As Pesticide Turns Up in More Places, Safety Concerns Mount

Jim Daley

For decades, Judy Hoy has run an independent wildlife rehabilitation center from her Montana home, where she also previously performed autopsies on deer struck by cars. In the late 1990s she noticed a bizarre trend: Many deer had pronounced overbites, enlarged right heart ventricles, and damaged or missing thymus glands and scrota. And the deer were not alone. “We were seeing those same birth defects on all of the big game and domestic animals,” says Hoy, who reported her observations in 2002 in the *Journal of Environmental Biology*. She suspected a new class of pesticides called neonicotinoids might be responsible.

Prompted by Hoy’s work, Jonathan Jenks, a wildlife ecologist at South Dakota State University, tested that idea in 2015 and 2016. He gave captive deer water spiked with imidacloprid, the most commonly used neonicotinoid, and measured its presence in various organs. Deer with higher levels in their spleens had pronounced overbites, just as Hoy had seen. What really startled Jenks was that he also found imidacloprid in his control animals—which had not been intentionally exposed to the pesticide. His findings add to an accumulating body of ominous indications that neonicotinoids may be posing an underrecognized health and environmental risk.

Neonicotinoids, which target insects’ nervous systems with lethal efficiency, were developed by Bayer in the 1980s as a safer alternative to existing pesticides. They are considered less toxic to vertebrates, and rather than being broadly sprayed over fields they can be applied directly to seeds or delivered via irrigation and incorporated into tissue as the plant develops—in theory minimizing their chances of spreading into the environment. But a growing body of research is challenging that paradigm, pointing to toxic impacts on nonpest species from bees to deer, and to transmission beyond farm fields. Only 2 to 20 percent of the neonicotinoids applied to seeds make it into the plant, says Jonathan Lundgren, an ecologist who worked with Jenks and directs the Ecdysis Foundation, an agricultural research organization. “That begs the question of where the other 80 to 98 percent of the chemicals are going,” he says. “And we’re starting to find them in other areas of the environment. We’re finding them in surface waters. We’re finding them in untreated plants.”

From Sparrows to Food

Jenks is not sure how the control deer in his experiment were exposed to imidacloprid, but he suspects they may have eaten vegetation from a field next to where they were kept or that their grain-based feed may have been treated with the pesticide. He notes that 90 percent of corn and 50 percent of soybeans in the United States are treated with neonicotinoids. The chemicals are designed to diminish in treated plants over time, but Jenks says their half-life runs up to 1,400 days—meaning annual applications to crops could be causing neonicotinoids to accumulate in the environment. “Any domestic feed that’s used in an experimental study would likely result in contamination,” he says. The pesticides are also water-soluble, which

is why they can be delivered to growing plants via irrigation, but also means runoff can carry them to lakes and rivers. Jenks says his study, published in March in *Scientific Reports*, was the first to experimentally examine imidacloprid's effects on large mammals. Neonicotinoids' effects on vertebrates more broadly are only beginning to be understood.

Christy Morrissey, an ecotoxicologist at the University of Saskatchewan who was not involved in Jenks' study, says neonicotinoid exposure has disturbing effects on migratory songbirds. In 2017 Morrissey showed in a *Scientific Reports* study that feeding imidacloprid to white-crowned sparrows caused them to lose up to a quarter of their body mass—and on a long migratory journey, every milligram matters. Additionally, the sparrows also could not find true north for weeks after being exposed. Morrissey says a high percentage of migrating sparrows caught in southern Ontario have detectable levels of neonicotinoids in their blood. "The levels are low, but indicative of widespread contamination," she says. "These chemicals are getting into the broader food chain… and they are not nontoxic to many species." Other studies have begun detecting neonicotinoids in wild birds of prey, rodents, fish, lizards and frogs; biologists suspect the animals are being exposed in a variety of ways, including eating treated seeds or contaminated prey, or coming into contact with tainted field runoff.

Neonicotinoids are also turning up in human food. A 2018 review in *Environmental Science and Toxicity* found that more than half of the fruits and vegetables served in the U.S. Congress's cafeteria contained neonicotinoids, albeit at levels the Environmental Protection Agency considers acceptable based on studies in rodents (the EPA's standard practice for testing pesticide toxicity). And a study published in January in *Environmental Health* found neonicotinoids even in some certified organic fruits and vegetables—possibly because of product mislabeling, postharvest contamination or wind-carried pesticide drift.

But the extent of these pesticides' toxicity to humans is not yet clear to scientists, partly because until very recently they lacked the analytical ability to detect such chemicals or their byproducts in humans, says Melissa Perry, a public health researcher at George Washington University. "In the past 15 years we have come to understand that many pesticides can mimic hormones, which can affect the activities of the human endocrine system," she says. "Because studies of the human health effects of neonicotinoids have been quite limited, whether they have human endocrine activity is not yet known."

According to David Fischer, director of the environmental safety division at Bayer Crop Science, today's environmental testing methods are more sensitive—and the levels of the pesticide being detected are not harmful. Lundgren, though, counters that even at low levels, "neonicotinoids are 5,000 to 10,000 times more toxic to honeybees than DDT [dichlorodiphenyltrichloroethane, a pesticide the EPA banned in the 1970s] was." Fischer also says the concentrations Jenks and Lundgren used in their experiment are higher than current environmental levels, which Jenks readily acknowledges. But Jenks and his colleagues have found some wild deer with concentrations of imidacloprid even higher than those in their experimental deer, indicating that environmental levels can vary.

Rethinking Pesticides

Jenks and others are looking at the impacts of neonicotinoids on other species, to

better understand the potential scope of the problem. In his current work with pheasants, Jenks has again found contamination in his control animals; he tested their feed and identified it as a possible source. Other researchers have begun calling for biomonitoring and large-scale epidemiological studies to determine neonicotinoids' effects on human health; the Centers for Disease Control and Prevention recently established analytical methods to study the presence of the pesticides in urine as part of the National Health and Nutrition Examination Survey, a broad survey of Americans' medical and dietary status. Devon Payne-Sturges, an environmental health scientist at the University of Maryland, says the NHANES study "will fill an important data gap" in neonicotinoid biomonitoring.

Largely because neonicotinoids have already been shown to be deadly to bees, which are crucial for pollinating plants, some governments have begun restricting their use. In 2018 the European Union expanded a ban on three neonicotinoids, including imidacloprid. In the U.S., Representative Earl Blumenauer (D–Ore.) reintroduced legislation in February to limit the use of imidacloprid and other neonicotinoids, and to direct the EPA to establish a "pollinator protection board" that would involve beekeepers, farmers and conservationists in pesticide toxicity reviews.

Morrissey says the problem is not as simple as banning one pesticide or another, though. "The bigger problem is that we've become complacent about using pesticides for everything," she says. Lundgren says alternatives such as regenerative agriculture—an approach that is advocated by the Ecdysis Foundation and promotes biodiversity to help control pests with beneficial insects—are already available and are scalable to commercial farming. But he adds that meaningful change will have to come from grassroots efforts. "I think these sorts of paradigm shifts throughout history don't necessarily come from the government or the university; they come from the people on the ground who decide to make a change," he says. "Within our food system, who needs to make that change? The farmers do, the beekeepers do, the consumers do. They need to demand something better."

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