NEWS LIFE

A vaccine for bees has an unexpected effect

Honeybees immunized against bacteria also fought off a virus

Honeybees are under stress from pesticides, mites and a variety of diseases. Now, a new vaccine aimed at protecting bees from a serious bacterial infection may do double duty by warding off a virus.

By Tina Hesman Saey

APRIL 24, 2024 AT 8:30 AM

WASHINGTON — The first vaccine designed for insects may make honeybees healthier overall.

Honeybee hives vaccinated against a bacterial disease had much lower levels of an unrelated viral disease than did unvaccinated hives, veterinarian Nigel Swift of Dalan Animal Health reported April 3 at the World Vaccine Congress.

Researchers at Dalan, based in Athens, Ga., designed the bee vaccine to protect against American foulbrood — a fatal disease caused by a spore-forming bacterium called *Paenibacillus larvae*. Adult bees don't get sick but can spread spores in the hive, where the disease infects and kills larvae. Spores can remain viable for more than 50 years, so beekeepers with infected colonies must destroy hives by irradiating or burning them to keep the disease in check. A vaccine may save bee lives and beekeepers' livelihoods.

Foulbrood disease is just one of many problems plaguing bees, Swift said. "Pesticides, parasites, climate change, nutritional stress — these all make bees more susceptible to infectious diseases." From April 2022 to April 2023, U.S. beekeepers lost an estimated 48 percent of their colonies, according to the Bee Informed Partnership, a nonprofit research organization.

Dalan's vaccine against foulbrood disease doesn't rely on tiny syringes. Instead, bees are inoculated through a sugar paste that researchers spike with heat-killed *P. larvae*. Worker bees eat the candy and incorporate it into their royal jelly, which they feed to the queen. Inside the queen's gut, bits of the bacteria attach to a protein, which in turn transports the vaccine fragments to the ovaries where they can be deposited in eggs. Larvae that hatch from the eggs should be protected from the disease.

Testing the vaccine wasn't easy. One larvae-producing site in Florida was hit by a hurricane, "another was taken out by bears," Swift said. But the team

persisted. In lab tests, the company infected larvae from both vaccinated and placebo-treated hives with *P. larvae*. About twice as many placebo larvae died as vaccinated larvae, the researchers reported in 2022.

Based on that evidence, the U.S. Department of Agriculture gave conditional approval for the bee vaccine, Dalan announced in 2023. The Canadian Food Inspection Agency authorized use of the vaccine later that year.

Beekeepers who had been using the vaccine told Dalan that vaccinated colonies seemed to have all-around improvements in health that couldn't be explained just by reducing the incidence of foulbrood disease. The company decided to look at a variety of diseases, honey production and other measures of bee health along with the efficacy of the vaccine in a real-world setting. An apiary called Vidalia Apicultural Services & Bee Co. in Lyons, Ga., let Dalan use 400 hives for the study, which lasted for one season. Half of the hives got a new vaccinated queen and half got a new unvaccinated one.

In one sense, the test was a bust. No cases of foulbrood disease were found in any of the hives. "This apiary was just too good" at controlling the disease, Swift said. So the company couldn't determine how effective the vaccine was against its intended target.

Yet the researchers found a surprising result: Vaccinated hives were protected from a viral disease spread by varroa mites (*SN: 3/7/16*). Both vaccinated and unvaccinated hives started the study with the same number of mites and a baseline level of virus, as measured by a PCR test. Virus levels continued to rise in the unvaccinated hives but declined in the vaccinated ones. At the end of the study, vaccinated hives had accumulated 83 percent less virus than unvaccinated hives did, Swift said. The number of mites per hive remained the same.

"It's an important finding for sure, if it's repeatable," says biochemist Andrea Gwyn of the biopharmaceutical company GSK, based in Middlesex, England. Gwyn, who works on vaccines for people, is a hobbyist beekeeper. She is particularly interested in whether queen bees can pass on defenses against American foulbrood and perhaps other infections for more than one egg-

laying season and whether a queen's drone sons and daughter queens could pass on the protections to a second generation.

The results are still preliminary, and the researchers aren't sure exactly why immunizing bees against bacteria might also protect against viruses, Swift said. It may be because bees' immune systems aren't as specific as those of humans and other mammals: Anything that revs up bees' immune responses may help them take on multiple intruders.

"We're just trying to think it through: What is really happening?" Swift says, "It's humbling.... You get these results sometimes that weren't what you were expecting. This could be somebody's Ph.D. now to go and tackle this particular topic."

CITATIONS

N. Swift. A vaccine for bees: targeting pollinator health for future food security. World Vaccine Congress, Washington, D.C., April 3, 2024.

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