



## Chapter 13

# POLLINATORS

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### LEARNING OBJECTIVES

- Define "pollination."
- Explain the role and value of animal pollinators.
- Understand potential threats to pollinators' health.
- List ways gardeners can help conserve pollinators.

Gardeners are increasingly concerned about the status of Ohio's **pollinators**. Honey bees, bumble bees, monarch butterflies and other pollinators have gained attention in recent years for their declining populations. These pollinators are vital to the production of many food crops and provide a service essential to the survival of many **native plants**. This chapter addresses pollination biology, bee biology and steps gardeners can take to protect the essential relationship between plants and pollinators.



*Bumblebee visits aster flower for pollen and nectar.*

## WHAT IS POLLINATION?

Pollination is the movement of **pollen** from the **anther** (male part) of one flower to the **pistil** (female part) of another flower. Without pollination, most plants can't make seeds and fruits. Many plants are



*Swallowtail butterfly drinks nectar from joe pye weed flowers*

wind pollinated, but others rely on animals, primarily insects, to carry pollen from flower to flower.

Plants attract pollinators by offering rewards, such as pollen, **nectar** and floral oils. Flowers also provide shelter and gathering places for pollinating insects. Flowers depend on repeat visits by pollinators, so many offer small rewards repeated at regular intervals to encourage return trips.

Flowers use a variety of strategies to attract pollinators, including petal color, scent, ultraviolet light patterns and nectar guides. Bees in particular use floral qualities such as polarized light patterns, petal texture, temperature, humidity and electrostatic charge to help them locate flowers.

## THE IMPORTANCE OF ANIMAL POLLINATORS



*Lines and coloration on petals help pollinators quickly find rewards.*

Animal pollinators are essential to the food we eat. Some scientists estimate that one in three bites of food we take can be traced back to the role of animal pollinators. A 2012 study by Cornell University estimates that bees and other insect pollinators contribute \$29 billion annually to U.S. farm income by pollinating 58 crops, including almonds, apples, berries and squash. Pollinators play a key role in the production of many foods in the home garden.

In addition to their role in farms and gardens, pollinators are essential to the survival of native plants. Approximately 75% of all plants depend on animal pollinators to move pollen from plant to plant. Without the work of pollinators, many native plants couldn't produce seeds to ensure the plant's next generation. These seeds and the fruit that often accompany them also provide important food sources

for approximately 25% of birds and many mammal species.

Key animal pollinators in Ohio include hummingbirds, bees, flies, butterflies, moths and other insects. No species of bat that lives in Ohio is a pollinator, although pollinating bats live in many other parts of the world.



*The non-native western honey bee is a key agricultural pollinator*

### **Bees: Essential Pollinators**

Bees are considered the most important pollinators because they are uniquely adapted to gather and transport pollen. Bees rely on flowers for food to feed their young, so they actively seek out and visit flowers. Bees' fuzzy bodies and branched hairs help female bees collect pollen into special structures, such as pollen baskets on the hind legs or long hairs on the thorax or abdomen.

Bees also forage for food close to their nesting sites, a practice called central place foraging. Bees visit one or only a few flowering species during each foraging trip, even when other flowers are available. This behavior, called flower fidelity or flower constancy, makes bees especially reliable couriers to move pollen to receptive flowers of the same species.

Bees can be divided into three broad groups:

- Social bees (e.g., honey bees and bumble bees)
- Solitary ground-nesting bees (e.g., mining bees)
- Solitary cavity-nesting bees (e.g., mason bees and leafcutting bees).



*Native mining bees frequently nest in sandy soils on south-facing slopes.*

### **Bees, Wasps and Stings**

Bees are often confused with wasps. Wasps may visit flowers for nectar, but they rely on insects – not pollen -- to feed their young. Ground-nesting yellow jacket wasps become aggressive towards the end of summer and may sting repeatedly.

Social bees like honey bees and bumble bees will usually only sting when defending their nest. Honey bee workers can each sting only once; in doing so, they release alarm pheromones that alert other stinging workers. Bumble bees can sting repeatedly, usually doing so when the nest has been disturbed. Solitary bees such as mining bees and leafcutting bees are not aggressive and often practice avoidance instead of aggression. Many of these bees have stingers that can't penetrate human skin.

### **Honey Bee Biology**

A honey bee flying from flower to flower is a common sight in the summer garden. Honey bees are generally considered to be the most important pollinators of many crops in the U.S, including almonds, apples, berries, squash, cucumbers and dozens of other crops. Without these important insects, farmers couldn't harvest and sell many tasty and nutritious fruits and vegetables.

