RON PILCHER

Beyond the honeybee

Scientists, farmers, and beekeepers are paying attention. Now that the world's most infamous insecticides are turning up in lakes, you should too

By Jennifer Kingsley

If you've seen a cornfield in Canada, you've witnessed ground zero for the insecticides that are making global headlines. They are used on almost every corn and canola plant in this country, half of the soybeans, and over 140 different crops around the world. They're called "neonicotinoids" (ne-o-*nic*-o-tin-oids), and if you've heard of them, it's likely through their link to honeybee deaths. But honeybees are just one part of a complex ecosystem that also includes 800 species of native bees in Canada alone, countless other insects, and the birds and fish that rely on those insects for food.

Proving the effects of a chemical in the environment is notoriously difficult science; however, in the case of neonics, as most people call them, the clues are piling up. The trail leads well beyond farmers' fields, and it might even come to your lake. One thing is for sure: this story is bigger than the bees. ››

Should we ban neonics? Blipp to tell us what you think.

THE SLEUTHS

Christy Morrissey is an ecotoxicologist at the University of Saskatchewan in Saskatoon—she studies the effects of toxic chemicals on living organisms. Morrissey and her students have found neonics in 90 per cent of prairie wetlands, called "prairie potholes"—before fields were even planted. Her research asks the next question: what is the effect of neonics on insect and bird populations? Michael Cavallaro, one of Morrissey's Ph.D. students, studies insects—"bird food," as the ornithologists in his lab like to say. Cavallaro sets bug traps to try to determine if neonics are affecting aquatic insects' ability to successfully emerge. These insects are tiny, but their impact is not. "If you think in terms of calories for bug-eating wildlife, it's tremendous," he says. Morrissey studies tree swallows, which feed on those insects, to see if the birds' decline might be linked, indirectly, back to neonics. That link, she admitted in a presentation to a group of beekeepers, is difficult to establish. As she went on to explain, "There are lots of pieces to the puzzle, but if you get enough pieces, essentially you will create a picture—a picture that tends to be believable."

NEONICS 101

Neonicotinoids are a class of pesticide that is chemically similar to nicotine. They came onto the market in the mid-1990s and now represent a third of the global insecticides market. Sales of neonics reached more than $2.6 billion U.S. in 2011 alone. Imidacloprid is the biggest seller; it's the most popular insecticide in the world and the second-most commonly used agrochemical overall.

Neonics are toxic, but this should come as no surprise; they are designed to kill the sucking and biting insects that can harm crops, and they are very effective. They are also systemic pesticides, which means that once they're applied to a plant, they will permeate every part of it from the leaves to the roots, including flowers, nectar, and pollen. Coating a seed with neonics—by far the most common application method—protects the plant from pests for its lifetime. This method has an upside—use of a small amount of a chemical that targets invertebrates and usually needs to be applied only once.

However, when it comes to neonics, it seems every upside has a flip side. Because the crops have pesticide in almost every cell, non-target insects, like the honeybee, are exposed. And applying the chemicals to the seeds is a preventative approach—like taking antibiotics just in case. So while there is a relatively small amount per plant, the pesticides are being used on an enormous scale.

Besides, Pierre Mineau, a co-author of the American Bird Conservancy's 2013 report on the impact of neonicotinoids on birds, points out that the amount of pesticide is not always the important thing—it's the effect that matters. Concentrations of neonics of a few parts per billion are enough to affect sensitive aquatic bugs like the mayflies that fish jump for and the midges that swallows scoop out of the air. As the report stated, "...neonicotinoid contamination levels in surface and groundwater in the U.S. and around the world are strikingly high, already beyond the threshold found to kill many aquatic invertebrates."

NEONICS AT WORK

Neonics affect insects and other invertebrates by interfering with the nervous system. The neonics bind to a "gate" in the cell membranes that is usually open only when a nerve is firing. The neonicotinoid holds this gate open and never lets go. With a high enough dose, this causes death in short order.

