Notes from the Lab:

The Latest Bee Science Distilled

by Scott McArt

Sometime in the early 1960s in the Philippines, a tiny mite that fed exclusively on the eastern honey bee (*Apis cerana*) encountered a new honey bee species – *Apis mellifera*, the western honey bee. The mite latched on, and the rest is history.

This is of course the story of *Varroa destructor*, THE major problem for beekeepers and what all of us spend a lot of time worrying about. "If you don't worry about *Varroa*, you're either wildly ignorant or not a beekeeper," I was recently told by a colleague. Very true.

Unfortunately for us, our western honey bee has not lived for a long time in the wild with *Varroa*. Thus, it harbors a small fraction of the defenses necessary to effectively combat *Varroa*. So that's where we as beekeepers and scientists and entrepreneurs and all-around tinkerers have stepped in. Over the past ~30 years, we've used knowledge, skill, hard work – and occasionally pure luck – to develop dozens of *Varroa* control tools. Where does luck come in? This is the topic of our fourth "Notes from the Lab", where we highlight **"Lithium chloride effectively kills the honey bee parasite *Varroa destructor* by a systemic mode of action"**, written by Bettina Ziegelmann and colleagues and published in the journal ***Scientific Reports*** **[8:683 (2018)].**

To understand their study, we first need to understand what happened *before* the study. The authors were working on something called RNA interference (or RNAi, for short), which is a nifty way to target pests like *Varroa*. Basically, you find some genes that are essential to the survival of an organism (for example, genes that allow *Varroa* cells to divide and grow), then introduce some RNA that interferes with those genes (hence why the approach is called RNAi). A major advantage of this technique is that you can target multiple genes that are unique to *Varroa*. In other words, the RNA will be bad for *Varroa* but will have little effect on other organisms that we like more than *Varroa* (e.g. our western honey bee).

This is what the researchers were playing around with when they noticed something really interesting. They exposed *Varroa* to some of the "bad" RNA and noticed that all the mites died. But they also exposed *Varroa* to some "whatever" RNA that should have had no effect, and all the mites still died.

After scratching their heads for a while, the researchers realized there was one thing in common between each of their RNA experiments. They had used lithium chloride to produce both the "bad" and "whatever" RNA that they used in the experiments. So, being astute researchers, they conducted a third experiment and exposed *Varroa* to only lithium chloride. Low and behold, all the mites died.

Bettina Ziegelmann inspects a honey bee colony

Several of the cages used to test the impacts of lithium on adult bees

What about the bees? Does lithium chloride kill them, too? This is partly what the authors' study is about. Over several follow-up experiments, the authors show that the dose of lithium that kills mites is more or less harmless to bees, especially if that dose is given in one 24-hr period. Thus, we have ourselves a potential new *Varroa* control tool that kills mites but doesn't harm bees. **This said, in the short time since the article was published, there are already follow-up data that suggest lithium chloride may be harmful to larvae.**

What's so special about lithium chloride? The authors wondered this same question, so they also tested lithium sulphate, lithium lactate, lithium acetate, lithium citrate and lithium carbonate. The short story is that all of these chemicals killed mites. Thus, it's the lithium that's special, not the chloride.

OK, so why does lithium kill *Varroa*? The short answer is that we have no idea. And that's where luck comes in. Sometimes in science you find a surprising result that can't be explained yet. If it's a useful unexplained result, such as lithium killing a highly problematic and widely distributed parasite of honey bees, then obviously it's time to embrace that luck and keep following up with better and more refined experiments (for example, the continuing work on toxicity to larvae).

The cages can easily be inspected for bee mortality and provide a piece of foundation on which the bees can cluster

Great. But in the meantime, is lithium likely to work in the colonies in my apiary? This is of course the important question. Scientists can get lots of potentially interesting things to work in the lab. But the real test is if it actually works in a real world setting outside the lab. So the authors set up colonies containing ~20,000 bees each and exposed them to the dose of lithium that killed mites in the lab. They didn't see 100% mite mortality like they saw in the lab, but they did see 90% mite mortality. Not bad for a first trial.

Clearly the next steps are to see if lithium can be applied more effectively to whole colonies in the field, and to see if it is indeed a significant threat to larvae. And these aren't just academic questions since lithium has many qualities that make it a potentially very attractive *Varroa* control tool: 1) it has low toxicity to mammals, 2) it won't accumulate in beeswax, 3) it's relatively inexpensive.

The verdict is still out on whether "lucky" lithium is indeed a lucky find. But I think it's a great example of how science is a process of continuous discovery and refinement. Our information regarding lithium will continue to be improved and time will tell whether or not it's a desirable new *Varroa* control tool.

Until next time, bee well and do good work.

Scott McArt

Reference:

Ziegelmann, B.,E. Abele, S. Hannus, M. Beitzinger, S. Berg and P. Rosenkranz. 2018. Lithium chloride e ectively kills the honey bee parasite *Varroa destructor* by a systemic mode of action. *Scientific Reports* 8:683.

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