Honey bees are social bees that live together in a colony. The colony members include the **queen**, thousands of female worker bees and male **drones**. These bees work together to create a functioning colony. As many as 50,000 to 90,000 or more bees can live together in one colony at the height of the season.

The queen's role in the honey bee colony is to lay eggs. She may lay as many as 2,000 eggs per day.

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The drones are male bees whose role is to mate with new virgin queens. They are not adapted to gather and transport pollen or nectar. This duty goes to the workers, who in addition to foraging for food carry out all other hive tasks, including building the comb, cleaning the hive, converting nectar to honey, feeding immature bees, caring for the queen and guarding the hive. Workers living during the spring, summer and early fall may only live for four to six weeks, while workers reared in late fall may live through the winter or approximately four months. On the other hand, queen bees may live for several years.

Like all bees, honey bees are vegetarians, surviving on a diet of pollen and nectar. Pollen gathers readily on the honey bee's hairy body. Viewed under a microscope, these hairs appear as branch-like feathers ideal for holding pollen. Bees' bodies also have a static charge, which helps pollen to stick. For females, a special modification of the hind legs, called a "**corbicula**," allows them to gather a load of pollen and transport it back to the nest.

To gather nectar, honey bees have long tongues and a special honey stomach. As they travel from flower to flower gathering food, honey bees inadvertently transfer pollen from flower to flower, allowing plants to make seeds and fruit.

Worker bees communicate the location of flowers through dance language. In the waggle dance, workers communicate the location, distance and quality of food by moving their bodies in a particular pattern. Other worker bees use this dance pattern to locate food-rich flowers. More workers will then visit these flowers and return to the hive with pollen or nectar, helping to ensure a steady food supply and the colony's survival.

Honey bees are key pollinators of many valuable crops. Because they live together in hives, honey bees can be loaded onto trucks and transported from farm field to farm field to provide pollination services. Honey bees play an essential role in modern farming systems in the U.S.

Honey bees are not native to North America. They were introduced to the East Coast in 1610 by early European settlers, who managed bee colonies for honey and wax. For centuries later, feral honey bees were able to survive and thrive in tree cavities and in human-made structures such as wall voids in houses and barns. The arrival of the varroa mite in the 1980s has wiped out nearly all feral colonies

and has had a large impact on managed colonies as well. Today, honey bees survive in managed hives with the careful attention and tending of beekeepers.

**Colony Collapse Disorder** (CCD) came to light in 2006 after many beekeepers experienced staggering losses, as high as 80 percent among some commercial beekeepers. Colony Collapse Disorder (CCD) is a specific syndrome, defined as a dead colony with no adult bees or dead bee bodies, only a live queen, immature bees and usually some honey still in the hive.

While the term "Colony Collapse Disorder" is sometimes still used by the media, most bee researchers now talk about "bee health" and the many factors that combine to negatively impact bee health. Besides the varroa mite, honey bees face many diseases, pests and pesticides. While the major, dramatic colony losses of CCD are not commonly seen today, these threats to bee health combine to kill between 30- 40% of all managed bee colonies each year. This still represents a high rate of colony loss that beekeepers consider unsustainable.

### ***Bumble Bees***

Like honey bees, bumble bees are also social bees that live together in a colony. Each colony is active for only one year, and new colonies are started by a new queen bumble bee, each spring. This differs from honey bees, which have a perennial colony that survives from year to year.

In early spring, the overwintering bumble bee queen must find a suitable home for her colony, commonly in an abandoned rodent burrow or sometimes directly on the ground, depending on the species. She then lays about a dozen eggs, using the heat from her vibrating flight muscles to keep the eggs warm. Once the larvae hatch, they eat pollen and nectar that the queen has collected. About two weeks later, the larvae pupate, then emerge in about another two weeks as adult workers.

New workers, all females, are much smaller than the queen. They take over the work of tending and guarding the nest and bringing pollen and nectar back to the colony. The queen continues to lay batches of eggs throughout the summer, rarely leaving the nest. Toward the end of summer, the queen lays special unfertilized eggs that will become male drones, and other eggs that will be reared as new queens. The new queens and drones leave the

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colony to mate.

Newly mated queens feed on flowers to pack their bodies full of fat to survive the winter. Each queen will spend the winter burrowed several inches below ground, emerging in spring to start a new colony. All the members of the old colony die with the winter's cold, including the old queen, old workers and old drones.

