Virginia Tech study aims to help explain honeybee losses

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A Varroa destructor mite found on honey bee pupa in one of Montgomery County beekeeper Richard Reid's hives.

BLACKSBURG — Richard Reid of Montgomery County had beekeeping foisted upon him in 1972 by a landlord and happily kept at it until all his hives died in 1995.

The 1990s kicked off a wave of honeybee losses that continue to afflict U.S. beekeepers and agricultural producers. Debate rages over why bees are dying but solutions are elusive.

Virginia's roughly 5,000 beekeepers lost nearly half their colonies last year, according to state figures. The die-off is troubling for the nation's seventh largest apple producer and the beekeepers who must bear about $4 million in replacement costs annually.

Beekeepers nationwide lost 44 percent of their colonies in the 12-month period that ended in April, the second highest loss in the last decade, according to an annual survey released this month by the Bee Informed Partnership, an organization of bee researchers from across the United States.

Since Virginia began tracking colony losses in 2001, the death rate has increased dramatically. Historically, 10 percent or less of hives died annually, according to Keith Tignor, state apiarist for the commonwealth.

Yearly losses swelled to about 30 percent following the invasion of two parasitic mites — tracheal mites in the 1980s and Varroa destructor mites in the ’90s.

To help identify causes of the die-off, the state Department of Agriculture and Consumer Services has commissioned a five-year study at Virginia Tech, funding the $1.4 million cost with fees from the agency’s pesticide regulation program. The work is expected to continue through 2018.

In phase one, which is winding down, researchers are collecting, mapping and analyzing samples of bees, pollen and wax gathered from beekeepers. In phase two, researchers plan to set up test colonies in areas flagged by sampling for more in-depth study. A graduate student is surveying beekeepers on their management practices and that data also will be incorporated.

Reid, who took up bees again in 2008, is one of several beekeepers across the state who have contributed samples to the study.

“I’m very interested to know what they are finding,” Reid said.

Knowing whether pesticides are showing up in his hives or other factors are affecting them could help Reid prevent future losses.

Richard Fell, a Tech researcher working on the project, said samples have been taken from about 100 hives around the commonwealth. The bees are being analyzed for nutrition, general health and immunity, and they, along with the pollen and wax, are being analyzed for pesticide residue.

Researchers hope a different approach to a familiar topic will yield concrete answers.

Big problems, big data

Technology is playing a key part in studying one of nature’s most ancient species.

Samples have been mapped using geographic information systems, or GIS. The millions of data points, including the location data, will be plugged into a statistical model to search for regional patterns. Those may help scientists zero in on major problems plaguing the commonwealth’s honeybees.

Other studies have used GIS to examine land use and one other potential factor affecting bee health, said Carlyle Brewster, a Tech insect ecologist who is working on the statistical model for the project.

“I’ve not come across any study that has linked landscape, pesticide and honeybee health,” he said.

Lessons from such a large data set could have wider impacts.

Because Virginia’s estimated 40,000 managed hives each forage on nectar- and pollen-producing plants over large areas of the state, “the bees are an indicator species of what is happening in the environment in terms of pesticide use.”

Tracking losses along with weather patterns also could shed light on climate change in Virginia and how that is affecting native pollinators as well as honeybees, Brewster said.

Honeybees pollinate up to $20 billion in crops in the U.S., according to government figures, and are big business in some parts of the country. In California, for example, honeybees pollinate much of the world’s almond crop, giving rise to large commercial beekeeping operations.

Tignor, the Virginia apiarist, estimates that more than 90 percent of Old Dominion’s beekeepers are hobbyists who maintain one to 10 hives for honey. A handful of beekeepers in the state make their living moving their hives short distances to pollinate crops, Tignor said.

But, Tignor said, whether they know it or not every hobbyist provides pollination for agriculture and forestry, which together make up Virginia’s largest economic sector.

In addition to apples and other fruits, Virginia produces “squashes and cucumbers, all of which require pollination,” Fell said. “We’ve got a lot of secondary crops, from cane berries to strawberries to blueberries to say nothing of home gardeners.

“And even if we say only about 50 percent of that pollination is provided by honeybees, that’s still a damn big figure.”

Many threats, few answers

Like others in the 1990s, Reid’s bees fell prey to the Varroa destructor, a honeybee parasite introduced to the U.S. from Asia that decimated small and large apiaries and continues to plague the industry.

The picture grew murkier in 2006, when a handful of large commercial beekeepers reported entire colonies disappearing seemingly overnight, sparking worries that crops dependent on bee pollination could be at risk. Scientists raced to find the root of what became known as CCD, or colony collapse disorder. They found mites, viruses and other problems, but no single cause.

Attention shifted to a class of pesticides derived from nicotine, called neonicotinoids. These chemicals pose little threat to mammals and birds and are used widely in industrial agriculture as well as by small farmers and homeowners. Most commercial corn and soybean seeds are treated with neonics, as they often are called, and the plants excrete the toxin in their leaves and stems. Sap-sucking and leaf-eating pests die when they feed on the treated crops. Some of the chemicals get into nectar and pollen, too, leading to fears that it might poison honeybees.

