PennState Extension

Honey Bee Management Throughout the Seasons

The honey bee colony lifestyle is closely linked to the seasons when the availability of flowering plants, temperature, and precipitation vary dramatically.

Figure 1. As outdoor temperatures rise and spring flowers bloom, bees will begin foraging for nectar and pollen. Photo: Kate Anton, Penn State

Modern beekeeping practices are adjusted to match the seasonal colony lifecycle by increasing honey production, limiting seasonal behavior (swarming), or managing parasites that also follow seasonal patterns.

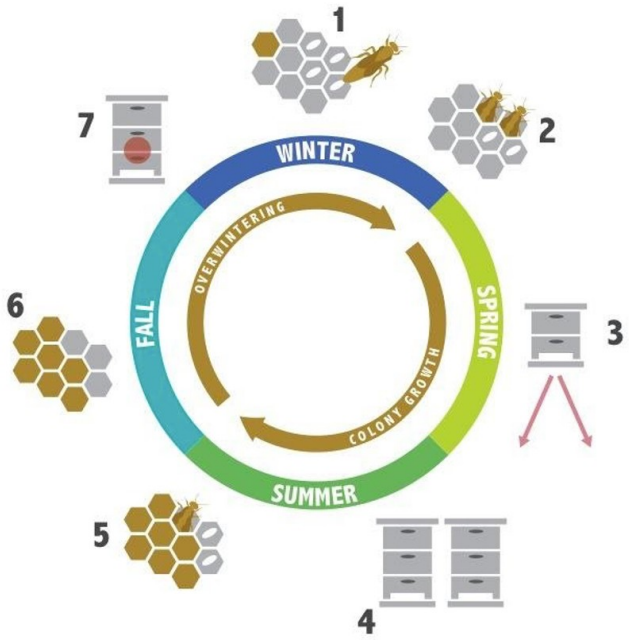

Figure 2. **Reference:** Mehmet Ali Döke, Maryann Frazier, Christina M Grozinger; Overwintering Honey Bees: Biology and Management, 2015. Graphical design by Harland Patch and Nick Sloff, Penn State. HPG — After Snodgrass, 1925. Vitellogenin — Heli Hvukainen, used with permission.

Honey Bee Colony Life Cycle

Figure 2. Hexagonal patterns represent cells in combs. Gray cells are empty, brown cells represent food stored (honey and/or pollen), and white elliptic figures in the cells represent eggs. Brood rearing starts in winter (1) and peaks in spring (2). The rapid increase in worker population in spring results in swarming (3). After swarming, both colonies rebuild their worker populations and forage to increase their food stores through summer (4). Brood rearing decreases by the end of summer (5) and ceases in fall (6), with the production of the winter bee cohort. In the winter, worker bees form a thermoregulating cluster (red circle inside the hive) with the decrease in ambient temperature (7).

Late Winter

In late winter and early spring (mid-February in the northeastern United States) honey bee queens resume egg-laying and the colony initiates brood rearing. Nurse bees will use stored honey and pollen resources to feed themselves and the developing brood. While the exact mechanism for the initiation of brood rearing has yet to be determined, it is likely due to longer day lengths, warming temperatures, and the availability of early-blooming flowering plants.

Early Spring

As outdoor temperatures rise and spring flowers bloom, bees will begin foraging for nectar and pollen. Typically, bees forage when outside temperatures are above 16°C/61°F and it is not raining. Early spring can be a perilous time of year for the honey bee colony. The nutritional requirements of brood are energetically costly, and weather conditions can be volatile. Sometimes days or weeks of warm temperatures and abundant flowers are followed by snow or freezing temperatures that slow or stall nectar flows. Once brood rearing begins, the colony can rapidly exhaust stored resources and risk starvation.

Beekeepers, especially those in cooler climates, must monitor their colonies regularly at this time of year to make sure they have adequate resources to feed their young and keep the colony warm. Brood diseases such as Chalkbrood, Sacbrood, and European Foulbrood are most likely to appear in the spring, particularly when floral resources are inconsistent.

For more information about honey bee diseases see A Quick Reference Guide to Honey Bee Parasites, Pests, Predators, and Diseases.

Many brood diseases can be treated by supplemental feeding and improved access to floral resources as the weather warms. When colonies have limited resources, supplemental sugar syrup and pollen substitute can be fed to sustain the bees until nectar flows are stable. Sometimes a beekeeper must cull a colony that is too weak to survive disease, which can be preferable to continuing to invest in feeding.

As freezing temperatures become less frequent, more flowers bloom, and honey bees begin foraging more intensively. The many flowering trees in the spring provide substantial amounts of nectar and pollen, which drives a rapid increase in brood rearing and colony population. This rapid increase leads to swarming behavior (see below) later in spring.