Unlike many other bees, bumble bees can forage for food in cool, wet temperatures and in low light conditions. This makes them important pollinators of plants that bloom in early spring or grow in shady conditions. Their robust bodies help them fly further from the nest in search of food – sometimes as far as six miles if food is scarce.

Bumble bees are key pollinators of crops such as apples, cucumbers, squash, raspberries and greenhouse tomatoes. They are also essential pollinators of native plants and, in some cases, serve as the only pollinator able to pollinate these plants.

Bumble bees can do something only a few other species of bees can: an action called **buzz pollination**. In buzz pollination, the worker bee wraps her legs around the flower and vibrates her wing muscles without moving her wings. This creates a “buzz” that is musically about the tone of a middle C. The tone shakes the pollen-holding anther, releasing the flower's pollen like a salt-shaker releases salt. Blueberries, cranberries, tomatoes and peppers are all plants that require buzz pollination to release pollen.

About 13 species of bumble bees live in Ohio. The most common species is the Eastern bumble bee. While bumble bees face many of the same threats facing honey bees, they are especially impacted by several introduced diseases that only infect bumble bees. Some native bumble bees that used to be common, such as the rusty-patched bumble bee, are now facing extinction.

### **Other Bees in Ohio**

Besides bumble bees, Ohio is home to approximately 500 native bee species. These diverse bees play important roles as pollinators of agricultural crops and native plants. Mason bees, mining bees, leafcutting bees and sweat bees are just a few of the most common types of bees seen in gardens and landscapes. See [Ohio Bee Identification Guide](#) to learn more about Ohio's native bees.

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## **POLLINATOR CONSERVATION**

Animal pollinators and bees in particular are currently facing many threats, such as lack of forage (flowers for food), pests, pathogens, pesticides, invasive plants, climate change and lack of suitable nesting sites. Gardeners can play an important role in pollinator conservation by providing plants and nesting sites for pollinators and by adapting gardening practices to protect pollinators.

### **Grow More Flowers**

Trees, shrubs and herbaceous plants can provide food and nesting habitat for pollinators. An abundance of different flower shapes, sizes and colors will appeal to a variety of pollinators. Grouping plants together in sunny locations further helps pollinators find and feed on desirable flowers while expending less energy in the search for plants.

By observing flowers in private and public gardens and taking note of flower visitors, gardeners can learn which plants are most attractive to pollinators. Additionally, many plant lists are available to help with the selection of plants for pollinators ([find plant lists at: go.osu.edu/gardensandbees](http://go.osu.edu/gardensandbees)).

Different flower shapes and colors attract different



*Some cultivars with complex petal arrangements and unusual colors are less attractive to pollinators, such as this purple coneflower cultivar*

pollinators. For example, red tubular flowers with a nectar reward tend to attract hummingbirds. Daisy-like flowers that provide nectar and pollen in shallow flowers are often visited by bees and flies with shorter mouthparts.

Some plant cultivars and hybrids don't offer the pollen and nectar rewards that so-called “straight species” do, since the quality and quantity of nectar and pollen are sometimes lost during breeding.

Plants bred with “double” flower petals, such as roses and peonies, are often inaccessible to pollinators. Gardeners can include less-refined plants along with plant cultivars to offer broad pollinator appeal.

While trees provide many well-known ecological benefits, the importance of trees as a source of food for bees is sometimes overlooked. When in bloom, a large tree can provide hundreds to thousands of nectar- and pollen-filled flowers. Because a tree’s flowers are often high up in the canopy out of view, the thousands of insect visitors to these flowers are rarely noticed or appreciated.

### Offer Blooms Through the Season

Different species of bees, butterflies and other pollinators are active in Ohio at different times of the year. Queen bumble bees, mourning cloak butterflies and blue orchard bees are active in early spring. Monarch butterflies, worker bumble bees and worker honey bees forage from spring into the cooler days of autumn.

Gardeners can help pollinators by planting flowers with a sequence of bloom throughout the growing season, from early spring through late fall.

Early-blooming trees such as maples, willows and redbuds provide food at an especially critical time. In March and April, queen bumble bees are establishing new colonies when few other flowers are in bloom. Foraging honey bees take advantage of warmer spring days to bring food back to the growing hive, which may be short on stored food after a long winter.

Later in the spring, black locust and tulip tree provide a rich source of nectar, just as the hive’s demand for food increases. For honey bees, honey stored during this period of “honey flow” is crucial to build the hive and ensure the health of the colony into the following winter. Late-season perennials like asters and goldenrod provide food at an especially critical time as bees are preparing for winter survival.