Some European countries have banned neonics temporarily to see whether bee losses there will wane. In the U.S., this class of insecticides is regulated by the federal Environmental Protection Agency. Spraying neonics on blooming plants is prohibited, for example.

But Fell and other bee experts say there is no good evidence to support the idea that neonics are the primary culprit in honeybee losses. Researchers still are analyzing Virginia samples for neonics, Fell said. But other studies have found few of these chemicals. Where they have been detected, levels have been so low, Fell said, it's like "a pinch of salt in 10 tons of potatoes."

"We're not saying it can't be a contributing factor," Fell said. "But it doesn't seem to be the major problem."

Calls to ban neonics are premature, he said: "We shouldn't ban something that we're not even finding in hives."

Sampling for the state study has been done in a wide area, from crop and pasture lands to orchard areas to urban and suburban settings. Researchers are looking for traces not just of pesticides but also of commonly used herbicides and fungicides. It could be that chemicals are a problem, but only in certain areas or under certain conditions, or in combination with each other.

Or it could be they are not a major factor.

Flawed conclusions?

The perception that pesticides, and neonics in particular, are to blame for die-offs has been boosted by some laboratory studies on small numbers of bees in cages.

But the immune systems of the young bees often used in those studies might not be as developed as in older bees, making them more susceptible to toxins. Furthermore, Fell said, pesticides at normal plant levels collected by a hive of 30,000 bees might be diluted and cause no problems.

Lab studies can be misleading if they are not followed up with good field studies, Fell said.

After leading field studies in which he fed neonics to a group of colonies over 13 weeks, Harvard public health researcher Chensheng "Alex" Lu concluded in results published in 2012 and 2014 that the pesticides can cause symptoms of CCD.

Fell and Troy Anderson, a pesticide and insect researcher also working on the Virginia study, said Lu fed high doses of neonicotinoids over long periods of time — a situation not found in

normal colonies. Specifically, the levels of pesticides exceeded what is found in the nectar and pollen of treated plants. That is a problem with many lab studies, too, Fell said.

Recent studies have shown that bees are good at detoxifying themselves after exposure to neonicotinoids, Anderson said. Besides, neonics are not widely used in Southwest Virginia, yet annual losses hover around 30 percent, he said.

In an email to The Roanoke Times, Lu wrote that he used levels of a popular neonic, Imidacloprid, below what EPA guidelines say is the maximum safe dose and pollen samples collected from across Massachusetts for a more recent project support his choice in dosages.

Neonics first were used in the 1990s. Colony collapse disorder was not reported until 2006, and then only by a handful of large commercial beekeepers. At the time, there were no diagnosis criteria and no official monitoring systems to identify the syndrome, according to Fell and Anderson. Much of the evidence was anecdotal.

In many cases, entire bee colonies disappeared, leaving no dead bees to test for pesticides or diseases.

Markers of health

The Virginia study could solve another riddle.

“My question has always been: What is a healthy bee?” Troy Anderson said.

Surprisingly, there are no standard measures for that, he said. Defining health could help researchers better monitor for disease and other problems. His lab is analyzing bee samples for protein levels, immune response and other markers in hopes of establishing criteria for bee health.

In fact, poor general health might figure into losses.

Commercial beekeepers truck thousands of colonies over long distances, concentrating them in agricultural areas, such as California’s almond country and fruit tree operations in the Pacific Northwest. This stresses the bees and might contribute to lack of nutrition during certain times of the year, researchers say. It also is a recipe for spreading diseases quickly across the country.

Big bee die-offs are not new.

About a century ago, a mass die-off occurred on Britain’s Isle of Wight, spurring a monk at Buckfast Abbey known as Brother Adam to breed a new strain of bees resistant to the mysterious ailment that came to be known as Isle of Wight disease. It alternately has been blamed on a mite species that infects the bee’s respiratory system, and an intestinal parasite called Nosema.

The Buckfast bee eventually helped repopulate hives and still is bred today.

The mighty mite

Students in Anderson's lab are working on other bee-related projects, from looking for a "bee repellent" that might be mixed with pesticides to research on Varroa mites. Better control of those mites alone would help honeybees, Anderson said.

Efforts so far have focused mostly on miticides. But the mites quickly develop resistance to the chemicals. There's also the worry that over time they might build up in beeswax, perhaps causing chronic, low-level problems in bees. The Tech study is looking at levels of hive contamination from those chemicals, too.

For his part, Reid decided in 2008 to work on keeping his bees without miticides. In 1996, a year after he put his empty hives away, a swarm moved into idle equipment near his house. They lived there for 12 years with no intervention, he said.

Believing there were honeybees able to fight the mites, Reid said, he was ready to try again. Today, he has more than 160 hives spread across the New River Valley. Last year, he said he lost fewer than 20 percent of his colonies.

Reid has focused — much like Brother Adam — on finding strains of bees that can survive pests and diseases without intervention. He keeps a dozen or so lines, some developed by breeders to resist mites, and some wild bees. He propagates queens from those strains, hoping to develop hardy stocks.

Over the next two years, Fell and his collaborators will set up test colonies and closely monitor them. They will look at factors such as Varroa mite infestation and the health of queens — the "mothers" of bee colonies.

This information will be added to the statistical model to refine what scientists know about Virginia's honeybees and perhaps lead to better ways to protect them.