

## Pheromones

- 1) WHAT are they?
- 2) WHAT do they do?
- 3) How much do YOU know about them?
- 4) How important are they for good bee MANAGEMENT?
- 5) Will they be MORE important for bee management in the 21st century?
- 6) How much more SCIENTIFIC RESEARCH has to be done?

The word PHEROMONE was first used in regard to honeybees just 40 years ago in 1959. During the first 35 years, 1959-1984, honey bee research money was steadily being reduced not only in our federal laboratories, e. g. Beltsville Bee Lab, but much more so in the university research facilities around the nation. This was due to many things, but surely the fact that all bee diseases were well under control primarily due to state inspection programs, and the fact that it was difficult to "sell" the importance of honey bee pollination of our food crops to university administrations. The arrival of the tracheal mite in 1984 coupled with an almost immediate multitudinous loss of colonies, followed by the more serious Varroa mite in 1987 materially altered the subjects of honey bee research almost overnight due to the carnage caused by these two mites in 49 of our 50 states. The research scientist, particularly the biochemists, biologists, and organic chemists had to leave the sanctity of their laboratories and work with professional apiculturists, queen breeders, and even some hobbyist scientists like me to further understand the natural BEHAVIOR of the honey bee. This research quickly produced Amitraz, Apistan, Menthol and more recently Formic acid and Coumaphos, which are the ONLY APPROVED chemicals for use against the mites today. However, perhaps of greater importance, the research for these colony saving chemicals led to scientists uncovering the role of honey bee pheromones and some of the chemical formulas that made up these pheromones, so that we can now even synthesize some of these important chemicals to create artificial pheromones.

I feel strongly that the beekeepers of 21st century will find that knowledge of honey bee pheromones is as important to successful beekeeping as computers have become to our mode of life over the past few years, or how the micro wave oven has totally changed our cooking methods during these same years. Hence, let's talk about these CHANGING TIMES and learn more about PHEROMONES.

### 1) WHAT are they?

I am sure that you have told your wife that you loved her; or told your children the evils of premarital sex; or told your restaurant that "the soup was cold"; or telephoned your distant parents on Mother's Day; or wrote a letter of explanation to Internal Revenue Service about the tax deduction you took. You COMMUNICATED! You transferred your thoughts to another human being by using your voice, or telephone, or by writing a letter. Make a note that this communication can only be done between members of the same species, and it would fail if you tried to communicate with your pet canary, cat, hog, a passing deer, or your honey bees.

Pheromones are chemical MESSENGERS, secreted by one honeybee that elicits a behavioral or physiological response by another honeybee. It is produced as a liquid and transmitted by direct contact as a liquid or as a gas (a smell as we think of pretty perfume or the stink of a skunk). Honey bees use pheromones to COMMUNICATE with each other in much the same way we humans use our voice. This communication is primarily used for the interactions of members of the same colony; and it is thought (but not yet proven) that the colony is regulated chemically by the pheromones produced by the queen. We now know that worker bees and drones produce as well as respond to pheromones, and, equally we know that the queen produces and uses pheromones considerably more than the other two castes.

Pheromones are NOT single chemicals (unfortunately), but rather a complex mixture of numerous chemicals in various different percentages of the total. Further, one single pheromone may have multiple functions, and, in contrast, a single behavioral response probably involves more than one pheromone. I trust that you will note the intense complexity caused by these many variables; and then when you consider the extremely minute amount of a given chemical that is a portion of the issue of one bee as a message to the other colony members, you can begin to appreciate the difficult task presented to a chemist to identify or synthesize these chemicals. However, technology has had almost exponential growth over the last 50 years, and the chemists of the next century will identify these now unknown chemicals and even synthesize them. After all, who had ever heard of atomic energy or fission when I reported to Oak Ridge National Lab to develop new methods of purifying uranium and man made plutonium 55 years ago in 1944?

Pheromones must be divided into two different classifications: RELEASER pheromones that trigger an almost immediate behavioral response from the receiving bee; and the PRIMER pheromones which cause the receiver bee to exhibit an ALTERED BEHAVIORAL RESPONSE at some future time. Although this division of releaser and primer pheromones is our current understanding of their actions, it is important to realize that a single pheromone can function as BOTH a releaser and primer under certain specific conditions.

## 2) WHAT do they do?

In BROAD generalities, pheromones affect many things, such as: mating, swarming, alarm behavior, security, social togetherness, sexual attractant, inhibition of queen rearing and ovarian development in workers, the glue that holds a large population of bees together as a single functioning unit, a "homing" message to other colony members, queen supersedure caused by loss of pheromone, inhibition of queen cell development on the "face" of the comb, and numerous other actions. Let's talk about the more important pheromone effects.

Perhaps the most important pheromones to most beekeepers are two of the many chemicals produced in the Mandibular Glands of the Queen:

9-ODA (9-oxo-2-decenoic acid) This chemical not only inhibits queen rearing as well as ovarian development in worker bees, but is a strong sexual attractant for drones when on a nuptial flight. It is critical to worker recognition of the presence of a queen in the hive.

9-HDA (9-hydroxy-2-decenoic acid) This chemical promotes stability of a swarm, or a "calming" influence to the natural excitement of a swarm.

These two chemicals, 9-ODA and 9-HDA, are often referred to as "queen substance". We know that this COMBINATION perform critical functions of worker retinue formation and development of colony cohesion. It is this combination that acts as the "glue" that binds all the elements of colony segments, even very large populations, into a SINGLE functioning colony unit.