For a sequence of native and non-native woody flowering plants for Ohio, consult the Ohio State Phenology Calendar <http://www.oardc.ohio-state.edu/gdd/>. This calendar helps predict the sequence of bloom from late winter to late summer.

### Choose Key Plants for Pollinators

While literally hundreds of garden plants provide important sources of nectar and pollen for pollinators, try these garden-worthy additions:



*Early-blooming maples provide an important pollen and nectar source for bees in spring.*

- *Trees:* maple, crabapple, linden, serviceberry
- *Shrubs:* hydrangea, ninebark, pussy willow, sumac, viburnum
- *Perennials:* aster, bee balm, hyssop, milkweed, purple coneflower
- *Annuals:* cosmos, marigold, sunflower, zinnia
- *Herbs:* basil, borage, catmint, lavender, oregano

### Caterpillar Host Plants

Adult butterflies will drink nectar from many types of flowers, but immature caterpillar stages require specific plant species to complete their development. For example, Monarch caterpillars require milkweed plants; pearl crescent caterpillars feed on New England asters, and black swallowtail caterpillars feed on plants in the carrot family, such as parsley and dill. Gardeners should plant butterfly host plants as well as flowers that provide a nectar source to attract egg-laying adult butterflies. Learn more about specific caterpillar food requirements in the ODNR field guide, “Butterflies and Skippers of Ohio,” at <http://www.flipseekllc.com/wildohio2009butterfly.html>

### Flowers for Vegetable Gardens

Flowers planted in and near vegetable gardens and fruit plantings help bring pollinators and other beneficial insects into the garden. Annuals, perennials and herbs provide important food sources for insect pollinators, especially in the heat of summer. Consider planting sunflowers, zinnias, marigolds and cosmos in or near the vegetable garden. Herbs

such as lavender, basil, borage, dill, fennel, oregano and catnip will also attract many pollinators.

### Native Plants

Local, native plants attract native pollinators. Native plants offer nectar, pollen and other nutrients in quantities that native pollinators need. Some insects are specialists, and can only gather pollen from certain plants to feed their young. Willow, goldenrod and asters are host plants to specialist bees that can only feed on these native plants. Consider adding more locally native trees, shrubs and herbaceous plants to the garden.

### Provide Nesting Sites

Besides providing an essential source of food for pollinators, trees and shrubs can also provide important nesting and overwintering habitat. Cavity-nesting bees make their nests in the pith of twigs like elderberry or sumac, or in abandoned beetle burrows in dead trees. Brush piles, dead standing trees and fallen wood provide important nesting and overwintering habitat for bees and butterflies.

In addition, bare soil can provide nesting habitat for ground-nesting solitary bees such as mining bees or sweat bees that nest in sandy, well-drained soils on south-facing slopes.

Artificial nesting sites (so-called “bee hotels”) can be made or purchased to encourage cavity-nesting bees. These structures require routine maintenance to prevent the build up of bee pathogens and parasites.

Bumble bees prefer to nest in pre-existing cavities with some form of insulation such as old rodent nests or bird nests, both above and below ground. They will also nest under clumps of grass. Pur-



*Bumble bees will frequently nest under clump-forming grasses.*

chased or constructed bumble bee nesting structures are generally considered unsuccessful at attracting bumble bee queens.

### Consider Water, Pesticides and Weeds

- **Water:** A water source in the garden helps thirsty pollinators, especially in the heat of summer. A shallow bowl or birdbath can provide sufficient water. A few sticks placed in the bowl will provide a place for bees and other insects to land and perch, thus preventing insect drowning. Additionally, a muddy puddle may be visited by pollinators like butterflies and mason bees.
- **Pesticides:** Limit pesticide use in the garden. Pesticides can have negative effects on bees and other insects, killing them outright or affecting their behavior or longevity. Insecticides and fungicides can act together to weaken bees' immune system. Use an integrated pest management approach with multiple strategies to reduce pest damage. Also, consider applying them at times when pollinators are least active.
- **Weeds:** Many plants frequently considered weeds can provide food for pollinators, including dandelions, milkweed, goldenrod and clover. Consider tolerating weeds with benefits to pollinators. On the other hand, many invasive weeds outcompete native plants important to pollinators. Eliminate invasive weeds such as privet, garlic mustard and buckthorn in natural areas.



