Honey Bee Life History

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(From Beekeeping in the United States)

A honey bee begins life as an egg. Bee eggs develop in the ovarioles or small tubes that make up the two ovaries of a queen. The egg is nourished and grows as it moves down this tube. When it is fully formed, it reaches the end of the ovariole, then moves through the oviducts into the vagina. The sex of the new bee is normally determined as the egg passes through the vagina. A lifetime supply of sperm (5 million to 6 million) is stored by each queen in the spermatheca, a little globular sac attached to the vagina. The queen controls the release of sperm with the so-called sperm pump. If an egg is fertilized, it will develop into a female bee, but if not fertilized, a male bee will result. The result is that male bees have only one set of chromosomes (haploid) acquired from the queen.

The queen bee attaches each egg to the base of an empty cell in combs that have been cleaned by workers. The honey bee egg is a smooth, white, sausage-shaped object about 1.5 ml in length. During the first day, the egg nucleus divides-if the egg is unfertilized; or if the egg is fertilized, the fusion nucleus or zygote divides. It is not until the third day that the embryo form (with head and body segments) can be seen within the egg. The head is present at the larger unattached end and the back (dorsum) is on the incurved (concave) side.

The first sign of hatching occurs when an egg is 72 to 84 hours old. Muscular contractions by the embryo cause a gentle, weaving motion that apparently results in a tiny hole being torn in the outer membrane (chorion). Fluid from within the egg soon emerges and covers the external surface. The embryo with its "tail" attached to the base of the cell continues to move about until its head also touches the base and an arch is formed. In this "croquet wicket" stage, the chorion evidently is dissolved. The larva then eases itself over against the bottom of the cell into the familiar C-shaped position).

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Honey bee larvae are fed a nutritious substance called royal jelly secreted by the brood-food glands (hypopharyngeal glands) of young workers. During the first 24 hours, worker larvae are fed lavish amounts of royal jelly by older nurse bees. During the second 24 hours, they get very little additional food and thereafter are cared for by nurse bees of all ages. Pollen and honey are present in the food of older worker larvae.

Honey bees use two systems of feeding larvae. Young larvae are fed amounts excessive to their needs and older larvae are provided small quantities of food as needed. It has been estimated that 110,000 visits are made to a single bee during its egg and larval stages, 3,500 of these during the last 24 hours.

A female larva fed continuously on lavish amounts of royal jelly and provided a large, peanut-shaped cell will become a queen. Another larva given a mixture of honey and pollen during the latter half of its larval life and kept in a worker cell becomes a worker. The process that produces the complete expression of sexual characteristics in a queen has not been determined; however, it is considered to be caused by differences in both the quality and the quantity of the larval food provided.

Drone larvae grow larger than either workers or queens and, therefore, require more food. Food given to young drone larvae is nearly devoid of pollen and is milky-white, while that given to older drone larvae is a yellow-brown color and contains considerable pollen. The food given older drone larvae also is higher in pollen content than that given older worker larvae. Thus, both qualitative and quantitative differences distinguish the lar val food given queen, worker, and drone.
The developing honey bee larva is a helpless creature whose principal function is eating. Both the malpighian tubules (analogous to human kidneys) and midgut are shut off from the intestine until a larva is nearly mature. In this way, body wastes are stored internally and the food surrounding each larva is protected from fecal contamination. The feces are expelled and pushed down to the bottom of the cell about the time the cocoon is made and after the larva has finished eating.

All castes of honey bees molt about every 24 hours during the first 4 days of larval life. When the ecdysis or molting occurs, the skin splits over the head and slips off the posterior end of the larva. This process normally takes less than 30 minutes. Each new larval stage (instar) is at first only slightly larger than the previous one, but it grows rapidly. The fifth larval instar gains about 40
percent of the total mature larval weight during days 8 and 9 (table 1).

By the end of the 8th day after the egg was laid, the cell containing the worker larva is capped. During the 9th day, the larva spins a cocoon using silk from a special gland in its head. On the 10th day, the larva stretches out on its back with its head toward the cell opening and becomes quiescent inside its cocoon. This stage usually is called the prepupa. The 5th molt, which occurs during the 11th day, reveals the pupal form-white in color and motionless. Color develops gradually, first in the eyes (13th day), then in the abdomen (15th day), legs (16th day), wings (18th day), and finally in the antennae (20th day).

Table 1. Moults of the Honey Bee

	Workers		Queens		Drones	
DAY	Stages	Moults	Stages	Moults	Stages	Moults
1						
2	egg		egg		egg	
3		hatching		hatching		(hatching)
4	1st larval	1st moult	1st larval	1st moult	1st larval	1st moult
5	2nd larval	2nd moult	2nd larval	2nd moult	2nd larval	2nd moult
6	3rd larval	3rd moult	3rd larval	3rd moult	3rd larval	3rd moult
7	4th larval	4th moult	4th larval	4th moult (sealing)	4th larval	4th moult
8						
9	gorging	(sealing)	gorging		gorging	

10							
11		prepupa	5th moult	prepupa	5th moult		(sealing)
12						prepupa	
13				pupa			
14							5th moult
15		pupa					
16				imago	6th moult emergence		
17							
18							
19						pupa	
20							
21		imago	6th moult (emerging)				
22							
23						imago	6th moult
24							(emerging)

Throughout this period, the pupa is encased in a thin outer skin which is shed in the 6th and final molt on the 20th day. Thus, legs, wings, and mouth parts are freed and the pupa becomes an imago (adult) which soon begins to chew its way out of the cell.

