Iowa Science Teachers Journal

Volume 7 | Number 3 Article 3

1970

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Do Honey Bees *Learn* To Work?

(An excerpt from *Sophomores and Honey Bees*)

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Another question that your students can answer for themselves is whether bees really inherit their work behavior. That's what we tell our students—that bees are creatures of instinct. And expect our students to believe it. We all know, of course, that too much of our teaching is like that. The least we can do is to offer evidence. Better yet, we can give the students a chance to see for themselves.

During its life span of a month to six weeks, a honey bee of the worker caste normally graduates from one job to another, in a fairly definite sequence. She begins with nursery duties and ends her career as a field bee —gathering nectar, pollen, and water. When you watch the precision of her work, you easily get the impression that her behavior is inherited. How could she be expected to learn to do such complex tasks in her short lifetime?

But remember this. The worker begins each task in close association with workers that are more mature. Perhaps she merely copies their behavior. If so, she *learns.*

One way to resolve this question is to establish a colony of young workers that have never associated (except in their larval life) with older workers. The bees themselves will then answer the question.

To arrange this test, you will need access to a full-sized colony as well as an empty glass-walled observation hive. Find the queen and place her on an empty comb. If the comb has a little honey pollen stored around the edges, so much the better; but the comb must be free of brood and have plenty of cells in which the queen can deposit eggs. Enclose this comb with the queen in a cage made of mesh grid that will allow workers to come and go but too small to let the queen escape. (This grid material, used to confine the queen to the lower stories of the hive, is a standard beekeeper's item.) Place this cage in the hive. In three or four days, if all goes well, there will be several thousand eggs in the cells. Now release the queen into the section of the hive where you found her, and replace the comb in the hive—in an area not accessible to the queen. In most hives a queen excluder prevents the queen from getting into the upper stories, from which the beekeeper harvests his share of the honey.

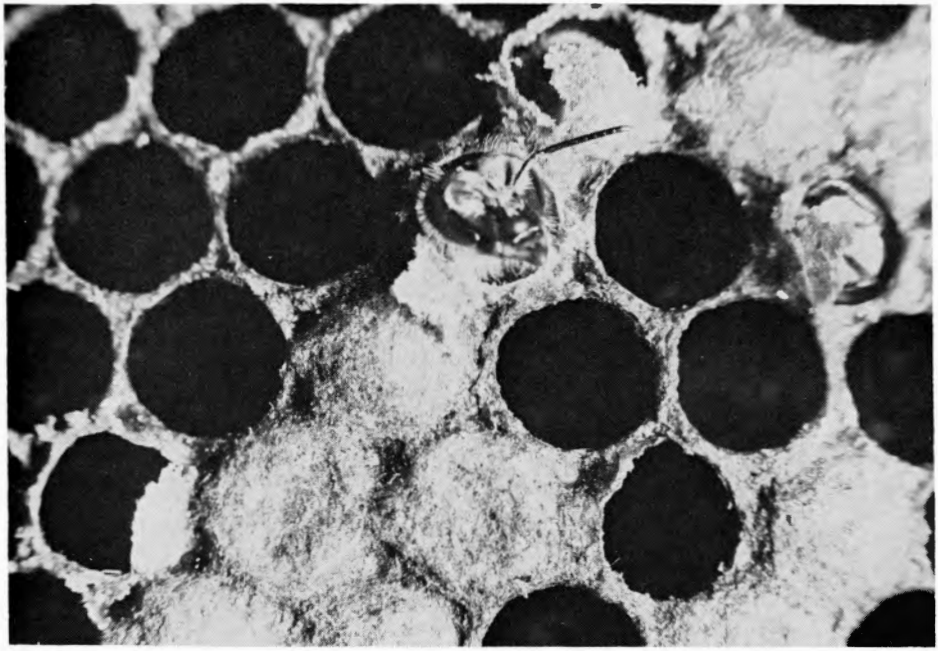
Workers care for the larvae that hatch from the eggs in your experimental comb. Eight days after the

A queen cage permits the workers to come and go through the mesh but confines the queen to a single frame. For clarity, the frame has been removed and is leaning against the cage.

eggs are laid, when the larvae are five days old, workers seal the brood cells with wax caps, and the larvae pupate, spinning a pupa case inside the cell. They emerge as adults about twenty-one days after the eggs were deposited.

Just before the brood is scheduled to emerge, move the comb to the observation hive, being sure to brush all of the attendant workers off the comb. Add another comb (above the comb of brood) that contains honey and pollen. Then close the hive entrance. For a few days, until the adult bees have all emerged, keep the observation hive at about 93° F.—the temperature that the bees normally maintain in the brood nest. You can improvise an incubator from a box and a couple of small light bulbs.

