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INTRODUCTION

Did you know that more than 4000 species of bees live in the United States and Canada? To put that in perspective, there are 4 times more species of bees in these two countries than all the bird species north of Mexico, 6 times more kinds of bees than butterflies, and about 10 times as many bee species as mammal species. Despite their diversity, few people know anything about bees, even the ones in their own backyards. For example, everyone knows that robins nest in trees, that bears hibernate, and that butterflies start out as caterpillars, but most people don't know where bees live, how they spend the winter, or what they eat. This book is designed to introduce you to the bees of the United States and Canada, including their lifestyles and habitat preferences, and what you can do to attract them to your neighborhood. Understanding bees is beneficial not only to the bees, but also to your gardens.

An *Andrena* species visiting a prickly poppy (*Argemone*).

Gotham's bee

A new species of sweat bee was recognized in New York City in 2010 (with the scientific name *Lasioglossum gothami*). While it has probably always lived in New York City, it was until recently completely overlooked by scientists. There are likely many similar cases around the world.

Over 20,000 species of bees have been identified around the world. New species are being found every year, even in places like New York City. Because new species are continually discovered, scientists estimate that up to 30,000 species might exist worldwide. Bees can be found on every continent (except Antarctica), on small islands, on treeless mountaintops, in jungles and deserts, and on top of high-rises in Chicago. They are most abundant in dry and hot environments, like Mediterranean Europe, and the southwestern United States.

Though the drab reddish-brown honey bee is the default image conjured by most when they hear the word "bee," these creatures are in fact diverse and stunning beauties, and the menagerie includes blue and green jewels like *Osmia* and *Agapostemon*, fire-engine red *Nomada*, jet-black fuzz-balls like *Anthophora*, and zebra-striped *Anthidium*. Some of the smallest bees in the world are found in North America. *Perdita,* found in the southwest United States, measure only 0.1 inch, smaller than George Washington's nose on a quarter. At the other extreme, North America is home to giant bumbling carpenter bees

The short and the long of it

The smallest bee in the world measures only 0.08 inch and is found in South America (*Trigona minima*). The largest bee in the world lives in Malaysia (*Megachile pluto*); it is 1.5 inches long.

The largest and smallest kinds of bees found in North America, a *Perdita* (left), and a *Xylocopa* (right).

(*Xylocopa*). At more than an inch long, they sound like miniature helicopters as they hover near flowers.

Bees are thought to increase seed set in 70% of all flowering plants, including many of the fruits and vegetables we enjoy. The special relationship that exists between bees and the flowers they visit is not only economically (and gastronomically) important; it is also unique from a biological perspective. Although there are other organisms that are capable of pollination (and are, in fact, good at it), bees are the only ones to actively gather pollen from the flowers they visit, creating an evolutionary dynamic seen nowhere else in the animal kingdom. Despite the particular talents and unquestionable importance of bees, scientists have reason to believe that some bee species may be experiencing widespread population declines. While the specifics are still being assessed, some things are certain: bees are all around us, they enhance the quality of our lives, and they benefit from our improved understanding of them and their needs.

Our hope is that this book will turn amateur naturalists, gardeners, entomologists, and curious souls on to the amazing lives of the bees that not only reside in untamed wild areas, but also flourish in our very neighborhoods. With understanding comes appreciation; in addition to describing the life stories associated with the many bee species of the United States and Canada, we provide examples of ways to encourage these wonderful pollinators on your own plot of land.

1.1 IS THIS A BEE?

Even though bees are common in most neighborhoods, frequently seen on hikes, and ubiquitous residents of city parks, it is hard to tell whether an insect buzzing nearby is a bee or something else. It's no wonder people get confused. Because bees sting, resembling one is a successful strategy for vulnerable insects, and many a bug has evolved the appearance of a buzzing bee; however, a keen eye and a little practice are all you need to see past the ruse.

