

WHAT HAPPENS TO DIPLOID DRONE LARVAE IN A HONEYBEE COLONY*

J. WOYKE

*Zakład Pszczelnictwa, Szkoła Główna Gospodarstwa Wiejskiego,
Skierniewice, Poland*

Manuscript received for publication 20th March 1963

SUMMARY

Queens producing brood of only 50% survival were bred by individual sibling mating. The non-surviving brood in these colonies consists of eggs laid in worker cells which hatch to give diploid drone larvae, which quickly disappear. Hive entrance observations failed to provide evidence that the bees carried the diploid drone larvae out of the hive, and no young larvae were found on sheets of plastic placed under the combs to catch debris. Investigations in special observation hives showed that all the disappearing larvae were eaten alive by the workers.

INTRODUCTION

Drone larvae of *Apis mellifera* normally develop only from unfertilized eggs, but Woyke (1963) showed that they can also develop from fertilized eggs laid in worker cells by queens produced by a series of sibling matings. Adult diploid drones are not produced in the colony, because although the so-called 'lethal' eggs are viable and hatch, the larvae from them disappear from the cells soon afterwards (Woyke, 1962). The mechanism of their disappearance is studied in the present paper.

MATERIAL AND METHODS

Five queens producing brood of low survival rate (about 50%), reared in the way described by Woyke (1962, 1963), were chosen to head the experimental colonies.

To discover whether the bees remove the drone larvae from the cells and throw them out of the hive, the hive entrances were watched for several days; the mouthparts of each bee leaving the hive were examined thoroughly to see whether she was carrying a larva or part of one. The floor board of each hive was covered with a sheet of dark plastic, which was examined periodically for any larvae dropped by the bees.

For further observations, two observation hives were prepared. They had double glass walls on both sides, the air within the double walls being connected with the air inside the hive. The circulating air thus heated the inner walls from both sides, which was necessary for the developing larvae. In one hive the combs were perpendicular to the glass walls, so that the outside row of cells could be observed from the side; in the other, the cell walls were cut off normal worker comb foundation and attached to the

*This investigation was supported in part by a research grant from the United States Department of Agriculture, authorized by Public Law 480.

inside surface of the inner glass walls; these cells were observed through their artificial glass bases.

All observations were made with a dissecting microscope. The hives were used in the laboratory, with flight tubes through a window. They were filled with worker bees, to which a queen producing brood of low survival rate was introduced. The bees were fed with honey or sugar syrup, with or without soya-bean flour. The colonies collected and stored plenty of pollen; there was no pollen shortage.

RESULTS

1. *Do the bees throw the diploid drone larvae out of the hive?*

At the hive entrances particles of debris much smaller than eggs or newly hatched larvae were seen being carried out, so there should have been no difficulty in seeing eggs or young larvae. But several days' observations on various colonies failed to detect any being carried out of the hives. No pieces of egg or larva were observed either, though occasionally pieces of pupa were seen being thrown out, especially after the inside of the hive had been inspected, and some sealed brood probably damaged. As the pieces of pupa were much larger than the young larvae, and partly sclerotized, it was impossible to mistake newly hatched larvae for them. These pieces of pupa were very rarely seen.

It was thus established that the diploid drone larvae which disappeared from worker cells were not removed from the hives by the bees.

2. *Are the larvae removed from the cells and dropped on the floor board?*

Examination of the sheet of plastic during the day showed that the bees cleaned it then, carrying out of the hive any debris that had fallen on it at night or in the daytime. As this examination disturbed the bees, especially when repeated several times a day, subsequent examinations were made early in the morning before the bees started to fly, the sheet having been inserted the previous evening.

The debris on the sheets consisted mostly of pieces of cappings of brood or honey cells, wax scales, pieces of comb, and dead bees or parts of them. Sometimes, but rather rarely, parts of pupae were found and, even more rarely, eggs. Their number was far too small to account for the disappearing larvae; moreover they were fresh, and were probably lost by the queen during oviposition; they have nothing to do with the 50% of brood that disappeared. Nevertheless it is interesting to note that although some eggs were dropped on the floor of the hive, none were seen being carried out of the hive. Careful examination of the plastic sheets revealed no larvae (young or old), nor any pieces of larvae. The diploid drone larvae that disappeared were clearly not removed from the cells and dropped on to the hive floor.

3. *What then happens to the diploid drone larvae?*

In the observation hive with the combs perpendicular to the glass, only a proportion of the cells could be observed. The queen was very unwilling to lay eggs in these cells adjacent to the glass, and used them so irregularly that it was impossible to observe more than a few larvae of the right age at the same time. Most observations were therefore conducted in the second hive, where all the cells could be observed through their glass bases. It was also possible to see clearly both eggs and young larvae, even when

brood food was present. Many observations were made of the act of oviposition, the behaviour of eggs, and hatching, feeding and behaviour of larvae.

It was again confirmed (see Woyke, 1962) that although only part of the brood survived, nearly all the eggs hatched, and all the hatching larvae were treated alike by the bees. All hatched larvae were supplied with bee milk, by several nurse bees; all appeared equally viable, and moved in circles in the bee milk on the glass base, consuming the milk. We could not see any difference in behaviour of different larvae.

With regard to the behaviour of nurse bees visiting the cells, none was ever observed to remove a young larva from a cell and throw it out. A bee entered a cell, and stretched out its antennae towards the larva; the antennae were in continuous motion. She then started to take up the bee milk with the glossa, sometimes eating it all, but usually only part of it, and sometimes very little. Finally she seized one end of the larva with her mandibles, and picked it up from the cell bottom. The larva was alive, and remained alive after being taken in the mandibles; it could be seen moving in the bee's external mouthparts. She started to eat the larva from one end, consuming it gradually towards the other end. It was thus established for certain that the bees ate the living larvae. Usually the bee consumed a larva completely, but sometimes she left part of it on one of the cell walls, which was eaten by the next bee visiting the cell. Any bee milk not eaten at once might remain in the cell for a long time, but was eventually licked off the glass cell base. Larvae in other cells were eaten in a similar manner. All were eaten alive.

A few bees were also seen to eat eggs, starting from one end, working gradually towards the other.

The queen laid eggs again in the empty cells from which the larvae had been eaten; these eggs hatched, and again a proportion of the larvae were eaten. In the empty cells more eggs were laid, and so on. It was thus difficult to calculate the percentage of brood that survived in the observation hive. It appeared that more than 50% disappeared, which would mean that some of the worker larvae as well as the diploid drone larvae were eaten. This phenomenon was not observed with larger colonies in normal hives; in these, practically only the diploid drone larvae disappeared from worker cells. Probably the unusual conditions in the observation hive caused more larvae to be eaten. The bees showed no tendency to *remove* larvae from the cells; in all observed 'disappearances' the larvae were eaten alive.

CONCLUSION

The present observations have shown that the bees of a colony in a normal hive, headed by a queen producing brood of low survival rate, do not remove diploid drone larvae from the worker cells and then throw them out. In an observation hive headed by such a queen, all these larvae were eaten alive by the bees, and it can therefore be reasonably assumed that this is what happens to them in a normal hive.

REFERENCES

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