# Honey Bee Biology

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## Bee Larvae: Busier than You Think

Healthy brood should not be taken for granted. During colony inspections, I always check to make sure the colony has plenty of glistening white worker larvae, at all ages, which tend to catch my eye.

Healthy larvae are white, and the older ones, covering the bases of the cells, glisten in sunlight, when held there briefly (see Figure 1). Larvae appearing off white, especially brownish, indicate various problems from chilled brood or different diseases or perhaps indirectly a connection with varroa infestations.

The honey bee larva is a specialized development stage for feeding, little else, except for pheromone production. However, larvae do move in their cells. The larva, curled in a "C" shape, can move slowly in a circle. The larva needs no external limbs for such moment, which can bring it to food placed in the cell by nurse bees. Notice in Figure 1 the larvae are in different rotational positions. Those positions would change in the next hour or so. The folds of the body surface on their sides and back are thought to provide the movement.

Observations from older research report the folds in a larva contract and then expand in an advanced position, which apparently pull the larva forward, in somewhat of a crawling movement. For example, three-day-old worker larvae can turn (rotate) twice in their cells every one and three quarter hours. Larvae move forward (head first) in their cells, although backwards-moving larvae have been reported. When moving in reverse, the larva pushes against the cell with its mouthparts (Jay, 1963). I have seen older larvae, near capping age, crawl out of their brood cells when the bee coverage was removed, and the comb kept warm. That may be due to a lack of food as brief comments in older research suggest. Anyway, those larvae being sedentary and immobile are an illusion – nurse bee magic. I have seen a similar behavior in older hornet larvae leaving their cells when I removed the comb from the nurse hornets. Out wiggle the older larvae. Going nowhere.

For feeding, larvae are essentially little eating machines made to grow quickly. Insects have their skeletal structure on the outside of their bodies, called an exoskeleton. In contrast mammals, reptiles and birds have internal skeletons supporting their bodies, called an endoskeleton. Given the rapid growth, an external skeleton, no matter how thin around a larva, cannot contain its expanding body. In terms of size, the old exoskeleton becomes out of date and must be shed, or molted. A developing bee has six molts. Five of them occur during the fast-growing larval stage. For queens and workers the first four molts occur approximately once a day allowing rapid growth by shedding old exoskeletons.

For digestion, internally larvae are mostly a mid gut and a hind gut, which comes to a dead end inside them while feeding. So the larvae do not defecate while the nurse bees feed the larvae. In addition, the nurse bees help digest the food before they give it to the larvae. Once larvae finish feeding with the cells open, nurse bees provision the cells with a little more food for worker larvae and probably drone larvae. Then bees cap their cells (see Figure 2).

Queen larvae are much different. Nurse bees put massive quantities of royal jelly in their cells. The entire base of the cell becomes coated in a thick layer of white material, which under optimum feeding conditions, cannot all be consumed by a larva. Some will be left over. Later on

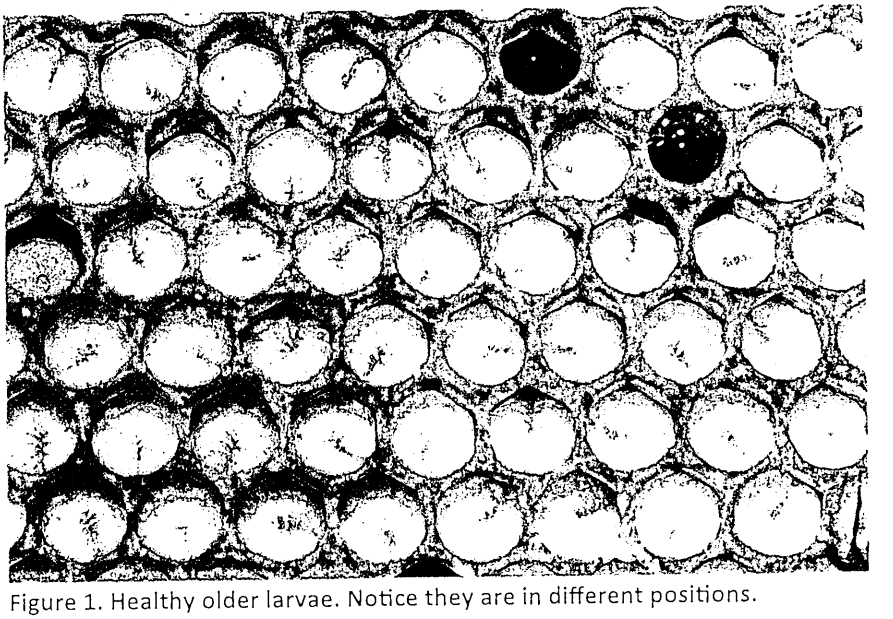

Figure 1. Healthy older larvae. Notice they are in different positions.

