



The Bumble Bee Lifestyle

Bumble bees are essential insects that pollinate many of the of the fruits, nuts and seeds we eat every day.

Introducing the Bumble Bee

Of over 250 known bumble bee species, 18 are found in Pennsylvania (Kilpatrick & López-Urbe 2020). Bumble bees are excellent pollinators due to the way that they attract and disperse pollen from their bodies with each floral visit, and because of a unique foraging behavior they engage in called buzz pollination. Just like honey bees, bumble bees store pollen within specialized branched hairs, (or scopae), that are located in a groove on their hind legs (called corbiculae). Together, the scopae and the corbiculae make a pollen basket, which can be easily seen with the naked eye. Pollen stored on the body of bees is transmitted to the female reproductive organ (the stigma) of the flower as they fill their pollen baskets, resulting in fertilization, and ultimately, the development of fruits, seeds, and/or nuts.

All bees possess branched hairs that enable pollen transfer between flowers, but buzz pollination is a specialized behavior performed by many large-bodied bees, including bumble bees. During buzz pollination, bees vibrate their flight muscles at just the right frequency while holding on to a blossom to dislodge pollen grains that are tightly packed away in the flower. This practice allows them to collect pollen from flowers that are more difficult for honey bees to reach. Two important crops grown in Pennsylvania that relies on buzz pollination to produce fruit include blueberries and tomatoes, whose pollen reserves are hidden in the flowers and must be buzzed, or sonicated, to be released.



Figure 1. This bumble bee is storing pollen wetted with nectar (Thorp 1979) in specialized, paired pollen baskets, which are located on their hind legs. Image: Anna Cressman, Penn State

Bumble Bees Versus Honey Bees: How Do They Compare?

Just like with honey bees, all individual bumble bees work together as a colony through the late spring, summer, and fall months. And, as with honey bees, individuals within the colony are divided into three distinct castes. Each colony includes a single queen, nonreproductive female workers, and male drones. The queen is the only one in the colony to lay eggs, while the workers maintain the hive and bring in local pollen and nectar resources. Male drones have fewer responsibilities to the colony and are less abundant than the workers. Their purpose is to mate with virgin queens that are typically reared by the colony during late summer. Task allocation is also a feature shared by both honey bees and bumble bees. In honey bees, the division of labor is dependent on age. Younger workers feed and care for the developing brood, while older workers are foragers. As new workers emerge, the more senior workers will adopt new colony tasks according to age (Johnson 2010). In contrast, bumble bee division of labor is correlated with body size, where larger bees can carry more pollen, and smaller bees perform in-colony tasks, such as caring for brood.

However similar bumble bee and honey bee colonies may seem, the appearance and life histories of the two species vary a lot. Bumble bees are an annual species that have one queen per year, whereas honeybees are perennial species, with one queen that can live for up to five years. The annual bumble bee's lifecycle is a fascinating process where the queen transitions from a seasonal solitary phase and progresses to a social phase later in the cycle.

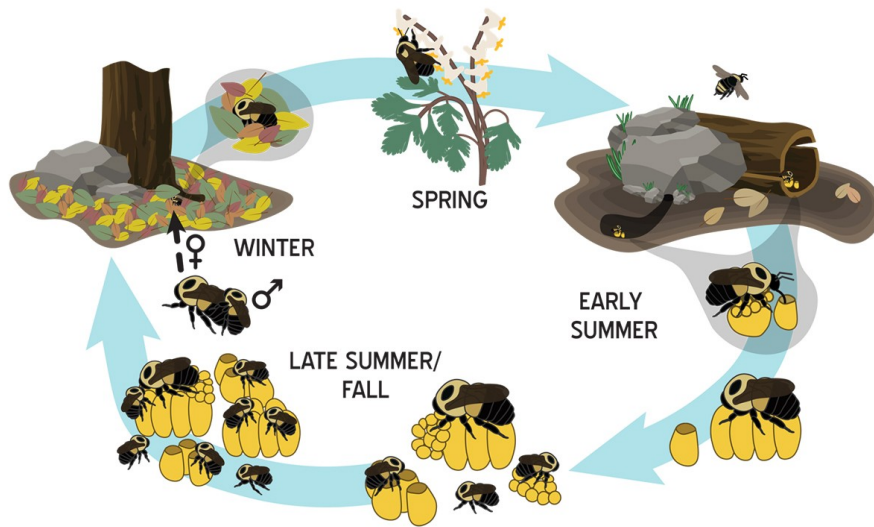


Figure 2. The bumble bee life cycle begins with queens emerging in the spring. During early summer, the first workers emerge, and the colony grows until the fall. In the fall, new queens will mate with males and go into diapause during the winter months (Illustration by Jeremy Hemberger, used with permission).

