent in New Brunswick, Canada, years ago when the blueberry crop was nearly wiped out despite the fact that the plants appeared healthy.

It was determined that the program to control the spruce worm in nearby forests had almost eliminated the native bees. Blueberry farmers started litigation that went all the way to the Supreme Court of Canada. Eventually, they succeeded in having the Government place restrictions on the use of pesticides. It took a number of years before the local populations of native bees were restored, and blueberry crops became plentiful once again.

The situation for all pollinators, but especially managed and native bees in the United States, caused sufficient concern that the National Research Council of the National Academy of Sciences issued a report titled "Status of Pollinators in North America" in October 2006. The document presents evidence of downward, long-term trends of the populations of many pollinators, including solitary bees and some bumble bee species. However, one of the report's more important findings was that a great deal of additional information is still needed to begin to assess population trends and discover their causes.

The National Research Council recommendations include the creation of economic incentives for the study of bee populations through a system of long-term monitoring and for the development of practices promoting pollinator conservation and sustainability. Another recommendation is to encourage public land managers and private landowners, including farmers and homeowners, to adopt "pollinator-friendly" practices, many of which require only a small expenditure to implement.

Pollinator Awareness

A number of government agencies, nongovernmental organizations, and private individuals are creating pollinator gardens throughout the country that will benefit native bees and other pollinators. The USDA Forest Service, the North American Pollinator Protection Campaign, the Pollinator Partnership, Urban Bee Gardens at U.C. Berkeley, and the Xerces Society each supply information to those who want to start gardening for pollinators or improving bee habitat in general.

In Canada, the citizens of Guelph, Ontario, have gone a step further, creating the world's first Pollinator Park at the Eastview landfill site. In part, they were inspired by the experience with the blueberry pollination disaster. They are turning an ordinary landfill, about 100 acres, into an oasis for bees and other pollinators with the right plantings and proper habitat for nesting.

What You Can Do

- Plant a pollinator garden. Some gardeners are fearful of being stung by bees and would rather they were not in their gardens. Most native bees are quite different from honey bees and yellow jackets (which are not pollinators) as they rarely sting gardeners and if they do, the sting tends to be mild. In fact, there are some bees, such as the Andrenid bees, that are incapable of stinging humans because their stingers are too small and weak to penetrate their skin.
- Avoid pesticides or choose non-chemical solutions to insect problems. If you must use a pesticide, read the label and apply and dispose of it according to label directions. Where appropriate, consider using organic pesticides. For example, aphids can be easily removed by spraying them with water from a garden hose. Pesticides can also be applied when pollinators are not active, before dawn and at sundown.

As best as you can, try not to apply the pesticide to the flowers. Doing so will keep visiting pollinators from sipping contaminated nectar or carrying off contaminated pollen. Avoiding the use of pesticides may be a reasonable choice in some cases. Nature has its own checks and balances and manages to keep most pests under control without gardeners having to resort to pesticides. Remember, some damage to plants is part of the ecology of your garden.

- Provide a source of pesticide-free water and mud. A dripping faucet, mud puddle, or birdbath attracts butterflies and beneficial insects. Mud is an important nesting material for some bee species. Providing a clean source of water for birds and other pollinators limits their exposure to possible toxins in the garden.

• Plant native plants from your ecoregion. Using locally native flowering plants is the best gardening you can choose to benefit your local pollinators. Native pollinators and native plants have become mutually adapted through millions of years of partnership with one another. Plant-pollinator partners exist in your ecoregion. Finding and planting the right plants makes a huge difference for pollinators.

• Provide a variety of native flowering trees, shrubs, and wildflowers that bloom successively throughout the seasons. Fortunately this is exactly what most gardeners aspire to have in their gardens. Many highly selected cultivars don't provide for the needs of pollinators. In most cases, they have lost the floral cues that attract pollinators to their flowers. In some cases, these improved cultivars no longer produce pollen or nectar and as such do not provide any food to bees. Using native plants also requires less care as they are adapted to local climates. Using native plants can be easy on the pocket book. Many modern cultivars and nonnative plants such as many of the roses require a great deal of time and money to care for them. Think of the flowers your grandmother used in her garden as a practical guide, especially when using nonnative plants. The pollinators will thank you.

- You can also plant the kind of lawn that provides habitat beneficial to bees. A perfectly manicured, pesticide-saturated lawn is a desert to wildlife, including pollinators. Reducing the size of the lawn by creating pollinator gardens will benefit native pollinators and other species of wildlife. It is possible to have a lawn that is good for native bees while being esthetically pleasing. As mentioned before, stay away from pesticides and herbicides as much as possible. Second, allow some small wildflowers to become part of your lawn. The look of your lawn may change as a result, but it will continue to serve its purpose. Clover is great food for native bees. It also fixes nitrogen, reducing the need for fertilizers. Other small plants that benefit native bees are plantago, and veronicas. Rather than calling them weeds, call them pollinator food.
- Provide nesting habitats for bees. A simple bare spot here and there (no mulch or grass, just bare soil) may be enough for an aggregation of hard working soil nesting native bees. A sand pile may be even better. Standing dead trees are important nesting habitats for 30 percent of our native bees. If you cannot tolerate a dead tree on your property, it may be possible to keep a stump or a standing log, and use it as an attractive planter. Perhaps it will, in turn, provide housing space for bees. Drilling holes on an old post or even a tree trunk would also make good nesting sites. The holes should be 3/32" to 3/8" in diameter (7-8mm) and 4 to 5 inches deep.