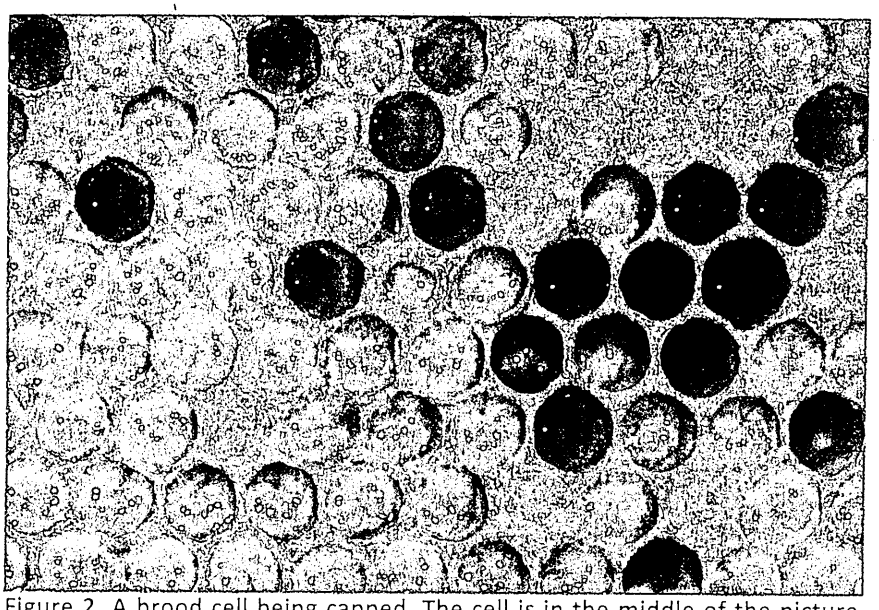

Figure 2. A brood cell being capped. The cell is in the middle of the picture, partly closed.

during pupation and right after the queen leaves her cell, the once white jelly-like consistency turns to a tough thick brown resin-like material. Even after the queen has emerged from a cell, the presence of the brown gooey material tells me the nurse bees gave the developing queen a proper feeding. I cut open the empty queen cell and look for the old royal jelly at the base of the cell. When letting a nuc rear its own queen, rearing under stressful conditions, sometimes the emergency queen cells do not have any extra old royal jelly or there is a little bit that perhaps the larva could not reach. Then I would expect the new queens to be under-fed and that would damage their development and the colony's honey production.

The weight gains are incredible from the egg weight to mature larval weight, although both weights can vary. Winston (1987) reported the weight gain increase as about 700 times for workers. That is, the mature worker larva weighed 700 times more than the worker egg. The factor increase for queens was about 900 times. The factor increase was the largest for the drone at about 2300 times.

Once the nurse bees cap the cell, provisioning from the outside is complete. Worker and drone larvae finish feeding on what little food remains in their cells. They begin spinning the cocoons in their cells. They also defecate early in cocoon construction. The dark brown contents become deposited at the base of the cell. A lighter color substance from the excretory tubules gets plastered in with the sil forming the cocoon. The cocoons of th workers and drones are not very thick, an their cocoons completely surround them like a wax moth cocoon.

It is tempting to think the sam surrounding cocoon occurs with queens but that is wrong. A queen's cocoon doe not completely surround the larva. Rathe the cocoon covers the cap end of the cel and extends part way up the sides of the cell The cocoon does not extend across the bad of the cell, to keep from cutting the larv off from the excess amount of royal jell remaining in the back of her cell. Unlik workers and drones, queens have extensiv food reserves. As the larva spins her cocoon she also continues to eat from the food reserve. This is why the extra royal jelly in her cell is so important. Queen larvae continue feeding for a day or so – after their cells are capped, the larvae are not inactive Rather just the opposite. This is importan to understand about queen cells so here is some more detail.

For thirty hours, the queen larva spins a cocoon composed of silk gland secretions formed in threads and thin sheets. As the larva spins her cocoon, she moves in a somersaulting fashion within her cell. She somersaults an average of 40 - 80 times, and each somersault takes 22 - 43 minutes. When the larva's head touches the food at the base of the cell, she appears to stop spinning and feeds for 1 - 10 minutes. The queen spins her cocoon over the cell walls, and builds it across the lower part of the cell, but not over the royal jelly (see Figure 3). At other end of the cell, the tip end, a small gap is usually present between her cocoon and the wax cap built by the bees (Jay, 1964).

In my experience, queen cells in the state where their larvae are spinning cocoons are extremely delicate. The larva may be in mid turn with silk strands coming from her spinnerets. She is vulnerable to physical shock and chills. When moving naturally-

Figure 3. A queen larva finishing her cocoon. Her head is down towards the cap end of the cell. She might just stretch out in the cell and become a propupa, a motionless stage before becoming a pupa. Note the excess royal jelly at the base of the cell.