Establishing new colonies is most often done in the spring. Many beekeepers purchase packages, which are screened boxes filled with approximately 10,000 workers and a queen. The package is opened, and the bees are poured into an empty hive and fed copiously until they are established, just in time to take advantage of the nectar flows that occur in May and June in Pennsylvania. Beekeepers must be diligent in feeding packaged bees, as the colony lacks honey, pollen, and comb from which to grow and expand. The advantages of packages are that they have a lower incidence of disease and parasites because the bees arrive without brood or comb. One disadvantage of packages is that they often are mass-produced by the thousands, and this can lead to reduced quality of the queens, which reduces colony vigor.

An alternative to installing packages is to purchase nucs – or “nucleus" colonies. Nucs consist of four or five standard frames of comb complete with bees, brood, pollen, honey, and a queen. They do not need to be fed as aggressively as packaged bees, because they have stores of pollen and honey and do not need to produce as much wax to create comb. However, because the comb is older, it may contain pesticides, parasites, and/or diseases. Beekeepers can purchase nucs from the south early in the spring or source them locally later in the season.

Another way a beekeeper can obtain a new colony is by catching a swarm locally. Swarms are very docile and, if the swarm is within reach, the beekeeper can shake the swarm into a cardboard box and bring it to their apiary and install it in a hive. If the swarm is not installed into a hive with comb and pollen/honey resources, it is a good idea to provide them with supplemental syrup. While swarms are free, they are usually only available later in the spring.

Late Spring–Early Summer

By late spring, floral resources have been available for several weeks and remain plentiful. The colony has been actively rearing new bees during this time. It takes three weeks for adult workers to develop from eggs, and another three weeks for those workers to become foragers. By late spring the colony population has increased substantially, including foragers who bring in even more resources.

The increased population in the colony triggers the rearing of new queens and drones (males). New queen rearing is initiated when levels of queen pheromone are reduced in the hive. In a larger, more congested colony, there is less spread of queen pheromone throughout the brood nest. The nurse bees will typically rear new queens on the edges of the frames, where queen pheromone levels are lower. Often, nurse bees will rear a large number of queen cells, and this is the first visual cue to the beekeeper that swarming is imminent.

Swarming is problematic for beekeepers because the colony size is reduced dramatically (by one-half or more). Furthermore, the old queen leaves with the swarm, leaving the remaining colony temporarily queenless while a new queen is established. The new queen must complete pupal development, emerge as an adult, mature, mate, and begin laying eggs. This results in a multi-week break in brood production, which further reduces the colony population and productivity. Swarming colonies may also be alarming to neighbors, who may be concerned when swarms appear in their backyard.

Figure 3. Swarm of honey bees in a tree. Photo: Ken Hoover

Beekeepers must check their colonies regularly to make sure the brood chamber and honey supers are not full, and that queen rearing has not been initiated. Since it takes only ~16 days from egg to adult queen, beekeepers typically check their colonies at least every two weeks to monitor for swarm prevention. Beekeepers can add more brood frames or honey supers to reduce colony congestion and delay swarming. Another option to delay swarming is to remove and destroy developing queen cells. While this option can be effective, it is time-consuming and prone to error. Vigorous, overwintered colonies will almost assuredly attempt to swarm; even colonies started earlier in the spring from nucs and packages may swarm if resources are sufficiently abundant.

The most effective method to manage swarming after the colony initiates queen rearing is to make a split. Splitting is the act of separating a colony into two: One half contains the queen and the other is left with one or more queen cells. This strategy takes advantage of the swarming behavior to increase colony numbers while retaining bees. Sometimes, beekeepers will purchase a mated queen to introduce to the queenless half of the split. The reproductive impulse to swarm is so strong that a colony will sometimes swarm with a virgin queen after a split has been made.

Beekeepers can take advantage of abundant floral resources and the colony's drive to reproduce during late spring by artificially rearing queens. Rearing queens from high-performing colonies allows the beekeeper to have more control over the timing of queen emergence, splits, and the quality of the queens.

For more information about queen rearing see Queen Cell Production: Grafting and Graft-Free Methods.

Summer

During the summer, the colony collects and stores the honey that the bees will consume in the fall and winter months. If the colony swarmed or the beekeeper made a split, the newly emerged queens will have mated and begun laying eggs. This is the season that many beekeepers harvest honey.

Summer is also a key time to start monitoring for Varroa mites. Varroa mites and their management remain the greatest challenge in modern beekeeping. Mite populations increase rapidly during periods of mass brood rearing, so, a beekeeper's strongest and largest colonies are often the ones most affected by mite infestations. Mites feed on developing bee larvae and pupae, thereby weakening the developing bee, and transmitting viruses. When mite-infested workers emerge as adult bees, they may have deformed wings, reduced ability to perform colony tasks, and reduced lifespans. This reduces the colony's ability to forage and rear brood and, if left untreated, can result in colony death. By monitoring colonies for mites early in the year, beekeepers can treat mite infestations before they become problematic.

For more information on honey bee viruses see Viruses in Honey Bees.

