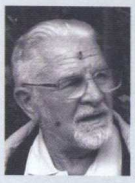
Interview with Prof. Jerzy Woyke

Honey Bees for 100 Grams of Toffee



JERZY WOYKE
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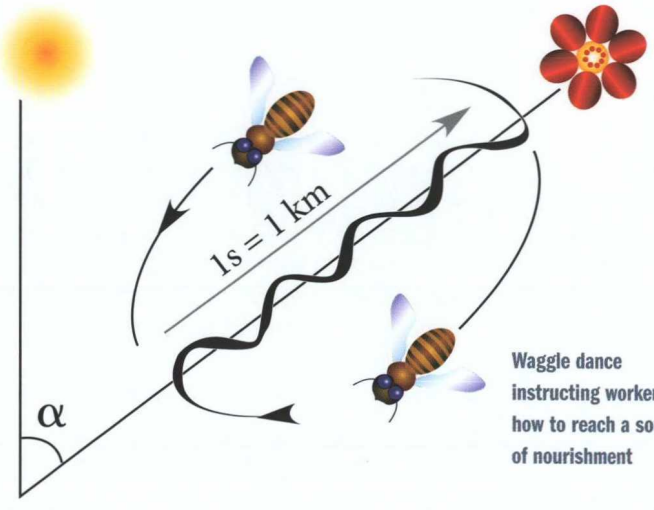
In 1952–1996, Prof. Jerzy Woyke headed the Department of Apiculture of the Warsaw University of Life Sciences. He has conducted research in 24 countries and traveled abroad 94 times as part of his research work.

Academia: Professor, do you talk to bees?
Jerzy Woyke: Of course I do!

How do bees communicate?
Bee communication was decoded by Austrian researcher Karl von Frisch, which won him a Nobel Prize in 1973. To make it simple, bees use sign language to communicate. They don't use their hands, of course – they just dance. Through dancing, successful foragers share information with other members of the colony about sources of nourishment, such as nectar, pollen, or sugar syrup feed. If a bee discovers such a source of food less than 50 m from the hive, she performs a round dance, making circles to the right, then to the left on the surface of the comb, seemingly wanting to say to her sisters: "look for food close to the hive."
However, if the source of nourishment is farther away, such information will not suffice. In that case, the informer performs what is known as a waggle dance, or figure-eight dance. It looks like this: A bee makes a straight waggle run on the comb, moving in a straight line while waggling her abdomen right and left (hence the name "waggle dance"), followed by a turn to the right to circle back to the starting point. After that, she performs another waggle run, this time turning to the left and circling back to the starting point (hence the alternate name "figure-eight dance"). This motion is repeated several times. If a bee keeps her head up during the waggle run, she instructs other workers to fly towards the sun, and if down – in the opposite direction. The precise location of the food is indicated by deviation from the vertical axis, which corresponds to the angle between the desired flight direction and the line between the hive and the sun. But direction is not yet enough; the bee still has to communicate the distance. This is indicated by the number of circuits: the closer the source of food, the more circuits the bee makes during a unit of time. Bees can inform workers about food located up to 8 km from the hive, but they prefer not to fly farther than 500 m, so they can collect food and bring most of it back to the hive. Flight is a very energy-consuming endeavor, and on longer trips the bee consumes some of the food she collected. A very long flight will often not be worth the effort.

How do other bees interpret the dance?
They watch the dancer, follow her and try to sense her movements with their tentacles. This ability is not innate and young bees have to learn it. What is interesting is that bees can't unlearn it, which was proven by an experiment. In the Northern Hemisphere, the sun moves from left to right, but in the Southern Hemisphere the reverse is true. In the experiment, a bee colony was moved from southern India to the other side of the Equator. After the bees were released, it turned out that their dances were indicating the opposite direction. The bees didn't realize that in their new location the sun's movement was different.

How do bees identify one other?



Pawel Adamów

Waggle dance instructing workers on how to reach a source of nourishment

Two of these bees have pollen baskets on their hind legs

They rely on ectohormones, which are hormones that are secreted outwardly into an individual's environment. Workers identify other workers, and if a bee from a different colony enters in the hive, she will be instantly killed. Alien individuals are identified by their scent, which depends on what they eat. Bees feeding on honeys from different plants secrete different hormones. Queens produce Queen Substance (QS), which is a type of ectohormone produced in a queen's mandibles that alters how other bees behave. In fact, the queen's mandible alone is sufficient to make the bees behave as though the queen was there, because they can sense QS. Different queens have different scents, even if they originate from the same colony.

