

AN INTRODUCTION TO BEES



What Are Bees?

Anyone who has spent a lovely warm morning in a garden in spring has shared company with a bee. From a farm in the Central Valley to a community garden in the center of Los Angeles, bees are busy buzzing around, visiting flowers, gathering resources for their offspring, and in the process, transferring pollen from flower to flower.

Bees are flying insects that first emerged about 100 million years ago, during the Cretaceous period, as part of the radiation of insects. The earliest record of bees is from fossilized amber in Myanmar (formerly Burma).

Bees are part of a larger group of insects, the order Hymenoptera that includes wasps, sawflies (a primitive and less well-known group), and ants. Bees belong to a large group within the Hymenoptera that are distinguished, in part, by having females with stingers. This group is called the Aculeata and contains the bees, ants, and stinging wasps. Recent work on the relationship between bees and wasps shows that bees are really just a very specialized group of wasps. Formally, we say that bees are in the superfamily Apoidea along with the sphecids wasps and make up the group Apiformes. No wonder bees and wasps can be so hard to tell apart!

While beetles were probably the first pollinators, bees were the first group of insects to really show a diversity of adaptations for pollination, such as specialized hairs and leg modifications, both for carrying pollen. This close relationship between bees and flowers is thought to have aided in the rapid evolution of different types of flowering plants and has strongly influenced both the body plans and lifestyles of bees and flowers.

When you look at most bees, you see a fairly hearty and hairy flying insect. Although there are bees that are slender and sleek, the most well-known, like the bumble bees and honey bees, are robust and hairy. Their hairs are an essential part of the service that bees are renowned for, transferring

pollen from plant to plant. The hairs hold pollen onto the bee body. However, while it may seem bees are providing this service to plants free of charge—almost as if the flowers were taking advantage of them—the bees are actually getting great benefits from the interaction. What the bees are really doing is searching out food for their offspring and themselves. Bees rely on plant pollen for protein and nectar for energy. In fact, the sole source of protein for most bees is pollen. These bees could not exist without flowers to feed them.

When you see a bee visiting a flower, it is probably either collecting pollen or drinking nectar. If the bee is collecting pollen at flowers, she is a female gathering food to take back to her nest for her larvae. She might stop to fill up on some nectar, but her primary aim is to gather pollen for her offspring. This behavior highlights one big difference between bees and the closest wasp relatives of bees, the sphecoid wasps: the larvae of sphecoids are carnivorous, eating spiders and insects, whereas bee larvae are vegetarians, relying on pollen for protein. Of course, as with everything in nature, there is an exception to this rule: a group of tropical bees that feed their offspring carrion. If you see a bee simply drinking nectar, it is more likely to be a male bee. Male bees do visit flowers to tank up on nectar, but they do not collect pollen, as they do not provision nests.

At first glance, it can be difficult to tell bees, flies, and wasps apart because they have similar sizes and colors. Flies and wasps are confusing because they often look like bees. Some striped flies may actually be bee mimics, trying to fool predators! To tell bees and wasps from flies, there are three main distinguishing features: the number of wings that there are on each side, the shape of the antennae, and where the eyes are placed on the face. Let's start by distinguishing flies from bees. First, the number of wings on a side makes it easy to distinguish flies from bees and wasps. Flies have a single wing on each side. Bees and wasps have two per side.

MIMICRY

Many distasteful or poisonous species that are trying to signal a warning use combinations of the colors yellow, red, and black. From snakes to butterflies to bees, those colors make them very apparent and protect them from attack. Predators quickly learn to avoid prey with particular color patterns. The color patterns of bumble bees are a good example of warning coloration. When two or more poisonous species share a predator and have a similar color pattern that cannot be attributed to relatedness, scientists call it Müllerian mimicry. This might explain the similarity in color patterns between bees and wasps. Another explanation for the similarity of color patterns might be that they all inherited the pattern from a common ancestor. We also see a different kind of mimicry of bees. When a harmless species mimics the color pattern of a dangerous species, it is called Batesian mimicry. In this situation, the dangerous species is called the model and the common species is the mimic. A number of species of flies have color patterns very similar to those of bees, especially bumble bees. These are probably examples of Batesian mimicry. For Batesian mimicry to be effective and maintained, the model must be more frequently encountered than the mimic. Otherwise, the predator may learn that the mimic is a good prey item and periodically consume some of the model.