Late Summer

In Pennsylvania, summer nectar flows diminish in July, resulting in a nectar dearth or scarcity. Honey bees become more defensive of their colony's resources during this time, and strong colonies may begin robbing smaller or weaker colonies. Robbing can be reduced by limiting colony inspections during a dearth and by placing a special screen on the entrance called a robbing screen, which prevents non-resident bees from entering the hive.

Late in the summer, August and September in the northeastern United States, colonies also begin to rear winter bees, who are physiologically distinct from summer bees. These workers live much longer—up to six months versus six weeks for summer bees. Winter bees also have larger fat bodies. Fat bodies are specialized organs located in the abdomen that provide bees with the nutritional reserves needed to survive winter. A healthy population of winter bees is essential to colony winter survival. If these bees are unhealthy or diseased, they will die during the winter when the colony is unable to rear new bees to replace them, resulting in a winter cluster that is too small to survive until spring.

Figure 4. (arrow) Worker with Deformed Wing Virus (DWV). Photo: Kate Anton, Penn State

Because winter bees are essential to successful overwintering, Varroa mite infestations must be assessed and treated at this time. Integrated Pest Management approaches (IPM) are recommended to manage mite populations. An IPM approach involves monitoring for pests or diseases, and when levels have reached a threshold at which damage will occur, treatment is initiated. It is recommended that multiple strategies are used to control pests/diseases, prioritizing approaches that do not involve chemicals that may have negative non-target impacts on bees.

See Methods to Control Varroa Mites: An Integrated Pest Management Approach for detailed information about varroa mite management.

Fall

At the beginning of fall in many regions of the northeast, there is another nectar flow that beekeepers call the fall flow. This late-season resource helps honey bee colonies store enough honey to survive through the winter months and, in some areas, a second harvest of honey is possible. Early in the fall, the colony is continuing to rear winter bees, though brood production is slowing.

Figure 5. In the fall, floral resources become scarce. Photo: Center for Pollinator Research, Penn State University.

Monitoring for Varroa mites is necessary at this time, both to ensure that late summer treatments were effective and to determine if the mite population has risen above the threshold since the summer. The mite population should be as small as possible for the best possible outcome of overwintering.

Honey bee colonies will soon be completely reliant on their honey stores. As floral resources become scarce, worker bees become increasingly defensive. Drones are often evicted during this time, as reproductive opportunities have come to an end for the season and the drones are now a drain on the colony's food stores. Workers can be seen carrying uncooperative drones out of the hive.

Beekeepers pay special attention to the weight of their colonies in the fall. Colonies with large population sizes and honey stores have the best chance of surviving winter. Weak or light colonies can be bolstered by feeding or combined with another small colony to give them a better chance of survival.

Winter

Winter for honey bees begins as the last flowers are eliminated by freezing temperatures. The summer bees have died off and brood-rearing comes to an end for the season. Cold temperatures trigger the colony to form a cluster. A cluster is a spherical group of bees that spans multiple frames. The cluster is formed by layers or shells of bees that are warmest in the center and cooler on the periphery. As outside temperatures decrease, the outer shells of the cluster contract. The bees vibrate their flight muscles to create heat, which requires access to carbohydrates (honey) as fuel. Workers must break cluster to access food located outside the cluster. This is only possible when temperatures are warm enough to permit movement.

Figure 6. Winter is a good time to treat the colonies for mites. Photo: Robyn Underwood, Penn State

Generally, the cluster of bees starts out in the bottom portion of the hive and slowly moves laterally and vertically to access stores of honey. Because honey bees are unable to consume cold supplemental syrup, northeast beekeepers may provide winter feed as fondant or hard sugar, which is placed on top of the uppermost frames inside the hive. As the cluster moves up

through the hive, the bees will gradually gain access to the supplemental feed.

Winter presents a unique opportunity to treat the colony for mites. Because there is no brood, the mites are all on adult bees - waiting for spring when they will have the chance to reproduce again. Beekeepers take advantage of this broodless period to apply an oxalic acid treatment. Oxalic acid is an organic ingredient that is naturally occurring in honey. When applied as a concentrated fumigant or as a liquid in the hive, oxalic acid does not affect mites that are sealed inside capped cells, but it is lethal to mites that are on adult bees. This winter mite treatment ensures that the colony will restart its lifecycle with very few if any, mites.

Resources

Further information about honey bee biology can be found in The Hive and the Honey Bee.

A Quick Reference Guide to Honey Bee Parasites, Pests, Predators, and Diseases

Methods to Control Varroa Mites: An Integrated Pest Management Approach

Viruses in Honey Bees

Please visit The Grozinger Lab to learn more about Grozinger Lab research

For a wealth of information on pollinators check out the Center for Pollinator Research.

References

Döke, M. A., Frazier, M., & Grozinger, C. M. (2015). Overwintering honey bees: Biology and management. Current Opinion in Insect Science, 10, 185–193.

Authors

Christina Grozinger, Ph.D.
Distinguished Professor of Entomology
cmgrozinger@psu.edu
814-865-2214

Kate Anton
Research Technologist
kxa138@psu.edu
814-865-9806

extension.psu.edu

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