**Headline:** Bees Are Sentient and May Be Self-Aware

**Teaser:** Bees are remarkable creatures, even for the mundane tasks we see them engaged in daily.

By Stephen Buchmann

**Author Bio:** [Dr. Stephen Buchmann](http://stephenbuchmann.com/bio/) is a pollination ecologist specializing in bees. He is the author or co-author of more than 150 scientific publications and 11 books. [*The Forgotten Pollinators*](https://islandpress.org/books/forgotten-pollinators#desc) (1997, Island Press) with Gary Paul Nabhan won the Benjamin Franklin Award and was a Los Angeles Times Book Prize finalist. He is affiliated with the University of Arizona and Northern Arizona University and is a fellow of the Linnean Society of London.

**Source:** Independent Media Institute

**Credit Line:** *This is an adapted excerpt from* [What a Bee Knows](https://islandpress.org/books/what-bee-knows#desc)*, © 2023 Stephen L. Buchmann,* [*Island Press.*](https://islandpress.org/) *It is licensed under the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License (*[*CC BY-NC-SA 4.0*](https://creativecommons.org/licenses/by-nc-sa/4.0/deed.en)*) by permission of Island Press.* [*Earth | Food | Life*](https://independentmediainstitute.org/earth-food-life/)*, a project of the Independent Media Institute, adapted and produced this excerpt for the web.*

**Tags:** Animal Rights, Books, Environment, Science

**[Article Body:]**

The sight and sound of a bumblebee or a honey bee buzzing from flower to flower in an alpine meadow or a roadside planting is calming to many, yet it invokes outright panic in others. This happens frequently in Western cultures, where we usually reach for a spray can of insecticide or swat at any flying insect rather than pause to admire its beauty or reflect upon its captivating and intelligent behaviors. We delight in the viscous sweetness of honey on the palate, direct from the jar or slathered across a piece of toast. We savor the distinctive and flavorful honey ripened from floral nectars but don’t care for confronting the winged honey makers.

Do you remember the last time you took a break and watched the passing escapades of a brightly colored bee, wasp, or butterfly? In the West, entomophobia—trepidation and anxiety around insects—is well developed, perhaps as strong as our apparently inborn dread of venomous snakes. We’re convinced that every bee is hell-bent on stinging us and that a single sting will be lethal. Not surprisingly, these largely unwarranted fears and irrational phobias support a thriving global pest control industry based upon deadly yet nonspecific chemicals.

In the United States, [at least 28,000](https://www.ibisworld.com/united-states/market-research-reports/pest-control-industry/#Faqs) mostly sole-proprietorship pest control businesses employ more than 137,000 people, a rapidly growing industry valued at $17 billion annually.

Over [1 billion pounds](https://www.georgetown.edu/news/unearthing-a-better-way-to-use-pesticides-with-an-environmental-toxicologist/) of insecticides are used annually in the United States. This is almost three times the amount of [neuroactive chemicals](https://www.sciencedirect.com/topics/neuroscience/neuroactive-substance) (350 million pounds, including 63 million pounds of [DDT](https://www.epa.gov/ingredients-used-pesticide-products/ddt-brief-history-and-status#:~:text=DDT%20(dichloro%2Ddiphenyl%2Dtrichloroethane,both%20military%20and%20civilian%20populations.)) applied in 1962 when [Rachel Carson](https://www.britannica.com/biography/Rachel-Carson) published *Silent Spring*, her revolutionary environmental science book. However, since Carson's prescient warning, we haven’t changed our actions or our ever-increasing chemical assaults against pollinating insects and indirectly against ourselves.

[Some 21,000](https://www.usgs.gov/faqs/how-many-species-native-bees-are-united-states) distinctly different species of bees live worldwide. Some are solitary females who dig their nest tunnels in the ground or dead wood without help. Others are social, living among tens of thousands of their sisters, hive mates, and queen mother. Whether social or solitary, bees are individuals. They have distinct personalities. They learn and memorize essential details of their world.

Bees also have a sense of time and return to the same flowers at just the right time when the flowers are actively producing nectar. Most bees find their flowers or other bee larvae as prey by individual initiative. Others use chemical signposts or an elaborate “[waggle dance](https://www.universityofcalifornia.edu/news/bees-dont-just-wiggle-wiggle-they-learn-newly-discovered-complex-social-behavior-behind-waggle)” to recruit nestmates, informing them about the direction and distance to rewarding patches of flowers.

Most bees are gentle vegans, subsisting upon the pollen and nectar made by flowering plants. Certain “[cuckoo bees](http://www.helpabee.org/cuckoo-bees.html)” sneak their eggs into the open brood cells of unrelated bees. Upon hatching, their larvae stab and kill the host bees’ eggs or young larvae with their ice-tong-like jaws. A few kinds, the “vulture bees” from Panama and Brazil, make their living by locating vertebrate carrion, ingesting it, and turning those carcasses into a substance similar to royal jelly to feed their young.