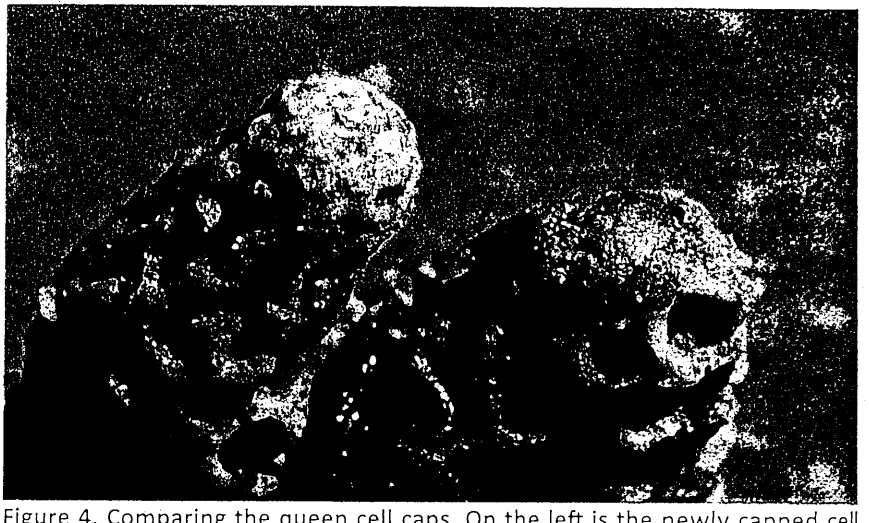

Figure 4. Comparing the queen cell caps. On the left is the newly capped cell with a spinning larva. On the right is the older capped cell with the queen's cocoon exposed, containing a pupal queen. The bees will also remove most all the wax from the tip end of the cell.

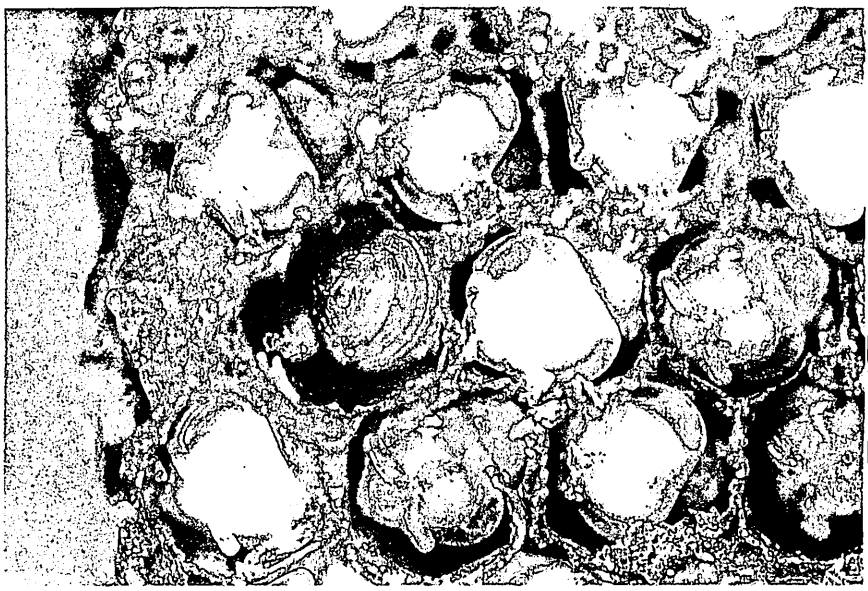

Figure 5. Wrong way. Near the middle of the picture is a pupa facing in the wrong direction. When the larva finished spinning her cocoon, she stretched out in the wrong direction. It is thought they make the decision by the texture of the cap versus the cell, but they masked the texture with their cocoon. So I am not convinced, though I have my hunches.

built queen cells for making splits or dividing colonies, I avoid using these cells, although they are sealed and technically are useable. (The rule is one can use a sealed, capped queen cell because the nurse bees have finished provisioning it with royal jelly.) However newly capped queen cells may be too delicate to survive the transfer, especially if moved out on a truck to the next apiary. To tell these newly capped queen cells, I look at the cap end. If the cell still has the thick wax dome, then the larva is probably still spinning. Later when the queen turns into a pupa and becomes more resilient to being transferred, the bees start removing that wax cap. Under the wax, the bees expose a brown fibrous material, which was the cocoon the queen spun as a larva. When I see the cocoon on the cap end of the queen cell, I know it is safer to move the cell, provided I handle it carefully (see Figure 4). Sometimes beekeepers call the place on the tip of the queen cell of the exposed queen cocoon the "bald spot."

For the worker, queen and drone, once they finish cocoon spinning and feeding, the now fully grown larvae stretch out lengthwise in the cell, and become motionless. They must orient their heads toward the cell's cap – a critical maneuver because as mature bees, they cannot turn around in the cell like the young flexible larvae could. Most of the time they orient correctly. I have cut open two queen cells and found dead queens facing the wrong way. After becoming active and with the urge to emerge, they gnawed into the tough resin-like old royal jelly until they starved. You can find workers facing the wrong direction with some "luck" and by uncapping cells as Figure 5 shows.

Larvae are not just lying in their cells, taking it easy, "getting" the good life. It is a time of incredibly fast growth, cocoon spinning and making sure they get pointed in the right direction for their next stage in life, adulthood.

Acknowledgments

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