PennState Extension

Beekeeping: Cell Builder Basics

Honey bee colony behavior is dynamic and extremely adaptable, which allows for easy manipulation and management of these amazing social insects.



Figure 1. Nurse bees provisioning a day old queen cell. Photo: Kate Anton, Penn State

Beekeepers leverage these plastic behaviors by creating special colonies called cell builders. Cell builders are used in queen rearing to initiate, provision, and care for queen cells. Creating cell builders requires integrating several concepts, including behavioral responses, physiology, and environmental conditions. Establishing and maintaining cell builders is generally the most nuanced and occasionally frustrating part of queen rearing; experience and applied knowledge are instrumental to success.

As discussed in An introduction to Queen Honey Bee Development, all young fertilized larvae can become queens, and provisioning queen-destined larvae requires thousands of feeding visits from nurse bees with access to abundant resources (Figure 1). Here, we describe the principles that allow the production of large numbers of queen cells by taking advantage of intrinsic honey bee behaviors.

Geographic location, nectar flows, colony condition and time of year influence the number of queens that can be produced at any given time. Rearing is technically possible whenever it is warm enough to open a colony, but the most productive time of year is late spring and early summer in the Northeastern states. During a May nectar flow, it is possible to rear 100 or more queens in a single cell builder. In a September dearth, it is challenging to rear more than 15 or 20 queens. The hypopharyngeal glands of spring nurse bees are larger and more productive than those of fall bees, making spring bees better equipped to provision growing larvae. In addition to the changing physiology of workers, the colony reduces brood and wax production as it prepares for winter, reducing the potential for cell construction and provisioning. Seasonal changes in the bees' behavior and physiology as well as seasonal changes in the availability of floral resources are important considerations when determining the method and scale of queen production.

In the natural life cycle of a honey bee colony, queen cells are initiated in preparation for reproductive swarming, supercedure, or in the event of queen death. With sufficient resources, once a queen cell is started, nurse bees will continue to care for the new queen throughout her development, unless she is destroyed by a rival queen. These features of colony behavior are critical to the establishment and success of cell builders.

The Cell Starter... a State of Emergency

Removal or death of a queen triggers a significant change in the behavior of the workers. When a queen is killed, the colony enters a state of emergency and will begin provisioning many young larvae to become new queens almost immediately. When rearing queens, the beekeeper can induce this behavior by physically removing the queen, or by setting up a new queenless colony. This colony is called a cell starter or starter colony and it is here that queen rearing begins.

In a cell starter, nurse bees initiate queen rearing when grafted cell cups are introduced to a colony that is queenless, and absent of queen cells and young larvae. If young larvae remain, the colony will rear emergency replacement queens from the larvae on the frames, diverting resources away from grafts, and creating undesired queen cells that are difficult to handle by the beekeeper. The most abundant, well-provisioned queen cells are obtained when grafted cells are the only source of young larvae in the colony.

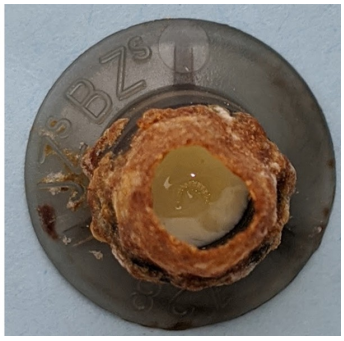



Figure 2 (Left). One day old queen cell, provisioned with royal jelly and partially drawn. Figure 3 (Right). One day old provisioned queen larva and royal jelly. Photos: Kate Anton, Penn State

There are multiple methods for creating cell starters. One way is to create a new queenless colony by shaking nurse bees into a nuc or a standard single deep hive. From there, a single frame of open brood is added to the center of the hive body and flanked by several frames containing pollen and nectar. Outer frames may be filled with empty, drawn comb and/or a frame feeder. Cell starters with more nurse bees and food resources can raise more queen cells. For example, four frames of nurse bees will generally start approximately 30 cells. A few hours to one day after the starter colony is assembled, it will be ready to receive grafts. The grafting frame is exchanged with the single brood frame in the starter colony. Nurse bees will begin provisioning the grafted cells immediately. Started cells can be viewed the following day by gently brushing the nurse bees from the cells and looking at the contents from below. It is important not to shake or invert the grafting bar; the young larvae are delicate and susceptible to drowning. Started cells will be partially drawn (Figure 2) and have a pool of royal jelly in the center with the larva visible, suspended on the royal jelly (Figure 3). At this point, if the beekeeper is using a separate cell finisher, the cell bar is transferred to the awaiting colony. Cell starters may be used consecutively for several days if desired, though its efficacy is reduced over time.