Where did this incredible diversity begin? About 100 million years ago, the world’s earliest known bee evolved from its wasp ancestors, which likely hunted tiny insects called thrips.

One example of this earliest bee was found nicely preserved in golden amber, fossilized plant resin, from Myanmar (Burma). Flowering plants evolved a bit earlier, around 130 million years ago. These earliest angiosperms were likely first pollinated by the wind, flies, and beetles. But with the evolution of bees and their transition to herbivory, bees started to visit flowers for their food nearly exclusively. By the Eocene epoch, some 56–34 million years ago, bees were highly faithful and dependable visitors of the world’s flowering plants.

The long and important relationship between bees and flowers has developed from this humble beginning. Usually, we consider them to be mutualists, with each one helping the other. Flowers are living billboards, displaying their beguiling scents and colors as advertisements for sexual favors. More than that, flowers are unabashedly plant genitals exposed on a stem for all to see. Your expensive florist’s bouquet should be X-rated. Stalked anthers house thousands of pollen grains, themselves containers for gametes, the male sex cells of flowering plants.

Think of pollen as a plant's sperm cells. With its sticky receptive end, the style is centrally placed in most flowers. This is where pollen grains land, sending their pollen tubes and gametes down into the heart of the flower to fuse and fertilize its ovules like tiny peas inside their pod.

The ovules become seeds within fruits. Although many plants can and do self-pollinate, thereby producing seeds, the best and most favorable genetic solution is for a distant and unrelated plant to father the seeds of a mother plant. This gives them the best chance of passing along their genes to healthy, fit offspring.

This is where bees and other vagile, or mobile, pollinators come into play. They can fly, and plants cannot. They do the plants’ traveling for them. Think of bees as travel agents on scouting missions. About 85 percent of the world’s approximately 352,000 species of angiosperms (flowering plants) rely upon animal pollinators, their sexual go-betweens.

In temperate zone regions, bees pollinate about 80 percent of flowering plants. Rooted and immobile—except for leaf and stem movements or their fruits or seeds hitching a ride upon or inside birds, mammals, and even one type of seed-dispersing bee—plants don’t get around much. To go on a date, a flower must either be a prom corsage or enlist surrogate aid from the wings and legs of a passing bee.

Tiny desert bees might fly only 50 meters (about 150 feet) from their nest to a flower. Other bees might travel vastly greater distances, 3.2–6.4 kilometers (2–4 miles) or even 14 kilometers (8.7 miles) in the case of a honey bee. Bees can move pollen over great distances.

Bees aren’t purposefully doing favors by moving flowering plant sex cells around. No, bees visit flowers for their own purely selfish reasons. Pollen and nectar are floral rewards that bring bees to flowers and hold their attention. Bees collect pollen and nectar as food for themselves and their immature brood, their blind, grublike larvae within carefully formed underground brood cells. Bees’ daily hunt for food is a life-and-death matter. Depending on floral resources and the weather, a bee might pollinate as many as 10,000 flowers daily.

Because of the branched hairs on their fuzzy bodies—and often a little help from electrostatics—when bees brush against anthers, the oily pollen grains stick to them.

Pollen grains also lodge in “safe sites” where bees can’t remove them—just as we can’t easily scratch between our shoulder blades. This tiny fraction of unreachable pollen grains that aren’t brought home and eaten by the bees makes possible the pollination of wild plants and crops alike. Bees accidentally deposit viable pollen grains onto floral stigmas when they move from flower to flower. Later, fertilization occurs, and seeds ripen inside fruits.

This is a lucky accident for fruit- and seed-eating wild animals and humans. We should thank bees and other pollinators for every third bite, about 35 percent, of the world’s food supply that isn’t derived from wind-pollinated cereal crops.

Through the food gathering and pollination accidents of bees and other pollinators, the world’s most nutritious, tastiest fruits and vegetables are brought to the tables of the world’s 7.9 billion people. Indirectly, bees keep us well-fed.

Rice, corn, and wheat are okay, but I prefer to eat the colorful and nutrient-dense plant foods brought to us on the wings of bees. Annually, the value of these pollination services, primarily due to bees, is [$267–$657 billion](https://research.usq.edu.au/download/9959062be6aed4a2b491f646a2e6b515ef6ff6f27768cfe54aa2063714af2b8b/2352957/Last%20submitted%20version%20China.pdf) globally and upwards of [$12 billion](https://pmc.ncbi.nlm.nih.gov/articles/PMC8396518/#:~:text=For%20instance%2C%20in%20the%20USA,bees%20%5B16%2C17%5D.) in the United States. We truly need to be thankful to bees for our bountiful harvests.

