

An Introduction to Queen Honey Bee Development

The queen is the most important individual in a colony. She is the only bee capable of producing workers and tens of thousands of workers are required for strong colonies.



Photo: Kate Anton, Penn State

Healthy, fertile queens are capable of laying eggs almost constantly, during peak season a quality queen can lay over 3,000 eggs per day - that's more than her own body weight in eggs in a day!

Although queens can live seven or more years, their productivity typically declines after the first year or two. Some beekeepers only replace queens when the queen is lost or failing, while others find it advantageous to replace their queens annually. Commercial beekeepers replace queens as often as twice a year. Queen health and quality can be controlled to an extent by the beekeeper. Queen rearing can be carried out at any scale, large or small and can be a rewarding and fun activity for beekeepers. The successful production of queens requires an understanding of key aspects of queen development. In this article, we will explore queen development from egg to a virgin queen preparing to take her mating flight.

All fertilized eggs have the potential to become a queen or a worker while unfertilized eggs become drones. Eggs hatch into larvae about three days after being laid. All larvae are fed royal jelly exclusively for the first three days after hatching. The term hatch or hatching is only used to refer to bee eggs hatching into larvae, the term emerge is used for when a bee

emerges from its cell as an adult.

Royal jelly is a sweet, protein-rich secretion exuded from the hypopharyngeal glands of worker bees. These glands are located along the sides of a worker's head and are largest in nurse bees between 6 and 12 days old. As workers grow older, the hypopharyngeal glands shrink and become increasingly less productive. Nurse bees consume large quantities of pollen and nectar to produce copious amounts of royal jelly required for queen production. Colonies with greater access to resources are able to rear larger numbers of well-provisioned queens. Every larva receives about 10,000 nurse bee feeding visits during development - this means that each larva is fed on average every 43 seconds!

It is possible for all female larvae under three days old to become a queen, though larger, more vigorous queens are produced with the youngest larvae, less than one day old. Larvae selected to become queens receive more royal jelly throughout development, younger larvae have a greater opportunity to receive optimal nutrition and meet their full potential. In contrast, worker-destined larvae transition to a 'worker jelly' diet on the third day. Worker jelly is a mixture of royal jelly, pollen, and nectar. Larvae exclusively fed royal jelly develop into reproductive queens while larvae fed worker jelly become sterile workers.

When the colony makes a new queen naturally it is either to reproduce by swarming, a collective decision that the queen is unfit and needs to be replaced (supersedure), or because the queen is missing or is dead. Several factors influence the selection of queen-destined larvae. Nurse bees do preferentially select their full sisters to become queens when possible. Preference will also be given to the most well-nourished larvae. Beekeepers are able to manipulate their colonies in order to create this state of emergency and provide selected larvae, from the stock of their choosing, to become queens. Detailed information on queen rearing will be discussed in detail in future articles.

Queen honey bees have the shortest development period of any of the castes. About nine days after being laid as an egg the developing queen's cell is capped, the larva spins a cocoon and pupates. With a total of about 16 days from egg to queen, rapid development is not only helpful to the beekeeper but is a fascinating evolutionary adaptation. When multiple queen cells have been provisioned in a colony, the first queen to



emerge will seek, sting, and kill her sister queens before they try to do the same. If multiple queens emerge, they will fight until only one remains, thus it is advantageous for a queen to emerge before her sisters. Another advantage to this accelerated process is the reduced time the colony is queenless, and therefore broodless, and unable to produce the numerous worker bees needed for a successful colony.

Upon emergence, a virgin queen spends five to eight days in the colony prior to taking her mating flight(s). Nurse bees continue to feed her during this time, allowing her reproductive organs to mature and her flight muscles to grow strong in preparation for mating flights. The appearance of a virgin queen differs from a mated, laying queen. Before maturation, her ovaries have not fully developed, thus her abdomen is not yet distended, allowing her to move quickly across the comb and take mating flights- often making it difficult for the beekeeper to locate her. The image below shows the same queen before and after mating. Notice the changes to her abdomen as well as the difference in response from the surrounding workers.



Figure A shows the virgin, unmarked queen. Figure B is the same queen after mating. This queen is laying and marked. Photos: Kate Anton, Penn State

Honey bee colonies rely on chemical communication using pheromones. Pheromones are chemical secretions that alter the behavior and physiology of other bees in the colony. Queen honey bees produce a complex pheromone that contains chemicals produced by several glands in the body. The mandibular gland is a particularly important source of these pheromones, and a subset of five chemicals produced in this gland are called “queen mandibular pheromone” or QMP. The types and quantities of the chemicals produced by virgin queens change with mating and mating quality. The virgin queen pheromone blend is very attractive to drones during mating flights, while the mated queen pheromone blend is important for social organization in the colony. QMP inhibits worker reproduction (laying workers) and prevents the rearing of new queens. The mated queen pheromone blend is more effective at inducing a retinue response. The retinue response is observed when the queen is surrounded by workers who are facing and touching her in order to spread her pheromone throughout the colony. Notice the difference in the workers surrounding the queen in the images above; retinue response is observed in the image with the mated, laying queen (B) and

absent in the image with the virgin queen (A). More information about pheromones will be provided in future articles. Understanding these signals allows beekeepers greater control when working with queens and manipulating queenless colonies.

In summary, understanding queen honey bee development is critical to successful queen production. Integrating this information into management allows beekeepers to enhance the productivity of their colonies and achieve a higher level of self-sufficiency.

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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