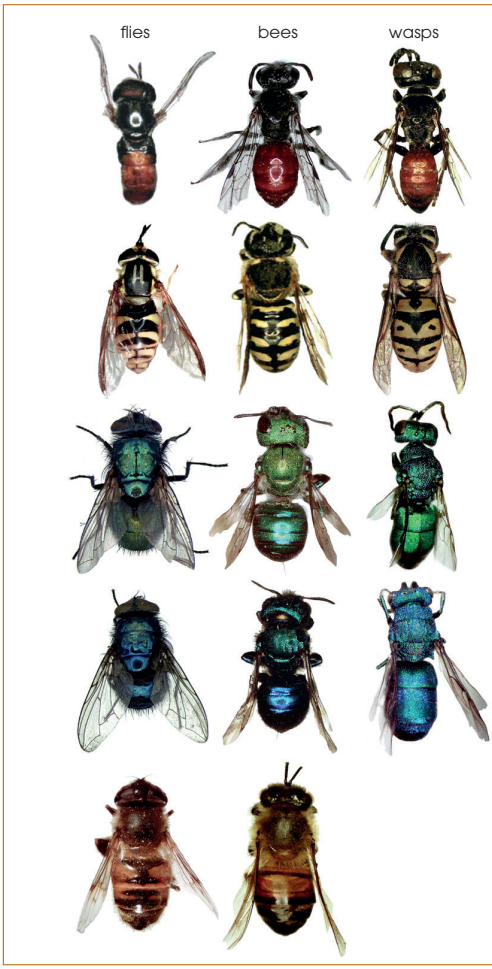
Bees and wasps are the most similar in appearance, and they are the most easily confused. It is not uncommon to hear complaints about the "bee" that landed on somebody's hamburger at a recent family picnic. Stories of the pesky nest dangling from a branch in the backyard abound. Hikers complain about the horrible buzzing creatures that swarmed from a log they used as a backrest halfway up the trail. And every summer, someone is attacked by "ground bees" while mowing the lawn. In all cases, the annoying insect was probably not a bee but a wasp. Wasps (including hornets and yellow jackets) and bees are close relatives, sharing in common a grandmother 100 million "greats" ago. In some instances the two are so similar that even trained scientists have difficulty distinguishing them. The bee called *Neolarra* (see section 9.1), for example, was thought to be a wasp by the first researchers to see it. It didn't help that the bee was dead and stuck to a pin, because the most telling

A *Megachile,* resting on a cactus flower (*Echinocereus*).

From highest to lowest, a fly, a wasp, and a bee visiting a "watering hole." On the fly, note the short antennae just visible on the face. On the bee, note the yellow masses of pollen on the legs, which the wasp is lacking. Photo by B. Seth Topham.

Meat-eating bees and pollen-eating wasps

There are exceptions to nearly every rule about the differences between bees and wasps. In South America, for example, a group of bees (*Trigona*) feeds its young with dead animal flesh, and in North America a group of wasps (*Pseudomasaris*) feeds its young with pollen.



This image shows some common flies (left), bees (middle), and wasps (right). You can see that the three groups commonly look a lot alike and that it takes an experienced eye to see the differences. Notice that all the flies have triangular heads (when viewed from above) with short little antennae and just one wing on each side of the body. Wasps and bees look even more similar; look for rough integument (skin) on wasps, with many tiny pits, as well as antennae that commonly are very close together on the face, and spindly legs.

differences between bees and wasps are their mannerisms and day-to-day behaviors.

