

2014

Microscopic poison

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MICROSCOPIC POISON

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Over the past few decades, pesticides have become increasingly popular in the United States because they help improve farm productivity and safeguard crops.¹ But, as with many presumptive remedies, there is a catch: pesticides also have become feared due to the dangerous effects they could have on the nervous system. Recent studies have shown that these chemicals are correlated with Parkinson's disease, and can affect embryonic development in the womb.² But where does the story begin?

It is no secret that honeybees are rapidly disappearing. Starting in 2006, honeybee hives have been decreasing at a rate of 30 percent each year, a phenomenon known as Bee Colony Collapse Disorder.³ Bees are essential to farming because many crops depend on them for reproduction, and their disappearance is leading to anxious farmers. Chensheng Lu of Harvard School of Public Health performed a field experiment on bees trying to find the cause of their disappearance. He established five different bee colonies and supplied each colony with high fructose corn syrup, which is what is most commonly used to sustain bees throughout the winter.⁴ In four of the colonies, he mixed the corn syrup with different amounts of a pesticide imidacloprid, and left the fifth colony clean to act as a control group. He found that the two hives with the highest doses of the imidacloprid corn syrup mix died off quickly, within 13 weeks of the start of the experiment.⁵

Lu chose to perform the study with the pesticide imidacloprid because it is sprayed on corn crops for protection against different types of insects.⁶ This chemical makes its way into corn kernels, the main ingredient in the production of high fructose corn syrup. Studies have also shown that imidacloprid is a neurotoxin that causes death by paralysis. The honeybees with the highest dosage of this pesticide died because their muscle function

was impaired by a blockade of receptors in the central nervous system.⁷

With a study showing that pesticides can be destructive to honeybees, could these chemicals potentially have a negative impact on humans? The National Academy of Sciences conducted a study to determine the effects of pesticides on infants and children, if any. Scientists recorded the type and amount of food that infants and children ingested, and then tested the subjects for levels of chemicals in their bodies as well as the longitudinal effects of the chemicals.⁷ The organization came to the conclusion that "infants and children may have special sensitivities to certain toxic insults." These toxins could "result in permanent brain damage during early brain development."⁹

Data from studies conducted at Harvard University and the University of Montreal revealed that 96 percent of the children they tested had traces of organophosphates, the basis of insecticides and herbicides, in their urine. Organophosphates are naturally cleaned from the body if ingested, but the large and persistent presence of this chemical in urine samples suggests that children are constantly exposed to it.¹⁰ Organophosphates also could prove to have an effect on the developing brain. The study found that children whose urine contained above average concentrations of organophosphates were more likely to develop ADHD.¹¹

Scientists also were curious to see if pesticides could have an effect on fetuses and newborns. A comparative study published in *Environmental Health Perspectives*, done on pregnant women living in New York City and California, set out to see if infants had any neurological damage after being exposed to acceptable levels of organophosphate pesticides set by the EPA. After testing the children's cognitive abilities throughout their childhood, researchers learned that some children



Untitled 2. Artwork by Jordana Churchil.

displayed deficits in memory and perception, compared to children who were pesticide free.¹² A study done by the National Institute of Health further suggested that exposure to organophosphate pesticides during periods of critical development could reprogram signaling in the brain. This chemical was found to specifically affect adenylyl cyclase, an enzyme that plays regulatory roles in nearly all cells. The effects of the pesticides were still visible, even after the exposure had been discontinued.¹³

It was also found that children whose mothers lived on farms where pesticides are used, on average had an IQ seven points lower than children whose mothers had less exposure to pesticides. Virginia Rauh of Columbia University reported in *Proceedings of the National Academy of Sciences* that pesticides might alter brain structures. Rauh and her team took brain scans of 40 New

York City children who had been exposed to low and high levels of organophosphate chlorpyrifos *in utero*. She found that there was a thinning of the prefrontal

cortex, an area of information processing and working memory, in these children. This thinning could potentially explain the drop in IQ found among children exposed to higher levels of pesticides. Rauh's brain scans also showed signs of sexual reversal in

some of the cortical structures; areas normally large in girls were larger than average in highly exposed boys. This included areas related to sensory information processing and self-awareness. It is known that hormones can have a significant effect on the developing brains of infants and young children. Rauh hypothesized that chlorpyrifos are able to mimic certain hormones found in our bodies, altering the way the brain develops.¹⁴

Pesticides also can have long-term effects on adults if exposed throughout a lifetime. *Science Daily*

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published an article describing two separate studies. One stated that people living near farms that use pesticides increased their chances of developing Parkinson's disease by 75 percent. The second study focused on people who worked on the farm, and found that their chances of developing Parkinson's disease were increased by 80 percent.¹⁵

These deadly effects result from the combinations of different pesticides being utilized on farms. Researchers found that the combined exposure to pesticides Ziram, Maneb, and Paraquat near any workplace can increase the risk of Parkinson's disease. Dr. Beate Ritz of UCLA School of Public Health suggests, "Pesticides affecting different cellular mechanisms that contribute to dopaminergic neuron death may act together to increase the risk of Parkinson's disease considerably." Ritz and her colleagues developed a geographic information system (GIS) that estimated a person's exposure to pesticides based on the distance the person lives from an affected area.¹⁶ Results of the GIS showed that exposure may have occurred years before the onset of the symptoms of Parkinson's.¹⁷

UCLA Professor Jeff Bronstein performed genetic screens on different types of pesticides, where genetically modified cells were used to identify the specific pesticides that contributed to Parkinson's. He found that protein alpha-synuclein accumulated in dopaminergic neurons with increased exposure to pesticides, thereby selectively killing them. When these pesticides were given to rodents, over time they started to show signs of Parkinson's, such as tremors and rigidity.¹⁸

A study done on rodents at the University of North Dakota suggested that the brain reacted to pesticides even at relatively low doses. Dr. Patrick Carr says that in some regions, the brain displayed loss of neurons after being exposed whereas in other regions, neurons were expressing chemicals in different amounts compared to the brains of control rodents. Carr also found that cells responsible for the production of myelin, insulation for neurons that helps transmit neural signals, were damaged or destroyed. This could be fatal because neurons without myelin are unable to effectively communicate with the rest of the brain.¹⁹

The adverse effects of pesticides has recently become a field of interest because a significant number of people are ingesting chemicals without any knowledge of the potential short and long-term effects that these chemicals may have. Some have suggested that any chemical found harmful should be restricted, but Brenda Eskinazi of the University of California at Berkeley observes, "If you remove one chemical or class of chemicals from the list of pesticides growers can use, they'll replace it with something we know even less about."²⁰ Americans are arguing that the system by which pesticides are approved needs to be reviewed as it is becoming clear that no matter what the dosage level is, these chemicals are essentially a poison.

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