Notes from the Lab:

The Latest Bee Science Distilled

by Scott McArt

Do you have children who are picky eaters? Or, perhaps you've looked at the kid's menu at a restaurant recently and thought, "Wow, that is some really bland food." Or, perhaps in a weak moment, you've actually snuck a taste of some of the pasty pureed food from the baby aisle at the grocery store (don't worry, no judging here at Notes from the Lab).

Regardless of how you've figured out that kid food is bland, you may not have known there are several potentially interesting reasons for *why* human babies prefer to eat bland food. And it turns out that those reasons may also be why honey bees feed their larvae bland food. This is the topic of our sixth "Notes from the Lab", where we highlight **"Nursing protects honey bee larvae from secondary metabolites of pollen"**, written by Matteo Lucchetti and colleagues and published in the journal ***Proceedings of the Royal Society of London B*** **[285:20172849 (2018)].**

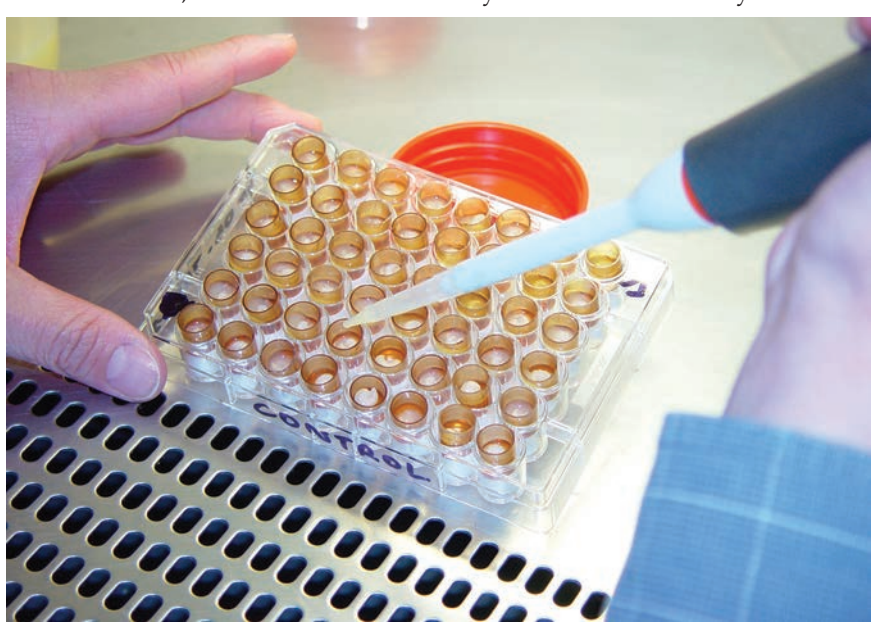
As spring kicks into high gear, hopefully you've been inspecting your brood frames and seeing lots of larvae. And along with the developing larvae, you've probably noticed that each one is swimming in a small pool of jelly. This is the stuff that makes the world go 'round in the honey bee colony – "royal jelly" if a queen is being reared, "worker jelly" for soon-to-be workers, and "drone jelly" for developing drones.

The jelly is produced by nurse bees (via hypopharyngeal and mandibular secretions, of course) and gives the small larva a well-rounded diet of sugars, starches, proteins, vitamins and fat, so the larva can grow big and strong. And where do those all-important bee-building proteins, vitamins and fats come from? Before they're secreted by nurse bees, they're brought into the hive in the form of pollen.

Honey bees are unique in the bee world since they're the only group of bees where adults consume the pollen and then transfer the nutrition to their offspring by nursing. Most of the other ~20,000 species of bees in the world – including solitary bees and other social bees, such as bumble bees – don't nurse their babies. Instead, they directly feed them a mix of nectar and pollen.

Interesting… why do honey bees nurse their young if almost all other bees don't? This is exactly the question that Lucchetti and colleagues wondered themselves, so they set out to find the answer.

The researchers first made the astute observation that most pollen contains toxins (often called secondary metabolites). These secondary metabolites are literally the spice of life, since they're responsible for all the unique flavors on the spice rack in your kitchen – from thyme to rose-



Feeding jelly to individual larvae reared in an incubator in the lab. It's easy to use plastic queen cell grafting cups.

Small cages allow researchers to test the impacts of specific products in the diet on adult bee health. Scientists fed the bees echimidine, which is related to caffeine and nicotine.

mary to nutmeg to cinnamon. Secondary metabolites also keep you awake (caffeine) and give some people a buzz (nicotine). Blueweed, the plant of interest to the researchers in this study, is loaded with echimidine in its pollen, a pyrrolizidine alkaloid that's related to caffeine and nicotine.

The researchers wanted to know if echimidine was toxic to bees. After determining how much echimidine was typically found in blueweed pollen, they fed this exact amount of echimidine to adult worker bees and developing larvae. Interestingly, adult bees were not impacted by the echimidine but many of the larvae died.

Wait, the echimidine was toxic to larvae, but fine for adult bees? Correct. And while there are many potential reasons for this, one of them is pretty simple. Like human children compared to their adult counterparts, larvae are a lot smaller than adult bees. And if you've ever shared a beer or two with someone half your weight, you know that size matters when it comes to detoxification!

OK great, but what does this have to do with nursing? Here's where things get really interesting. The researchers used a fancy instrument to figure out exactly how much echimidine was consumed by nurse bees and then transferred to larvae via nursing. Low and behold, only a small amount of the echimidine consumed by adults made it into the jelly. In fact, the levels in jelly varied but were always below the threshold where larvae died from the toxin. In other words, by nursing their young, honey bees are able to feed their babies much safer (i.e. blander) food than if they feed them pollen directly. Pretty cool, right?!

Some of you astute readers may recognize two things. First, echimidine, caffeine and nicotine are all alkaloids, which are the inspiration for a similar class of synthetic chemicals, the neonicotinoids. Second, nurse bees did not remove all the echimidine from their jelly secretions, and how much echimidine was removed varied in each of the researchers' trials. Apparently, there are limits to how much toxin removal can occur by nurse bees, and this is variable.

Why is this interesting? Well, a wealth of studies now show that neonicotinoids accumulate in nectar and pollen and are transferred to jelly, and thus fed to susceptible larvae, by nurse bees. This exposure can cause both lethal and sub-lethal negative effects in developing larvae. However, as research in Lucchetti and colleagues' study may suggest, perhaps there's genetic variation among nurse bees for the ability to remove toxins such as echimidine (or neonicotinoids) from jelly. If so, this could be a potentially important topic to pursue, given the quantity of toxins that we're exposing bees to nowadays.

Until next time, bee well and do good work,
Scott McArt

The honey bee larvae complete development in the lab. This allows researchers to control the diet and closely monitor for mortality during development.

Reference:

Lucchetti, M. A., V. Kilchenmann, G. Glauser, C. Praz and C. Kast. 2018. Nursing protects honey bee larvae from secondary metabolites of pollen. *Proceedings of the Royal Society of London B* 285:20172849.

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