*Dandelions provide an important source of nectar and pollen for pollinators.*

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## Learn More

To learn more about pollinators and pollinator plants, consult these resources:

- The Xerces Society for Invertebrate Conservation: [www.xerces.org](http://www.xerces.org)
- Pollinator Partnership: [www.pollinator.org](http://www.pollinator.org)
- The Ohio State University Bee Lab: [beelab.osu.edu](http://beelab.osu.edu)

## FREQUENTLY ASKED QUESTIONS

### **My vegetable garden doesn't yield much produce: is a lack of pollinators the problem?**

As with so many other problems in the garden, the answer is, "It depends." Poor yields can be caused by the selection of poor-yielding cultivars or cultivars unsuited to local conditions. Temperature fluctuations that result in blossom drop or other cultural conditions (e.g., poor soil or poor nutrition) are also associated with poor yields. Unfavorable weather conditions during bloom (e.g., rainy or cool temperatures) can inhibit insect pollinators, resulting in poor pollination. Alternatively, local pollinator populations could be down (e.g., a nearby beekeeper stopped keeping bees or lost hives to disease or pesticide kills).

### **I see circular discs missing from the leaves on my roses and redbuds. Are Japanese beetles the culprit?**

Female leafcutting bees are likely at work in the garden. These docile solitary bees remove round and oval pieces of soft leaves from plants like hosta, rose, maple, redbud, epimedium, itea and others. They also cut discs from petals, all with their mouthparts. Each leaf or petal disc is rolled up between the adult bee's legs and flown back to a hollow twig where the discs are used to create a soft cell, like a stuffed grapeleaf, inside the twig. The female then visits flowers to collect pollen and nectar. The leafcutting bee lays an egg on this watery pollen solution that will feed her offspring. The female may provision a dozen or so individual cells inside the hollow twig.

The discs removed from leaves and petals only cause cosmetic damage. These bees are important pollinators of many summer crops; insecticides are not necessary or recommended.

### **A swarm of honey bees just landed on a tree branch. What should I do?**

Generally, swarms are not dangerous. Honey bees are only defensive near their nest. Prior to swarming, honey bees gorge themselves on food reserves, which reduces their ability to sting. Even though swarms can contain thousands of honey bees, these bees do not have developing bees or food reserves to defend. They are unlikely to sting unless directly provoked.

Honey bee swarms can contain thousands of bees that have broken away from the original colony, including workers, drones and the original queen. Swarms are common in late spring and early summer, when hives may be overcrowded and congested. An old queen, a mild winter, or a cool, rainy spring can also trigger swarming. Swarming is a natural mechanism for the honey bee colony to reproduce itself. The workers and drones left behind in the original hive produce a new queen by feeding some larvae royal jelly.

Swarms often leave on their own within a day or two, and often within hours. At the center of the swarm is the queen bee. Her pheromones attract the other bees to her. A few scout bees will leave the swarm to seek out a suitable location for a nest, such as a cavity in a tree. When a location is found, the swarm will move to the cavity.

Rarely, when a suitable cavity can't be found, the bees may initiate comb construction on a tree limb or other exposed location.

Many beekeeping associations compile lists of local beekeepers who will capture nearby swarms. The beekeeper will place an empty container, such as a bee hive, at the base of the swarm, and shake or dislodge the bees from the swarm into the entrance. The now-occupied hive can be moved after dark, when the bees are done foraging and are less active. To find a local beekeeper in Ohio, contact a local beekeeping club or association: visit [beelab.osu.edu](http://beelab.osu.edu) for a list of county clubs.

### **Bees are often sleeping inside my squash and pumpkin flowers in the morning. Are these honey bees?**

Although they resemble honey bees, the bees you see are most likely squash bees. The squash bee



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is a native, solitary bee that nests in underground tunnels and cells, often close to the pumpkin patch. Male squash bees frequently spend the night together inside closed flowers, waiting for the females to arrive at dawn.

**I was stung repeatedly by a “bee” nest I ran over with the lawn mower. Which bee was it?**

Yellow jacket wasps are the most likely culprit. These social, ground-nesting wasps are often alarmed by power equipment and will sting repeatedly. Although it’s less likely, bumble bees also live together in a colony, often nest in the ground, and they can sting repeatedly. Honey bees don’t nest in the ground.

**Dig Deeper**

In late morning (ideally a sunny day) in summer, observe pollinator activity in a private or public garden. Record the types of pollinators you observe (are they bees, wasps, flies, butterflies or others?) and the flowers they visit. Don’t forget to look at trees and shrubs as well as annuals and perennials. Consider bringing along a camera to take photos of the pollinators on the plants. If possible, continue the observations at the same time of day every two to four weeks. Continue to record the pollinators and the flowers they visit. Notice the changes between each visit.