Because a bee egg hatches into a larva which becomes first pupa and then imago, bees are said to have a complete metamorphosis. The length of the egg stage (3 days) is the same for all three castes, but the larval and pupal stages are shortest for the queen and longest for the drone (table 1). As with most biological development, the duration may vary between individuals, and the data in table 1 should be considered as close approximations. For example, hatching occurs between 72 and 84 hours, and workers may emerge as early as 19 days or as late as 23 days after the egg was laid.

Activities of Worker Bees

Workers within a honey bee colony engage in various tasks, depending on their age and the needs of the colony. Division of labor by age exists within the worker caste. Bees less than 2 weeks old become involved in cleaning cells and feeding first the older larvae and then larvae of all ages. Workers function as nurse bees during the period that their hypopharyngeal glands are producing brood food.

Older house bees work with honey, pollen, wax, and propolis. Nectar-collecting field bees are met by

house bees, usually near the entrance, and are relieved of their nectar loads. The conversion of nectar into honey requires both a physical and a chemical change. The physical change involves the removal of water, which is accomplished by externally manipulating nectar in the mouth parts and then placing small droplets on the upper side of cells and fanning the wings to increase air move ment and carry away excess moisture. (Nectar is 30 to 90 percent water, but honey should have no more than 18.5 percent water.) The chemical change requires the addition to nectar of the en zyme invertase, which the bees produce in their salivary glands. This enzyme breaks the disac charide sugar, sucrose, into two monosaccharide sugars, glucose and fructose. (Nectar may be nearly all sucrose or may contain no sucrose, but honey contains an average of only 1 percent sucrose.)

Pollen pellets are deposited in empty cells near the brood nest by the pollen-collecting workers. In the cells, the pollen undergoes a maturing process to what is commonly called bee bread. Details of the maturing process are not understood.

When bees are about 12 to 15 days old, their wax glands become functional and comb building is possible. Wax scales are removed from between the ventral abdominal sclerites and positioned into place using both feet and mouthparts. Young house bees in the process of comb building hang in festoons and pass the wax scales from bee to bee.

Propolis-collecting bees also serve as propolis storage reservoirs. Propolis is not stored in combs or elsewhere, but is removed from the corbiculae of these field bees and used as needed. House bees fill cracks and cover rough parts with propolis.

During their third week as house bees, workers take short flights for orientation and defecation. Hives painted different colors aid the bees with orientation and reduce the chance of young bees drifting between adjacent colonies. Some of the oldest house bees also serve as guards at the entrance.

After approximately 3 weeks as house bees, the workers become foragers, gathering pollen, nectar, water, and propolis for the colony. This period of their lives also averages about 3 weeks. Most foragers collect nectar and pollen, but nectar is collected in greater quantities than pollen. Pollen collection tends to be an activity of younger foragers and nectar collection a function of older foragers. Water collectors may comprise 10 percent of all foragers, but this figure is much higher during periods of heat stress. Propolis collectors are quite rarely observed.

The schedule of worker bee activities is both flexible and reversible, depending more upon physiological age than on chronological age, and is altered according to the needs of the colony. During autumn, a reduction in brood rearing and an increase in pollen consumption result in a population of long-lived "winter" bees having increased fat bodies and protein reserves. The normal 6-week adult life of "summer" bees may be extended to several months in these "winter" bees. Similar extensions of life expectancy also occur when brood rearing is interrupted at other times.

Activities of Drones and Queens

Drones take their first flights at about 8 days of age and are sexually mature at 12 days. Drones fly out on cleansing flights and orientation flights-both of short duration-and also on longer flights to congregation areas in search of a virgin queen. Drones do not forage and spend about three-fourths of their time at complete rest. Their normal lifespan is 8 weeks or less.

Queens newly emerged from their cells are at first ignored but are later touched and licked by workers.

This apparently helps prepare the virgin queen physiologically for her mating flight. Mating occurs in drone congregation areas-special locations in the air regularly visited by drones. These occur in the same places year after year.

A queen generally mates 6 to 10 days following emergence. She may go out on several mating flights, mating with several drones on each flight. Additional mating flights are taken until the spermatheca contains an adequate supply of semen (5 million to 6 million spermatozoa). If mating is delayed more than 3 weeks, there is a high risk of her becoming a drone-layer. Egg-laying usually commences within a week after mating, and a queen can continue to lay fertilized eggs throughout most of her life-usually 2 to 5 years. An old queen will not go out and mate again when her original supply of semen becomes depleted-she simply becomes a drone-layer. An old queen and her supersedure daughter sometimes coexist, thus contradicting the commonly accepted idea of one queen per colony.

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