- Build or buy your own bee houses. There are many in the market, and it is relatively easy to build your own by following instructions posted on several websites. Watching the comings and goings of busy female bees can be as much fun as observing a bird house. They become watchable wildlife. Hollow paper tubes, just about the size of drinking straws, can also be used as bee nests. Some of the suppliers listed sell them. You can also tie up a bunch of hollow twigs, such as elderberry, or paper drinking straws together (plastic ones are not used by the bees) or pack them into a container such as a small milk carton and place them horizontally facing south or southeast. They should be closed at one end (see links at the end for instructions). Gluing the straws at their back ends into your container is helpful.

Conclusions

Helping native bees is essential to our continued survival, health, and well-being. These animals benefit us all because of the invaluable ecosystem services they provide to the environment and to our farms, forests, and gardens. Not only do they pollinate most of our flowering plants, their bodies feed other wildlife and their ground-nesting behaviors aerate and enrich soils. They enrich and sustain our lives. The observation of native bees can become a lifelong pastime and pleasure. Become involved. Observe bees with close focusing binoculars; plant a small pollinator garden; or help a neighbor, student, or family member drill small holes in scrap lumber to create a bee

house. Join a pollinator and plant-friendly organization to learn more about pollinators and their flowers, like the Pollinator Partnership (www.pollinator.org). Become a pollinator observer as a citizen scientist and report your observations. Some of our bees are declining, and your findings are invaluable to understanding the big picture. Most importantly, get outdoors with your children and experience the amazing natural and urban habitats that we share with pollinators and flowering plants. Do your share to make sure that this precious legacy continues.

Resources

- http://www.pollinator.org – Bee articles, planting and gardening guides
- http://www.fs.fed.us/wildflowers/pollinators - one of the Web's most informative sites concerning pollinators.
- http://www.nature.berkeley.edu/urbanbeegardens/ Urban Bee Gardens. Berkeley University.
- http://www.nwf.org/gardenforwildlife/beehouse.cfm Bee houses. National Wildlife Federation. (How to build a bee house)
- Attracting Native Pollinators. 2003. The Xerces Society and The Bee Works. Portland, Oregon. (Bee gardens, bee houses, etc.)

Sellers of bee houses

- http://www.knoxcellars.com/ Knox Cellars.
- http://www.masonbeehomes.com/index.php Mason bee homes.

Additional readings

- Buchmann, Stephen L., Nabhan, Gary Paul. 1997. The Forgotten Pollinators. Island Press, Washington, DC, Covelo, CA, ISBN 1-55963-353-0. 292 pp.
- Mader, Eric, Spivak, Marla and Evans, Elaine. 2010. Managing Alternative Pollinators: A Handbook for Beekeepers, Growers and Conservationists. SARE Handbook No. 11, NRAES-186. Natural Resource, Agriculture and Engineering Services (NRAES), Cooperative Extension, Cornell University, Ithaca, NY. 162 pp.
- Packer, Laurence. 2010. Keeping the Bees: Why All Bees Are At Risk and What We Can Do to Save Them. Harper Collins Publishers LTD., Toronto, Canada. 273 pp.

Bee families, description, classification

- O'Toole, Christopher, Raw, Anthony. 1999. Bees of the world. Cassell Illustrated. ISBN 0-8160-5712-5.
- http://www.umext.maine.edu/onlinepubs/htmpubs/7153.htm Understanding Native Bees, the Great Pollinators. University of Maine Cooperative Extension. Bulletin #7153
- http://www.everythingabout.net/articles/biology/animals/arthropods/insects/bees/ Everything About Bees. Everythingabout.net
- http://www.gnb.ca/0171/10/0171100025-e.asp Native Bees that Pollinate Wild Blueberries. (Families that pollinate blueberries; nests, etc.) Department of Agriculture and Aquaculture of Canada. New Brunswick
- http://www.greatsunflower.org/ The Great Sunflower Project. (Information on bee families).

Conservation

- http://dels.nas.edu/dels/rpt_briefs/pollinators_brief_final.pdf Status of Pollinators in North America. The National Academies.
- http://nappc.org/pollinatorEn.html North American Pollinator Protection Campaign
- http://www.pollinator.org – Useful resources page has 20 bee articles.
- http://www.xerces.org/wp-content/uploads/2009/01/how_to_protect_native_bees.pdf Native Pollinators. How to Protect and Enhance Habitat for Native Bees.

Photo Credits

p. 30-31, carpenter bee (*Xylocopa virginica*) on rose (*Rosa* sp.) by Teresa Prendusi
p. 32-33, women in native plant pollinator garden by Laura Christman
p. 34, megachilid bee (*Megachile* sp.) on blanket flower (*Gaillardia* sp.) by Jim McCulloch
p. 35, bee house created by Beatriz Moisset
p. 36, a bumble bee (*Bombus* sp.) on purple coneflower (*Echinacea purpurea*) by Teresa Prendusi

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