You discovered that queen mates not with one but with several drones during a mating flight. How did you come upon this?

One drone produces on average 1.5 mm^3 of sperm, while the queen has a lot more of it in her oviducts after a mating flight – we found queens that had as much as 20 mm^3 of sperm. The conclusion was simple: the queen must be mating with several males. That discovery improved instrumental insemination of queen bees. Instrumental insemination itself was successfully done for the first time in 1926 by Watson. However, he used only 1 mm^3 of semen, since at that time the beekeepers thought that the queen mated only with one drone. After that procedure only some of the queens were inseminated. I tried different quantities and concluded that since the queen had on average 8 mm^3 of sperm, then such an amount should be used. Nowadays this quantity is considered standard.

You were an FAO expert and traveled the world. Is the hypothesis of colony collapse disorder true?

There are many explanations for the disappearance of bees. One of them is pesticides. For example, in the United States I had to use an 18-wheeler to transport four thousand beehives in the course of three days. Pennsylvania is a horticulture state with many apple orchards, which have to be sprayed, and because of those pesticides the state has no honey bees. Orchard growers therefore have to sign contracts with beekeepers to bring in bees for pollination. The terms and conditions of those contracts are very rigorous: the hives may stay only for two weeks, after which spraying begins, no matter what. Hence for three days and nights I didn't sleep because I had to move all those hives!

Weren't the bees disoriented after being moved to a different location? The sun in Pennsylvania may shine at a different angle than elsewhere.

Not at all. If after being let out of the hive the bees discover that something changed, they make a series of pre-flights. They also do it un-

der normal circumstances. After hatching from a brood cell, the bee works in the hive for 21 days: initially she feeds the larvae, then converts nectar into honey, manipulates wax, evaporates honey, and collects and stores pollen. In the afternoon, young bees fly out from the hive to defecate and learn the surroundings. These flights are referred to as orientation flights. The same happens if the hive is moved. The bees only have difficulties in orientation if – as I have already said – they are taken across the Equator.

You have done research on bees in India, Bhutan, Thailand, and Nepal. How does their apiculture differ from ours?

Asia is home to different species of bees. European honey bees live in enclosures, such as tree hollows or hives, whereas Asian bees build their nests in exposed places. The giant honey bee Apis dorsata *builds honeycombs on tree limbs that are 1.5 m tall and more than 2 m wide. The Himalayas are the natural habitat of the Himalayan cliff honey bee* Apis labriosa, *which builds honeycombs under cliff overhangs. More than 80% of honey in India and Nepal comes from those species.*

Jerzy Woyke

A female *Tropilaelaps clareae*, parasitic mite of bees. Length: 1.0 mm

You also studied bee parasites.

In Europe, a significant threat is posed by the parasitic mite Varroa destructor, *which lays eggs on the larva and feeds on bees in early development stages. It either causes the larva to die or severely damages the bee's wings so she cannot fly and dies. I did research on the Asian parasitic brood mite* Tropilaelaps clareae, *which is a parasite of Asian bees. Local bees are able to cope with that threat but foreign ones are not. In Asia, the European honey bee* Apis mellifera *produces 10 times more honey than the Asian honey bee* Apis cerana. *So several attempts were made to introduce European bees to Asia. Unfortunately, they usually didn't survive there for more than three years, being destroyed by* T. clareae. *The methods that had been used to protect them against* V. destructor *turned out to be ineffective here. I came up with an explanation for this. After the larva of a European honey bee is killed by the mite before hatching, the workers open the cell and remove the dead remains. But by so doing they release the mite, which then enters more cells and kills more larvae. Asian bees, on the other hand, don't open cells with dead larvae. Consequently, the parasitic mites die instead of being released, and can't spread throughout the colony.*

I developed an effective method of eradicating T. clareae, *which doesn't involve chemical agents. As a result of this, Asian countries, which used to import honey, are now exporting it. For these achievements I received the Khwarizmi International Award from Teheran and the Asian Apicultural Association Award.*

One of your most important discoveries involved the determination of sex in honeybees.