At lower concentrations, the effects on invertebrates are less straightforward. The leading theory is that the insect in question, let's say a honeybee, picks up a few neonic molecules at a time while foraging, and the effects of the chemicals build up in the bee's system. Nigel Raine from the University of Guelph is Canada's first research chair in pollinator conservation, a position created to study why so many pollinators are declining. He is concerned that neonics can have sublethal effects on navigation, communication, and even immune system response. His most recent study involved exposing bumblebees to different doses of neonics and then monitoring their foraging behaviour. Those bees exposed to the pesticides collected pollen from different flowers than those not exposed, and brought home less pollen. Their overall performance deteriorated over time, which is unusual for bees as they are typically good learners whose foraging skills improve with practice.

In vertebrates, such as birds, fish, and people, the neonic's bond is weaker and shorter lived, so the pesticide is more easily metabolized and removed; it does not build up over time. However, if they are ingested at high enough doses, neonics are poisonous for vertebrates too. For example, European scientists estimate that a farmland bird could die from eating fewer than five seeds coated with imidacloprid.

WHERE NEONICS GO

Because neonics are used primarily for crops, there is a tendency to think of their environmental impact as an agricultural issue, but the biological world is always on the move—insects fly from one field to another, birds eat insects, and so on. Also, the neonics themselves don't always stay where they're put. They degrade quickly when exposed to sunlight, but can otherwise persist for months or even years in soil. They are water soluble and easily washed into ponds, puddles, ditches, and lakes. Within 48 hours of a runoff event, such as a rainstorm, more than half of the pesticide may break down, but smaller concentrations can stick around.

While the debate about the effects of neonics continues, it's becoming increasingly clear that they have an impact on watersheds. While they don't accumulate up the food chain as we saw with DDT in the 1960s, and they don't spread around the planet in the atmosphere like some persistent organic pollutants, neonics can move quickly away from a treated field and into surface water.

In a living system, the impact can be complex. Here's one scenario: swallows rely on insects to hatch at a time that coincides with their breeding schedule. In a single hatching event, millions of insects can take flight, which means millions of units of energy for hunting birds. But if those insects don't hatch, or don't hatch at the right time, the birds are in big trouble. "Missed timing is as bad as not having those insects in the first place," says Mineau.

Neonics, which can kill and/or disrupt important bird food like midges and mayflies, are a suspect in the mystery of disappearing insectivores. But, again, there's more to it than that. In the last 40 years, birds that are aerial insectivores, such as swallows and swifts, have seen a 60-70 per cent decline. During this time, insect populations have decreased dramatically the world over, climate patterns have changed, agricultural intensification has altered field sizes, wetlands have disappeared and, yes, neonicotinoids have become the new favourite insecticides. But proving links among these factors, especially outside a controlled lab environment, is so difficult that many scientists shy away from it.

A RIPPLE EFFECT

In 2013, the European Union voted to restrict the use of three neonicotinoids for two years in an effort to protect honeybees and other pollinators. Last year, U.S. President Barack Obama created a Pollinator Health Task Force. In November, the Ontario government announced a plan—the first of its kind in Canada—to cut the acreage planted with neonic-treated seeds by 80 per cent in the next two years. Action on this issue, including a flood of scientific papers, a global task force on pesticide research, and statements from political leaders, is increasing. Citing a loss of profit due to neonicotinoids, last year the Ontario Beekeepers' Association launched a $450 million class action lawsuit against the two largest manufacturers and their parent companies. These initiatives are increasing awareness about agricultural and household applications (neonics are used for flea collars and to treat some nursery plants), but a big-picture solution won't come without cooperation on regulation and pest management.

While honeybees have made the most headlines so far, other wildlife—insects, pollinators, and insectivores—might not be far behind. Regulatory change to support pollinators is starting to happen around the world. And while there may be a place for neonicotinoids in a farmer's tool kit, a growing number of experts agree they should never be as common as a cornfield.

Jennifer Kingsley is a writer, an audio producer, and a naturalist based in Ottawa.