PART 2

ADDRESSES AND CONTRIBUTED PAPERS

Hanover, Indiana

October 24, 1969

The address, "The World of the Honey Bee" was presented by retiring president, Dr. Howard R. Youse, at the annual dinner meeting of the Academy at the J. Graham Brown Campus Center at Hanover College on Friday evening, October 24, 1969. The address by Dr. John B. Patton, Chairman, Department of Geology, Indiana University, and State Geologist, Indiana Department of Natural Resources, was given at the Spring Meeting dinner at the J. Graham Brown Campus Center at Hanover College on Friday evening, April 26, 1969. His subject, "To Ruine a World," deals with the problems of solid waste accumulation and the accelerating consumption of non-renewable resources.

PRESIDENTIAL ADDRESS

The World of the Honey Bee

HOWARD R. YOUSE

DePauw University, Greencastle, Indiana

This has been a very eventful year for science. The climax was probably reached this summer when the Apollo astronauts set foot on the moon, thus fulfilling a dream of man for centuries. At the same time we hear many reports among scientists that all is not well on earth. Several of our recent presidential addresses have been concerned with ecological problems that face us today. We have a Science and Society Committee which is exploring the ways in which the Academy might play a more active role in attempts to solve many of the problems of society.

It may seem strange to some of you that a botanist would choose as his topic *The World of the Honey Bee;* my only qualification is that I have worked on pollen grains utilized by honey bees. I thought it might be a topic that would be of interest to many of you in various branches of science, since scientists from various disciplines have found the study of the honey bee to be a source of lasting wonder. I personally am convinced that the study of the honeybee may give us important biological information that may be helpful in understanding some of our problems.

The honey bee is one of the few insects that has been domesticated by man. The species we are most concerned with is *Apis mellifera* of which there are many varieties. Life in the hive centers around the queen. She is larger, lives longer, and forms the hub around which all activities move. Most of the routine activities in the hive are carried out by numerous workers. An average hive might have about 30,000 workers, but this may vary widely, and man may manipulate the hive to have 100,000 workers. Then from time to time a few drones may be observed in the hive.

When the geneticist examines the hive, he finds that the drones are males with a haploid set of chromosomes. Thus they must develop by parthenogenesis. The queen and workers are females with a diploid set of chromosomes and thus must have developed from fertilized eggs. The chromosome complement thus determines if we have a male or female bee. When we examine the growth and development of the larvae emerging from the eggs, we find that all the larvae receive royal jelly, honey, and pollen the first 24 hours of their lives. The larvae that develop into queens are continually fed royal jelly and mature in about 16 days. The other larvae are fed only honey and pollen as they are developing, and it takes about 21 days for workers to mature and 24 days for drones. Royal jelly is a glandular extract from young worker bees, and it must be a

remarkable material, as it determines whether the diploid eggs will develop into a functional female capable of laying eggs or a non-functional worker unable to lay eggs. One might conclude that both genetics and nutrition are important in the growth and development of the honeybee and perhaps of all living organisms.

If we examine a hive early in the spring, we often find a number of queen cells developing and a relatively large number of drones. The hive is usually crowded with workers at the same time. The society then goes through a stage known as swarming. At this time the old queen takes off from the hive with some of her workers. This usually occurs just as the young queens are ready to mature. As the new queens emerge from their cells, they engage in mortal combat until just one queen is left. In case the old queen has not left, she in turn is killed. When the new queen of the hive is about 5-7 days old, she is ready for her nuptial flight. There is quite an air of excitement around the hive at this time. Mating of the queen takes place outside the hive, and it is the one big day for the drones. The virgin queen takes off from the hive with all the drones in pursuit. Presumedly the drone that is strongest and fastest mates with the queen. Enough sperms are deposited in the queen to last her lifetime. In the process the drone loses his life. When they return the other drones are usually killed by the workers. This drama in the hive might lead us to conclude that nature is often very ruthless.

Within 48 hours after the queen returns from her nuptial flight she settles down to the main activity of her lifetime, laying eggs. The queen can lay unfertilized eggs, although she most often lays fertilized eggs. She may average about 2,000 a day, but at the peak of the honey flow, she may lay 5,000 a day. She will lay over a million in her lifetime. She is constantly attended by a host of workers as she goes about her business. The workers also go about a wide variety of jobs. Anyone who has observed a teaming mass of thousands of bees has probably asked how do bees communicate with each other.

An examination of a hive will reveal some bees busy building comb by secretion of thin scales of wax from their wax glands which are then moulded into almost perfectly hexagonal comb cells. Others may be mending damaged comb structure. Other young workers are engaged in giving royal jelly, pollen, and honey to the developing larvae. Some are engaged in cleaning the hive and removing waste from the hive. The largest number of workers are involved in collecting pollen and nectar. As they return to the hive other workers receive the nectar and deposit it in the comb where it is evaporated to the right consistency and then capped. Other workers strip pollen and stamp it into cells. As all these activities are going on, a number of guard bees stand at the entrance of the hive to see that no bee gets in except a working member of the hive.