| | Sociality | Appearance | Body Size | Colony Size | Division of Labor |
|-------------------|----------------------|--|---|---|---|
| Honey bee | Highly Eusocial | Slender, less fuzzy | Queen: 18-22mm, Worker: 12-15mm, Drone: 15-17mm | Ranges from 60,000-80,000 individuals | Temporal Polyethism (age dependent) |
| Bumble bee | Primitively Eusocial | Robust, lots of hair on thorax and abdomen | Queen: 20-30mm, Worker: 5-20mm, Drone: 10-20mm | Up to several hundred | Physical Polyethism (size dependent) |

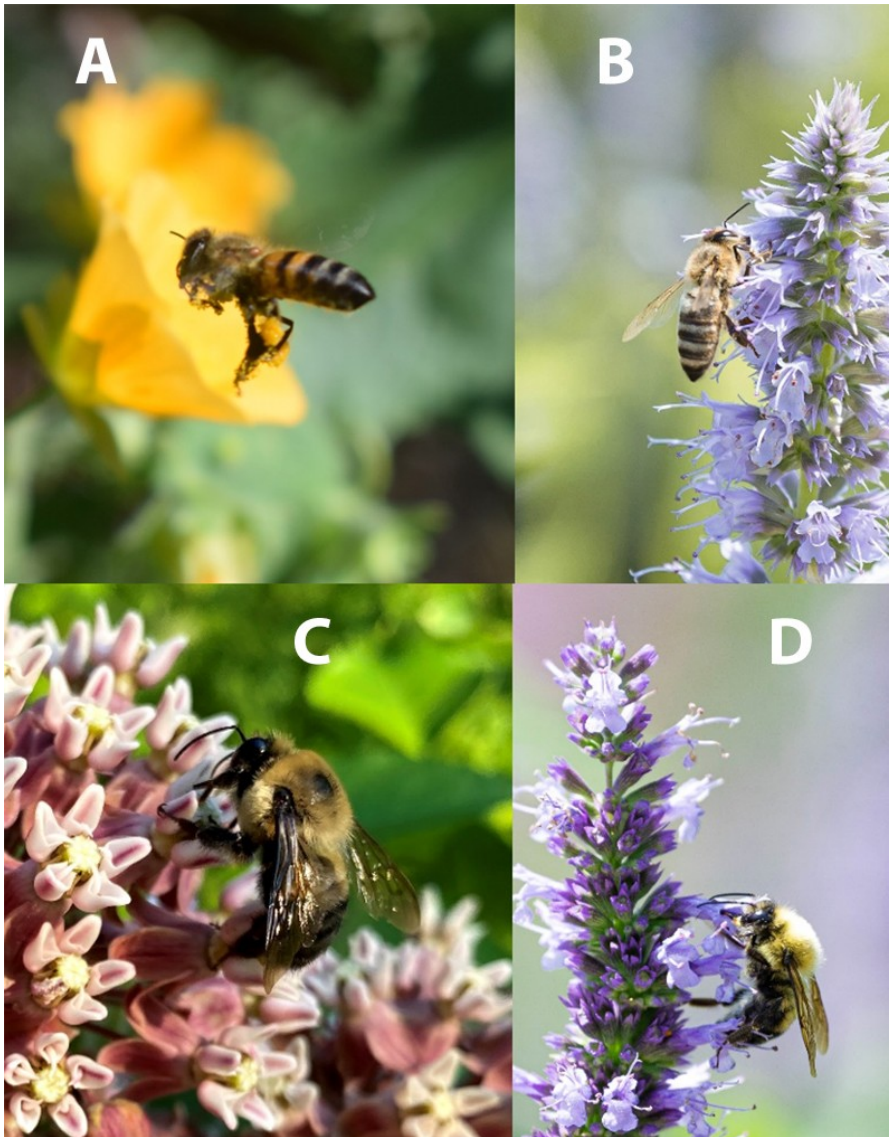


Figure 3. Honey bees (A and B) are easy to distinguish from bumble bees (C and D) due to differences in their size and body shape. Image credits: (A and C): Anna Cressman. (B): Darya Alvarez (D): J. Lana Mejias