Most important among these behavioral differences is that bees are pollen eaters. Wasps, in contrast, are meat eaters. While both visit flowers for nectar (the "energy drink" of the insect world), bees also visit flowers in order to collect pollen for their young. On the contrary, wasps pursue other insects and drag them back to the nest for their offspring to devour. This one dietary difference has resulted in very different bearings. To aid in the gathering of pollen, bees are usually hairy (pollen sticks to hair), and many species look like cotton candy with wings. Rooting around in flowers is messy business, and a few minutes rummaging among floral parts leaves a bee coated in hundreds of tiny grains of pollen. Using her many legs, the bee grooms herself, wiping all the pollen to the back of her body, where she stuffs it into the spaces between special stiff bristles on her legs or belly. These tufts or masses of special hairs are called scopa. Quite the opposite of the furry bee, wasps look like Olympic swimmers, devoid of all hair, skinny-waisted, and with long spindly legs.

A *Melissodes* bee foraging on a sunflower (*Helianthus*) with a large pollen load stuffed into the pollen-collecting hairs (scopa) on the back legs.

It's so *fluffy*!

Bees generally have lots of hair; wasps don't. In fact, one of the few consistent differences between the two is that, somewhere on their little bodies, bees have branched hairs similar to tiny feathers.

There are exceptions to every rule, of course. Some bees have scant hair on their bodies and are wasp-thin. In these cases, look for silvery or golden hairs on the face; wasps tend to have glistening mugs, while bee hairs don't shimmer from any angle. Behavior, as mentioned above, can be telling, too. Bees spend more time on flowers than wasps do; wasps in contrast are more likely to raid your backyard barbeque in search of animal proteins accidentally left on a plate.

A wasp. Note the silvery hairs on the face, and the long spiny legs. The spines help hold onto insect prey the same way cat claws do.

Since bees and wasps are difficult to distinguish, many stung victims often blame the hapless bee for crimes not committed. The culprit in these cases is likely a paper wasp, a hornet, or a yellow jacket. All live socially in hives. Ever the opportunists, these wasps take advantage of the many resources found in urban environments, often building their homes along fences, under eaves and decks, attached to windowsills, or in various holes or cavities. All three will collect fibers from dead wood and plants and then use their saliva to make a papier-mâché house of sorts. These nests often bear a strong resemblance to the honey bee hives depicted in Winnie the Pooh books, and it is thus not surprising that many people think these wasps are bees. These kinds of wasps also enjoy taking a bite of your grilled chicken back to the nest to feed their offspring, or stopping

A paper wasp ripping apart a katydid to transport back to the nest (wasps are voracious carnivores). Note the long narrow wings, folded in half and draped like thin ribbons down each side of the back.

The hive of a paper wasp at the height of activity. Most bees do not live in hives, and their homes can more accurately be called nests. Nests are typically in the ground, and each nest usually houses one individual, instead of a whole colony.

A yellow jacket's nest is built from a paper-like substance and is frequently mistaken for a beehive. While many people think these wasps' nests are beehives, bees do not make exposed paper-like hives. Photo by Lindsey E. Wilson.

Bee vs. wasp (physical differences)	
Bee	**Wasp**
usually thick-bodied	skinny body with narrow waist
no silver hair on face	often with silver hair on face
often very hairy	generally hairless
pollen-collecting hair on legs or belly of females	no pollen-collecting hairs
stout legs with relatively few spines	long thin legs with spines

on the lip of your glass of root beer for a sugary sip. The gangly, thin-waisted, and hairless body gives them away as wasps and not bees, however. In addition, the wings of these wasps in particular are folded in a distinctive way. Rather than lying flat across their back (thorax) so they overlap over the abdomen, their wings run as parallel dark strips on either side of the thorax.

Though not close relatives of bees the way that wasps are, many flies mimic the bee look. For a fly, the advantages to playing copycat are huge. Bees have spent millennia evolving stings and every creature on land has learned that they are not to be messed with. For a fly, looking so painful can save them from becoming the lunch option of hungry birds, reptiles, and other potential predators. For a predator, of course, being able to tell the difference between a bee and a fly increases the number of options at the insect buffet. Over time, the discerning eye of the predator has therefore weeded out the not-so-good fly look-alikes, leaving behind flies that at first glance seem identical to bees—down to "pretend" pollen-collecting hairs on the legs!