After emergence has started, place a mated queen in the hive. You can "borrow" the queen from the parent colony; if there are eggs or young larvae in the parent colony, the bees will rear a new queen. You are ready now to place the observation hive in its permanent location and open it to the outside. And the young workers are about ready to begin answering your question. Their answer is *work*. Without any help from older sisters, they begin by cleaning the cells from which they emerged. They groom and feed the queen. They repair damaged cells.



Emergence of newly developed workers is easily studied in the lab with the help of an observation hive. Three workers are emerging in the upper right. The darkened cells have already been vacated and are ready for either food storage or further brood rearing.

They care for young larvae. Well ahead of the usual schedule, some of the workers become field bees, harvesting nectar and pollen. They sting too—without being taught!

In connection with another investigation, involving larger numbers of bees, I have put fifteen colonies of young workers to this test (Trump, Thompson, and Rothenbuhler, 1967). They all behaved as though they were being instructed by their ancestors, through the DNA they inherited.

A few qualifications, however, are in order. The working force is very small. The bees may need help in keeping the temperature high enough for brood development. Small light bulbs near the lower air vents will help. Also, in some of their duties these young workers are not as efficient as older bees. The secretion of royal jelly, for example, depends on the development of a pair of brood food glands, which produce this high-protein food. These glands normally become active about the sixth day. The wax glands, which are essential for building new comb, normally begin to function somewhat later. But these are matters of physiological maturing, not of learning.

Do honey bees have to learn to work? From these observations, the answer is no. The experiment doesn't show that bees are *unable* to learn,

merely that they can perform their duties without a period of learning. There is increasing evidence that learning may be subtly involved in behavior that has a genetic basis (Rothenbuhler, 1967). But your students should not have to accept even this qualified answer without evidence. If you cannot actually work with bees, discuss this experiment and ask your students if it has an adequate control. If you can get even a tentative answer from the living bees, comparing the experimental colony with a more normal colony, both you and your students will probably say that this is real biology.

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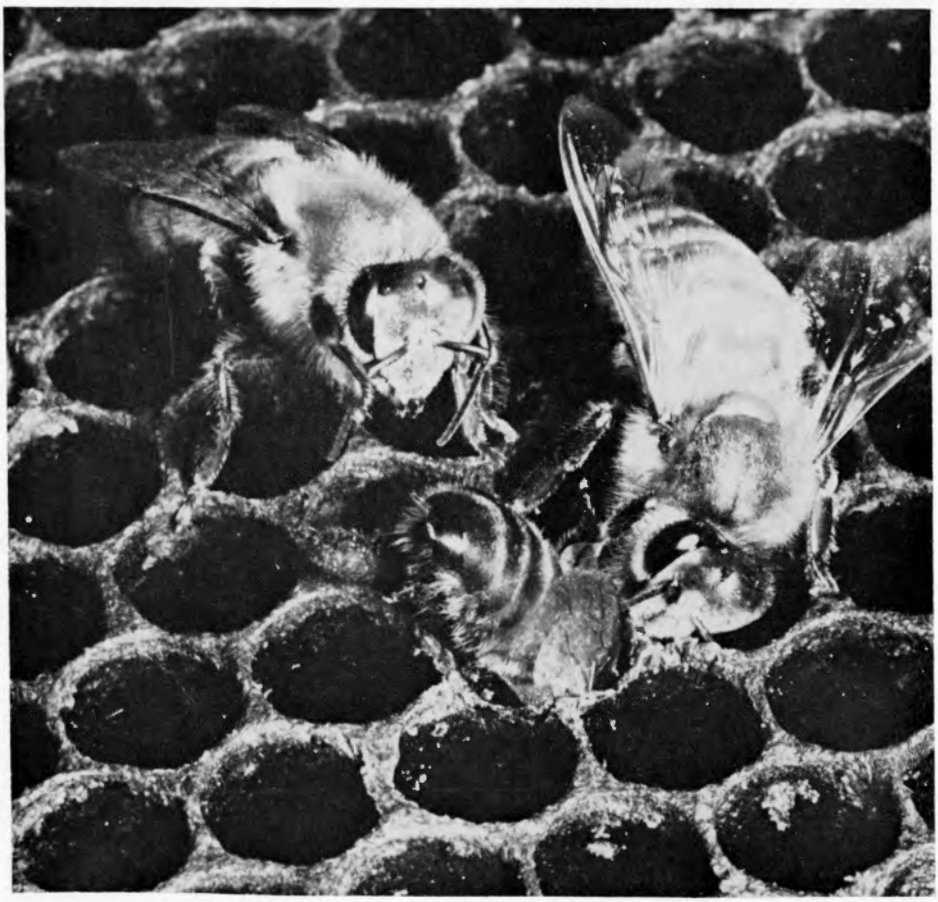

Here worker bees are cleaning cells from which adult workers have recently emerged.