It can be hard to tell that bees have a pair of wings on each side, because the wings on bees and wasps can be hooked together with special hooks called hamuli. When looking for bees on flowers, you can often tell that an insect is a fly because its wings are not neatly folded over its back; instead they point out at an angle. Second, you can look at the insect's antennae. Flies generally have short, thick antennae, whereas bees have longer, thinner antennae. Finally, bees

have large eyes that are on the side of the head. Flies have large eyes on the front of the head. Other general rules of thumb are that bees tend to be hairy, and they carry loads of pollen, whereas flies have fewer hairs and do not generally carry pollen. This does not work when distinguishing male bees from flies, as male bees do not generally carry pollen and do not have elaborate structures like scopae, the pollen-carrying structures on a bee, for doing so. Behaviorally, bees do not hover whereas many but not all flies do.

Wasps are much more difficult to distinguish from bees. Given that bees and wasps are much more closely related than bees and flies, this is not too surprising. Bees and wasps both have two pairs of wings per side and are often the same size, shape, and color. In general, wasps look “meaner” than bees. This may be because wasps seem to have more armoring in their exoskeleton, the protective covering over the body, than bees. Bees tend to have a broader body and wider abdomen than wasps. Bees’ bodies are usually hairy, and in general, their exoskeleton is a single color, except for stripes on the abdomen. Wasps are less hairy and often have patterns or designs in their exoskeleton. One unique thing about wasps is that the hairs on their faces are often shiny or metallic, often silvery, whereas bees have duller hairs or no hairs. Under magnification, bees can be identified by the presence of plumose or branched hairs on some parts of their body and their legs and by the hind basitarsus (basal segment of the tarsus), which is often more flattened (broader in one dimension and narrower in another) than the next segments of the tarsus.

Importance of Bees

The conservation of bees is central to biodiversity and life on Earth, to food security, and to the global economy. While bees are well known for their honey production, it is pollination that makes them critical to life on Earth. Bees

are involved in pollinating about 70 percent of the world's flowering plants. For flowering plants, which cannot move themselves, having a bee move pollen dramatically increases the distance pollen can travel to fertilize seeds and thereby increases the potential number of mates. There are many advantages to expanding the number of potential mates. In particular, mating with more individuals increases genetic variation, which provides the raw material for evolution and adaptation, and those populations with greater genetic variation are going to have a higher probability of surviving as environments change.

There are several examples of plants that seem to be declining more than they would if they had a healthy pollinator community. For example, in the Antioch Dunes of the San Francisco Bay Area, there is a primrose (*Oenothera deltoides* subsp. *howellii*) that is pollinated both by hawk moths and by bees. In fact, it has a specialist bee that visits it, *Sphecodogastra antiochensis*, that flies in the early morning and evening when the flowers are open, and this bee is now rare. This primrose is producing only 35 percent of the seeds that it might with a healthy pollinator community. Both the specialist bee and the primrose are considered rare or endangered and are only found within the 75 remaining acres of the Antioch Dunes.

If we think about the benefits of bees to people, the pollination of food plants is equally important. Bees pollinate about 75 percent of the fruit, nuts, and vegetables grown in California. Amazingly, with this much of the food supply at stake, agriculture relies almost exclusively on a single pollinator, the Western Honey Bee, *Apis mellifera*. In the United States alone, the value to crop production of pollination by this single species is estimated to be \$14 billion. Our reliance on this species is still increasing. Demand for Honey Bee colonies increased approximately 25 percent from 1989 to 1998 and has continued to increase since that time.