In 1845, the priest Jan Dzierżoń discovered that female honeybees, i.e. workers and queens, develop from fertilized eggs, whereas drones origin from unfertilized eggs. This triggered a storm in the world of biology, which lasted for 50 years. In 1951, Mackensen published test results showing that a queen who mates one time with a male having a sex allele identical to one of hers will have 50% mortality of her diploid offspring. I examined the eggs and determined that there was nothing unusual about them, that larvae hatched from them. But they disappeared from the colony within six hours of eclosion. They were eaten by the workers. This was due to a 'cannibalism substance' secreted by the young larvae. I did the following experiment: I kept such larvae for two days in an incubator, then reintroduced them to the colony, and the workers raised them to the imago stage. Drones from such fertilized eggs were larger than from unfertilized ones. I was completely surprised to discover that they produced diploid sperm. I conducted this study at the world's oldest bee sanctuary on Australia's Kangaroo Island.

You've said that bees don't attack you. Is it justified to call you a bee whisperer?

In most of the cases, the bees that sting are the older workers that fly out of the hive to collect food. Their stingers are already hard. Young workers, who remain in the hive, are still learning to fly, their stingers are soft and they don't attack. So the best time to open the hive is in the afternoon when older workers are gone. We applied the same approach to African bees. And on the first try we got stung big time! So I placed

BE&W

Workers encircling a queen

a ball of leather in front of the hive entrance and observed how and when the bees attacked it. It turned out that they were least likely to attack in the morning. At that time of the day the temperature is lower and the flowers are full of nectar, which gathered there overnight. Older workers leave the hive to collect it while younger workers remain. So in the morning, you can open the hive without the risk of being stung. In Ghana, I worked on bees without a net on my head and even without a shirt on. And the local press heralded the arrival of a Polish bee enchanter.

Why do bees sting?

Bees sting when something disturbs them. They might sting a person standing on their way to the hive, if they happen to run into someone. They also don't like it when people waive their hands to drive them away. They have compound eyes, so they don't see one hand but several thousand waiving hands. On the other hand, a person standing still looks like a single point to them. So the best way is to calmly back away from the bees while covering your hair, so they don't get entangled.

How did you first get involved with bees?

During the Nazi occupation of Poland, Germans confiscated our farm in the Pomerania district, and my family was relocated to Warsaw. We didn't have any money, but there was a certain beekeeping book I really wanted to have. So I would buy 100 grams of toffee candies in the famous E. Wedel store, then go to a different location and sell it. I had to make about 50 rounds to buy the book I so desperately wanted! That meant I already had some knowledge of bees when one winter we moved to the country. I noticed that there were beehives in the backyard. I knocked on one of them but no one answered. I thought that the bees were dead. I took one of them into my hand, warmed her up, and she moved her legs. I concluded that the bees could still be saved. I moved the hive to the kitchen, and when I later came back I discovered that they were sitting on the lamp, attracted by the light. There was no honey in the hive, and therefore the bees were all numb. I fixed a honey cake for them and I put it in the hive. But I had no idea how to make the bees fly back. So I lit a desk lamp and put it next to the entrance, and I switched the ceiling light off. And the bees went back in! That is pretty much the kind of thing I've been doing ever since.

Interview by **Anna Zawadzka**

Prof. Jerzy Woyke (born 1926), one of the pioneers of modern research into honey bee biology and genetics, and one of the creators of modern apiculture. Holds honorary doctorates from the University of Agriculture in Szczecin and the University of Warmia and Mazury in Olsztyn. Developed the queen bee instrumental insemination method, now considered standard. The author of many papers on the genetics, biology, and breeding of *Apis mellifera* and other honey bee species, and more than 350 original publications (http://jerzy_woyke.users.sggw.pl/) which according to the Web of Knowledge have been cited 1.248 times. Prof. Woyke's most frequently quoted article is a guide in Polish on "How not to write scientific papers", which gets 600 to 1200 hits per month, 66,300 in the last four years. Recently received the Commander's Cross of the *Polonia Restituta* Order from Polish President Bronisław Komorowski (03 May 2014).