Flies have several important characteristics that can help separate them from bees. First, flies have only two

Bee vs. fly (physical differences)	
Bee	**Fly**
long slender antennae	short antennae
four wings	two wings
distinctly separated thorax and abdomen	"thick waist" where thorax connects to abdomen
pollen-collecting hair on legs or belly	no pollen-collecting hairs
eyes on sides of head	eyes large, often forward facing, sometimes touching on top of head

Five insects. Only one is a bee, though the other four are commonly mistaken for bees. From top to bottom: a mud dauber wasp, a paper wasp, a yellow jacket, a hover fly, and an actual bee (*Svastra*). Note the pollen-collecting hairs on the legs of the *Svastra*, the overall hairier body, and the stocky legs.

A fly that mimics a bumble bee. Though it is hairy like a bumble bee, notice that the eyes are very close together, almost touching, and that the antennae are hardly noticeable. It also has only two wings (one on each side).

A bumble bee (*Bombus*). Note the long antennae, the two wings on each side of the body (one bigger, and one smaller one behind), and the distinct and widely spaced eyes.

wings, while bees have four (a fore and a hind wing on each side). Second, flies usually have two short, blunt antennae that emerge from nearly the same place on their faces; bee antennae are longer (often *much* longer) and more widely spaced. Third, fly eyes are usually bigger and closer together than typical bee eyes, often almost touching at the top. As they do not carry pollen, flies have no dense tufts of stiff hairs on their bellies or legs (though a few species mimic this look with bright spots on their abdomens near the back legs). And finally, if you've actually captured a specimen for your collection, flies are much squishier, and piercing them with a pin is like piercing Jell-O. Bee bodies are much more resistant to the insect pin.

Even when a bee is properly identified as such, there are many common misconceptions about how it lives. Because of the importance and abundance of honey bees, we are most familiar with their life cycle. It is often assumed that all bees follow a lifestyle similar to that of the honey bee, when in fact honey bees are the exception rather than the rule for the habits of bees as a whole. Though extraordinary creatures, they are poor representatives of their fellow bee kin. First, honey bees live in hives, but 70% of all bees live in the ground. Second, honey bees are social and work together to build their hive nest; in contrast most other kinds of bees work alone. Third, honey bee mothers meet their offspring; the majority of bee mothers never encounter their young. And finally, honey bees make and store honey to eat in the winter, which few other bees do. We delve into each of these topics in more detail in the following sections.

What's the point?

You may have heard that bees can sting only once before they die. In reality, almost all bees and wasps can sting multiple times. It is only honey bees that die after their first sting. Not to worry, though: bees sting only to defend themselves.

1.2 BEE NAMES

If we are to talk about bees, we need to be able to distinguish between those that *are* bees, and those that aren't. This is trickier than you might think, and scientists have classified and reclassified bees and their relatives many times over the last 300 years.

Traditionally, scientists have used a system of classification known as taxonomy to group organisms together according to the way they look, and they use the same conventions across all living organisms. At the most inclusive and "highest" level of classification is domain, followed by kingdom, phylum, class, order, family, genus, and species. For example, all insects fall into the same class (Insecta) because they have a hard exoskeleton (rather than a soft skin like mammals), three distinct body parts (a head, a thorax, and an abdomen), six legs, compound eyes, and antennae. Within that large class, all butterflies are grouped together in the same order Lepidoptera, all flies are in the order Diptera, all bees are in the order Hymenoptera, and so on, according to certain characteristics that are shared in common by all members of the group. Each grouping in the taxonomic hierarchy is more exclusive than the one before it, until all the organisms in a group are considered the same species. For most purposes, these levels of organization suffice; however, bees require some additional divisions. Tribes and subfamilies are both smaller than the level of family, but larger than the level of genus. We use tribe and subfamily divisions frequently in this book. Subspecies are also discussed in this book; they are distinctive, often regional, variations of a species. (CONTINUED.