A QUEEN LOSES THE ABILITY TO MAKE "QUEEN SUBSTANCE" EVERY DAY OF HER LIFE AS SHE AGES! Hence, a 12 months old queen is an "OLD" queen who cannot produce enough queen substance to prevent swarming when the population begins to become large. This might be "nature's way" of honey bee expansion, but it sure ruins a good honey yield for that season. A new queen, produced in August or March will rarely swarm in the buildup period of April, May, and June because they are young enough to produce adequate supplies of queen substance which prevents swarming.

Often overlooked, is the "footprint pheromone", the oily secretion of the queen's tarsal glands that is deposited on the comb as the queen walks across them. This pheromone, which also diminishes as the queen ages, inhibits queen cell construction (thereby inhibiting swarming)

Many beekeepers are familiar with the Nasonov (Nassanoff) Gland Pheromone, and often remark about seeing bees "scenting". This gland produces at least 7 different terpenoids, the most abundant being geraniol and citral. These are easily synthesized cheaply and are used as swarm attractants or "homing" pheromones to a swarm trap. In normal use the worker bees spread the Nasonov scent when foraging for water to aid other water foragers to the site, "scenting" at the doorstep of the colony to guide colony bees home, and scenting at a new site during a swarming procedure to notify other swarm members "Here we are, over here!". The queen is not thought to produce this pheromone; and is able to utilize her queen substance to aid workers to find her if need be.

All beekeepers are quite familiar with the STING ALARM, although many are not aware that this is a pheromonal action. The KOSCHEVNIKOV gland, near the sting shaft, produces an alarm pheromone consisting of more than 40 chemical compounds, of which isopentyl acetate (IPA) is note worthy due to its banana odor. When a bee stings you, the stinger and venom sac is left impaled in your flesh; and the banana odor of the alarm pheromone signals to other workers to aid in the attack and plant another sting close to the impaled stinger emitting the odor. It is of interest that IPA inhibits bees from scenting with the Nasonov gland. Hence queenless workers can find their queen by Nasonov scenting, but release sting alarm pheromones upon finding a foreign queen, and this IPA is used to promote aggression against an alien queen. Does this explain why a new queen must be INTRODUCED for several days to a colony before she will be accepted?

It is known that comb building worker bees synthesize certain oxygenated compounds in the new comb as they construct it. We now believe that these compounds give freshly prepared wax comb its characteristic odor that pheromonally stimulate the hoarding behavior of foraging bees.

Drones produce a pheromone that attracts other flying drones to promote the formulation of drone aggregations at sites suitable for mating with virgin queens.

Believe it or not, there are BROOD pheromones. The presence of brood (both larvae and pupae) in a colony inhibits the ovarian development in worker bees. Hence, you rarely find evidence of a laying worker in a colony that still has live brood. Further, nurse bees can readily distinguish worker and drone larvae and pupae is correlated with the presence of brood recognition pheromones.

And there are more, and then, MORE; but in 1999, research scientists just have not yet had the time or funds to delve into these fascinating "mysteries" of "the life of the honey bee". As I have said many times, it is only now that I regret my advanced age knowing that I will not be on the scene as science throws light into this now darkened area. Wow, wouldn't it be great to be a young scientist at the beginning of this 21st century to explore the underpinnings of the ice berg tip in honey bee pheromones, outer space, medical advancement, and learning to live in the speed of the computer age.

### **3) How much do YOU know about pheromones?**

If you have made it this far reading my writings, you surely know more than most other beekeepers. I only hope that I have awakened your appetite to read some more and pheromone research.

### **4) How important are they to good bee MANAGEMENT?**

With a better understanding of pheromones, a beekeeper would have many less swarms, have higher forager populations, increased honey production, receive less stings, learn to manage bees without wearing all those hot protective clothes, and find the JOYS OF BEEKEEPING! If all those things are not enough to excite you to learn more about pheromones, I suggest that you find another less scintillating hobby like stamp collecting or identification of rocks or something else that is dead rather than vibrantly alive because of your knowledge and aid to honey bee survival.

### **5) Will they be MORE important in honey bee management in the 21st century?**

Just ask your neighbors or a group of unknowns on Main Street in America: Do you object to honey bees on your neighbors lot, or are you allergic to bee stings? America is no longer a rural country and over 80% of our population are city dwellers. Many adults have never experienced a single bee sting in their lives, and the Hollywood "terror" films about "killer bees" have made the American public almost frantic in fear of a single bee sting. Hence, the old saying of "not in my back yard" comes into play. By you knowing more about pheromones, you will better MANAGE your bees; and hence, you will have less swarms than now that might wind up in your neighbor's yard or even under the eaves of his roof. Further, by you working your bees with little or no protective clothing will demonstrate to the public that their fear of honey bees is unfounded. Lastly, because of your pheromonal knowledge, your bees will make much more honey because of your improved management skills, and, hence you will have plenty of honey "gifts" for your neighbors, church, and clubs.

## **6) How much more SCIENTIFIC RESEARCH has to be done?**

Maybe you can tell me how much more scientific research we have to do before we establish living facilities on the planet MARS; or how much more until we find a shot that prevents cancer, or how much more before we can go over to London for lunch and be back home in a couple of hours. There is a tremendous amount of research yet to be done regarding the role of pheromones in the life of the honey bee colony, but the hard part, i. e., just knowing that pheromones play a very important role in the lives of honey bees, is already done. Now, it is just a matter of finding the money to support pheromonal research among honey bees in our schools of scientific learning today.

I hope that I have made a good case for you to learn more about the role of pheromones in beekeeping; and I will give you some time to digest this. Probably my next topic has even greater bearing on UPGRADING BEEKEEPER'S KNOWLEDGE, and that is:

Understanding BEE BEHAVIOR

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