These observations might lead one to conclude that each bee specializes in a particular function, but if a bee is tagged and observed over a period of time, it will be evident that this is not true. Each worker performs a succession of each of the various tasks. Some of these may be more or less synchronized with the development of the bee, but one finds

great variation depending on the environmental conditions inside and outside the hive. How is an individual bee informed of the tasks that need to be done? Lindauer (1) tagged individual bees and observed them over a period of time. He is convinced that each bee gathers her own information by extended inspection tours around the hive. Then she seems to do what needs to be done. This seems to be a rather good way to get the job done in the event that each bee is willing to do something.

The general activity in the hive is the collection of nectar and pollen. Nectar is used for the production of honey, which is the main carbohydrate food. Pollen is the main source of proteins and vitamins, and it is stored directly as it is brought into the hives. For many years it was a source of much debate as to how bees were able to communicate rich sources of nectar and pollen to the workers. It was known that bees were very sensitive to different colors. They also were very sensitive to different odors or essential oils found in flowers. Von Frisch (2) observed that bees seemed to go through a curious dance when returning to the hive with a load of nectar or pollen. When sources were close by, the bee performed a "round dance." This seemed to indicate that the bees need only to go out of the hive and collect. If the source was at some distance, the bees went through a "tail-wagging" dance. The direction is conveyed by the orientation of the dance in relation to the sun. The rhythm and intensity of the dance as well as certain sounds indicate the distance. There are records of bees flying ten miles to a nectar source, although they seldom will fly more than three miles. On one of these flights, the honey bee collects a load of nectar equal to half its own weight, then cruises non-stop back to the hive at about 15 miles per hour. This would suggest that the bee is indeed a superior flying insect both from the point of view of design and use of energy.

Individual workers may average about ten trips a day, and bees from a single hive may visit over a quarter of a million blooms a day. Thus they are our most effective pollinators of flowering plants. It has been estimated that over 100,000 species of flowering plants would disappear from the earth if bees were eliminated. When DDT was first applied over orchards by airplanes, it was observed that both fruit production and the bee population dropped in the area. Since honey bees work only during the day, they tried to get around this by dusting at night or on cloudy days when bees were not active. Now we are beginning to have some additional concern of the effect of DDT on other organisms such as fish and birds.

The product from bees that man is most interested in is honey. If one were able to collect nectar from flowers and evaporate the water, one would still not have honey. As soon as nectar is sucked into the honey bee's crop, enzymes are mixed in that convert the sugars to dextrose and levulose. At the hive the load is transferred to the crops of young workers The young bees thoroughly mix it with more enzymes. It is finally deposited in open cells of the combs. Other workers then gently fan it to evaporate the excess water. When it is just the right consistency, it is capped. A chemical analysis of the honey at this point would show about

40% levulose, 35% dextrose, and 18% water. Thus honey is a very concentrated carbohydrate food, and anyone familiar with the complexities of sugar chemistry might decide to just let the honey bee go on doing the job.

Honey is stored in wax combs. The comb is only about 0.002 inch thick, but it can support 25 times its own weight. The wax comes from the wax platelets on the abdomen of young bees, and it is estimated that six to seven pounds of honey are consumed to produce one pound of wax. The wax has a high melting point of around 140° F and can be used in a wide variety of products. It is used to make candles and to insulate wires. It is often used in furniture waxes and varnishes as well as in phonograph records and lubricants of various types.

In concluding, I would like to give you a few tips on how to get along with bees. For some reason bees do not like black; so it is a good policy to never wear black clothes around them. They are very sensitive to vibrations so one should avoid jarring them, especially their hive. They are very sensitive to odors, and I am convinced that many people just have B.O. as far as bees are concerned. Smoke seems to quiet bees, so they are frequently smoked before a hive is opened. A good pipe or cigar tends to keep them away from your face in case you do not want to bother with a veil. If you are stung, you may rest assured that it hurt the bee more than it does you, as the honey bee dies. When stung by the honey bee, one should quickly cut off the stinger with a sharp knife, as the stinger acts as a little syringe that gradually forces the venom into your skin as it contracts. One should also wash after being stung, as the venom tends to excite other bees. Bee stings usually lead snake bites as a cause of death each year, and thus one might decide that they should be eliminated in order to save human lives. However, we might find that more human lives would be lost due to starvation. The problem of what to do with honeybees is rather typical of many ecological problems that face us today. There seem to be several courses of action, and we are uncertain what path will be best in the long run. Perhaps if each problem were studied in a variety of ways, we might gain additional insight as to the best course to follow. It is my hope that the Indiana Academy of Science will be a leader in attacking the many problems we face, and I hope each of you will keep busy as a bee doing what needs to be done.

Literature Cited

1. LINDAUER, M. 1961. Communications Among Social Bees. Harvard University Press, Cambridge, Mass. 143p.

2. VON FRISCH, K. 1950. Bees, Their Vision, Chemical Senses, and Language. Cornell University Press, Ithaca, N.Y. 119p.