The Cell Finisher… a State of Abundance

The cell finisher feeds and builds the started queen cells. Queenright colonies are ideal for this task and can be used for successive rounds of finishing. Nurse bees must be abundant to care for the developing queens, while vast numbers of foragers must be available to feed and sustain the nurse bees. In a state of abundance, resource-rich colonies can provision 100 or more queen cells at a time! Cell builders are most commonly made from colonies that occupy two deep hive bodies, but they can also be made with mediums or nucs. It is crucial that the queen is trapped in the lower hive body by a queen excluder, preventing her access to the vulnerable, developing queens above. Inspect the frames in the finisher (especially above the queen excluder) for any unexpected queen cells. An unexpected queen who emerges above the excluder will kill all of the grafted queens (see the discussion below on how to avoid this).

Cell finishers are managed for constant growth, a state that would lead to swarming in nature. Management of these colonies requires regular assessment and intervention by the beekeeper. Robust colonies with young queens (less than one year old) are less likely to swarm and are more prolific layers. Resources and brood in the finisher may be exchanged with other colonies to maintain growth. Sugar syrup, along with fresh pollen or pollen patties, should be freely available and replenished regularly. Queenright cell finishers can be used for successive, though not indefinite queen rearing efforts. Eventually the finisher will lose efficacy, at which time the colony is often split into nucs or requeened. The precise number of times a colony can be used as a cell builder is variable and largely determined by time, resources, and colony temperament.

Combination methods

There are many variations of the cell builder and it is possible to use the same colony to start and finish queen cells. In a combination starter/finisher, the queen, frames with young brood, and some workers are temporarily removed from the colony. This leaves the remaining colony in a queenless state of emergency and a state of abundance. Grafts can be placed in this colony any time from four hours to one day after the removal of the queen. After the grafted larvae are introduced it is possible to use this colony to finish building the queen cells. The most simple, but least sustainable, method is to allow the colony to remain queenless after initiating the grafts. Queenless cell finishers are typically converted into nucs after a single use because the behaviors that allow for productive rearing diminish with extended periods of queenlessness.

An alternative option is to reunite the colony with the original queen (creating a queenright cell finisher), because the colony has been queenless for a maximum of two days they will readily accept their original queen. In this scenario a queen excluder is placed between hive bodies and the queen is confined to the lower portion of the hive, while the grafted cells remain above the queen excluder.

Harry Cloake, of New Zealand, developed a method that uses a combination of starter and finisher colony and eliminates the need to move the delicate queen cells. The Cloake Board system relies on a division board that acts as a queen excluder and entrance (Figure 4). A metal slide is used to divide two hive bodies, trapping the queen in the lower portion and creating a perceived state of queenlessness in the hive body above. Severing pheromone communication allows the upper, queenless portion of the colony to be used as a cell starter. Removal of the slide restores communication and worker movement, creating a queeright finisher.

Other systems use the nurse bees from one colony to start the cells and rejoin the starter with its original colony using swarm boxes, screens or other custom fabricated components. There is no single cell builder method that is considered standard, beekeepers use systems to suit their own production and management needs.





Figure 4 (Left). Cloake division board and slide. Figure 5 (Right). Capped queen cells in a grafting frame. Photos: Kate Anton, Penn State

Finished Queen Cells…. a State of Bliss

After successful grafting and cell building, the beekeeper now has many queen cells that require special care. The total time for queen development from egg to adult is 16-17 days. When day-old larvae are used for grafting, the queen cells will be capped 4 days after being placed in the cell builder (eight days after being laid as an egg). Once capped, queen cells no longer require a colony to feed them. While it is possible to leave queen cells in a cell finisher for up to 11 days after grafting, a miscalculation that results in one early-emerging queen (who stings the other queens in their cells) will leave the beekeeper with a single virgin queen along with her many, newly-deceased sisters. In commercial operations, capped queen cells are removed from the cell builder and placed in an incubator with controlled temperature and humidity. Queen cells may be placed in a queenless nuc or other colony two to five days before emergence (six to ten days after grafting). Alternatively, queens can be allowed to emerge from their cells into cages in the cell builder or incubator. Virgin queens can then be shipped or released into a queenless colony one to seven days after emergence. Further information on handling queens will be available in a future article in this series.

Managing cell builders requires time and patience. With experience, it quickly becomes a rewarding activity that provides flexibility and independence in honey bee colony management.

More Information

- Information on honey bee biology: The Hive and the Honey Bee by Lorenzo Langstroth.
- Information on queen rearing: Queen Rearing Essentials by Lawrence John Connor.
- Learn more about The Grozinger Lab research.
- Center for Pollinator Research

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