Bees prefer blue or yellow flowers with sweet scents, which contain 30 to 50 percent sugar in nectar. Think your child has a sweet tooth? Not compared with bees. Coca-Cola Classic is only 10 percent sugar and 90 percent water. Bees are sugar junkies. Nectar fuels bees’ flight and warms them, allowing them to rev up their thoracic flight motors preflight and enabling a queen bumblebee to incubate her brood just like a mother hen.

But as we will discover, flowering plants and bees are not strict mutualists. Flowering plants don’t want to give up all their precious pollen to undesirable pollinators or even to generally dependable pollinating bees.

A small fraction of a flower’s pollen grains must make their way to other flowers to ultimately produce seeds and foster new generations of plants. Bees, on the other hand, would like to collect all the pollen and not give any of it up. This leads to cheaters in the system. Some nectar-robbing bees cut slits or holes at the bases of tubular flowers and never deposit pollen on stigmas. They are anti-pollinators.

Orchids and a few other flowering plants offer no food to bee pollinators. Instead, they dupe male bees into thinking a particular orchid flower is a receptive, ready, and waiting female of their species. Why not? They produce the same chemical scents and even sort of look like those female bees—at least to the eyes of a myopic male bee.

This trick works because bees have developed a diverse and intriguing array of adaptations when it comes to sex.

Many male bees are highly territorial and defend clumps of flowers from other males. There, they hope to mate with a female of their species. Carpenter bees in Arizona seek out prominent hilltops. In small groups, they display their presence by releasing a rose-scented sex pheromone. Females follow the scent uphill and decide which male to mate with. This is called a lek mating system, just like some bird species.

Honey bee drones fly high above the ground in drone congregation areas, following the scent of virgin queens, with which they mate in midair. Certain desert bees in the genus *Centris* have two types of males. Larger males are diggers and warriors. These so-called metanders can smell virgin females waiting underground. After battling with other metanders, digger males excavate their partners and fly them to a nearby bush on which to mate. Smaller males adopt a less successful strategy of patrolling nearby plants in search of potential mates.

Most remarkably, we now know that bees are sentient, may exhibit self-awareness, and possibly have a basic form of consciousness. Bees can feel pain and likely suffer. Some bees plan for the future by cutting resin mines into fresh bark, to which they return again and again.

Others cut small holes in leaves, causing those plants to flower as much as a month earlier to benefit the bees. They think and may form mental maps of their foraging routes. Bees remember their preferred flowers' characteristic scents and shapes for several days. They make choices and can be easily trained to select and remember various colors or odors. They can navigate complex mazes and intuit other challenges as swiftly and efficiently as any rat or mouse. When presented with certain flowers, many bees innately know to use their powerful flight muscles to [vibrate pored anthers](https://academic.oup.com/aob/article/133/3/379/7468467), instantly releasing protein-rich pollen, which will be inaccessible to other bees or pollinators.

Bees can also learn to do highly unusual things, such as pulling a string or rolling a ball to receive a sugar water reward. Maybe you’ve seen that YouTube video of [bumblebees playing soccer](https://www.smithsonianmag.com/science-nature/bees-can-learn-play-soccer-score-one-insect-intelligence-180962292/). These are tasks they would never do in nature, and they might be surprising from a creature with a tiny brain housing just one million neurons (humans have at least eighty billion). Bees spend a good deal of time sleeping, during which memories are formed and stored in long-term memory, just as in us. It may be impossible ever to know, but bees may even dream.

Bees do not perceive the world as we do. Their sensory systems would be entirely alien, and perhaps horrifying, to us if we could, for but a moment, jump inside their bodies and experience their world. What would it be like to see polarized light patterns in the sky, the invisible ultraviolet light patterns on flower petals, or electrostatic patterns left on flowers from earlier bee visits? What if we couldn’t see flowers unless we were a few inches from them? A bee’s vision is sixty times less sharp than our own. On the other hand, bees detect the microscopic textures and patterns on flower petals, much as a blind person can read the tiny bumps in a printed braille book with their fingers.

For a bee, it’s a difficult and busy life. Her brain, though no larger than a poppy seed, can handle the complex thoughts and challenging celestial and landmark navigation that daily foraging requires. Every trip to a flower is a new learning experience, and she easily memorizes the flowers’ locations, colors, scents, and rewards. The bee navigates and actively chooses the kinds of flowers she visits, making use of her past experiences and memories. She thinks, makes quick decisions, and learns for herself from her complex and ever-changing interactions with the environment.