The Bumble Bee Colony Lifecycle

Spring

During the spring and early summer months, bumble bee queens emerge from their hibernacula, which is an underground alcove where they shelter over the winter. Queens terminate diapause using cues related to warming temperatures and increasing day lengths. Queens can be seen searching for a place to start their colony by flying close to the ground in search of pre-existing cavities, like rodent holes or other burrows, to initiate their colonies and lay the first eggs. But before a queen can lay eggs, she must forage for pollen and nectar as a source for proteins and carbohydrates. These macromolecules play an important role in the activation of her ovaries and initiation of egg-laying. A queen has found a suitable habitat for her colony once she is seen with pollen on her hind legs. She then uses this pollen and nectar to feed her first brood as well as to form wax pots for the storage of nectar. The queen will continue to forage for resources that allow the growth and development of the brood. As the brood is developing, they go from an egg to larvae and then to pupae. After about 3-4 weeks of development, the first female workers will emerge. This is the onset of the social phase of the colony.



Figure 4. Bumble bee queens go into diapause as individuals and emerge from their hibernacula in the spring before founding a new colony. Image credit: Anna Cressman, Penn State

Summer

By summer, the queen transitions to in-colony tasks, such as laying eggs. While she is caring for her brood, she is also producing pheromones that inhibit reproduction by workers. This is called the "pre-competition phase" where the queen is the sole egg-layer for the colony. Along with the queen, nurse workers are assisting in feeding the colony's brood, while foraging workers are tracking down floral resources throughout the day to supply the colony with sufficient pollen and nectar.



Figure 5. By summer, the queen lives full-time inside the nest alongside many non-reproductive female workers, who forage in the landscape and provide colony care. Image credit: Anna Cressman

Fall

As late summer and fall arrive, bumble bee colonies can grow to contain several hundred individuals. By now, queens will cease worker production and begin laying unfertilized eggs, which develop into drones, or male bumble bees. Nurse workers will help rear the remaining fertilized eggs into new queens. Once queens stop laying reproductives (gynes and males), workers may start to lay their unfertilized eggs, initiating the "competition phase" between the more dominant workers and the queen and among other workers for male offspring. The new, virgin queens, called gynes, and the males will go out to forage and mate with members of other colonies. The original queen, or the founder, of the colony, will die naturally with the remaining workers.

Newly emerged, virgin queens leave the colony to mate and fill up on pollen and nectar resources in preparation for diapause. Diapause is an arrested state of development and behavior, which is like hibernation in mammals. Many bees and most insect species in temperate climates undergo diapause throughout cooler months, only to reemerge once the right temperature and day length is reached.

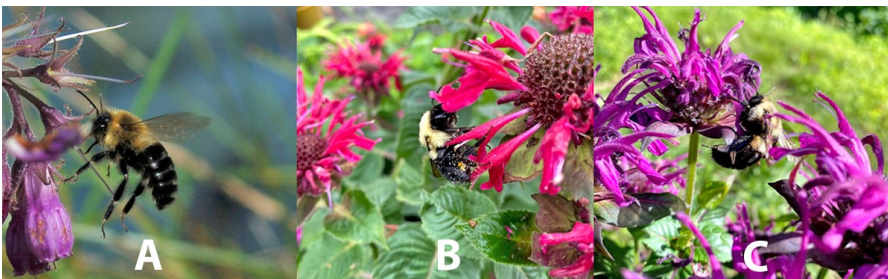


Figure 6. This series of photos includes the different caste of *Bombus impatiens* A) male B) worker and C) queen. Image credit: (A) Francesca Ferguson, (B) and (C) Anna Cressman

Winter

During late fall and winter, the queen is completely dormant inside a cavity under the soil. Diapause can last for 6 to 9 months, meanwhile, she is surviving for months in cold temperatures without feeding. You can imagine the physiological stress this might have on the queen which is why it is imperative for her to 'fatten up' prior to entering diapause. These nutrient stores will then be used throughout diapause. Floral resources contain pollen, which is the main source of protein, lipids, and other micronutrients, and nectar, the main source for carbohydrates (Treanore & Amsalem 2020). These nutrients are stored in the fat body, an organ that is mainly used for nutrient storage. Having a sufficient amount of nutrients stored in the fat body during diapause plays an important role in the survival of the queen. After the 6 to 9 months in the solitary phase of diapause, the surviving females will emerge in the spring and continue the life cycle as the new founder queen!

The lifecycle of bumble bee colonies is an ongoing area of research, especially the factors involved in the transition from the pre-competition to the competition phase as well as the transition into diapause for newly emerged queens. The research on these fuzzy insects is critical for understanding the environmental and physiological mechanisms directing bumble bee behavior. Bumble bees contribute to ecosystem services, where humans can benefit so much from these pollinator habitats. The next time you see these busy bees buzzing around the yard, appreciate their hard work!

References and Resources

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