



The Disappearance of Honeybees – Colony Collapse Disorder

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What is Colony Collapse Disorder?

- The abrupt disappearance of bees
- Signs: presence of eggs, queen bee and food stores in abandoned colonies
- Workforce made up of young bees as a result

Why do we need honeybees?

- They are responsible for the pollination of countless fruits, vegetables and farming crops. For example: strawberries, cabbage, papaya, mustard, coconuts, hazelnuts, lemons, tomatoes and MANY more...
- It is estimated we need them to pollinate 66% of the food humans eat



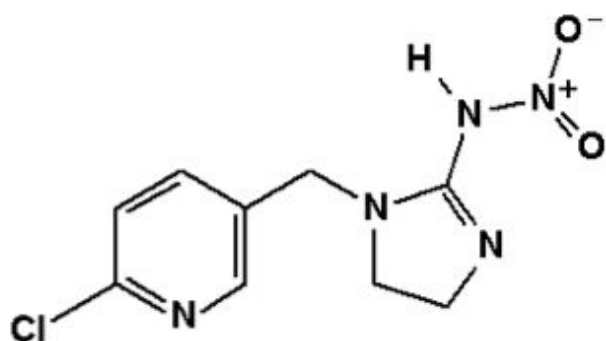
What is Killing Them?

- Varroa mite: external parasite that can only reproduce in a honey bee colony, attaches to the bee and weakens it by sucking hemolymph, possesses viruses that are implicated in colony collapse disorder



- Israeli acute paralysis virus: a virus transmitted by means of the varroa destructor
- Pesticides: primarily neonicotinoids with active ingredients of imidacloprid, clothianidin, thiamexthoxam and dinotefuran

Chemical Makeup of Pesticides



Imidacloprid is a neonicotinoid insecticide, meaning that it is chemically similar to nicotine.

Its molecular formula is $C_9H_{10}ClN_5O_2$

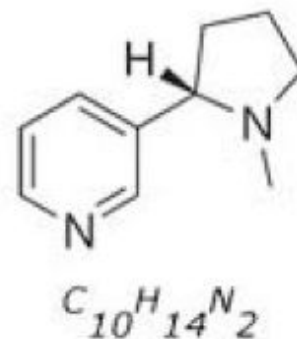
Like nicotine, imidacloprid is an alkaloid, an organic molecule derived from ammonia where the hydrogen is replaced by the cyclic structures of carbon and hydrogen

The makeup of many drugs is an alkaloid structure. LSD, steroids, morphine, codeine, marijuana are all composed with a similar structure.

Alkaloids work by fitting into the receptors on post-synaptic bulbs.

The receptors stay open when there is a molecule binded to them so neuro-transmitters build up in the synaptic cleft, stimulating the nervous system

In pesticides, the nervous are stimulated so much that the insect is paralyzed and dies.



How Are They Dying?

- The varroa mite harbours pathogens that serve to weaken the bees by means of transmission.
- Infection caused by the Israeli virus
- Causes deterioration of ribosomes
- The pesticides (neonicotinoids) themselves have sub lethal effects, impairing their development and behaviour
- The chronic problems caused by long term exposure to these pesticides gradually deteriorate the health of the bees, despite an absence of lethal doses.
- The pesticides used further interfere with learning circuits in the bees' brains
- Targets brain area affiliated with learning and memory.



Existing Solutions

- **Organic Farming:** minimizes pesticide use by monitoring for pest insects and planting pest-resistant plant species
- **Banning Neonicotinoid Pesticides:** by forbidding the use of these pesticides, we can protect honeybees as well as other pollinators and aquatic insects. Also, this would stop the toxic accumulation of the pesticide.
(European Union has started with this method!)

Going Further

- The bees naturally possess an immune system capable of resisting the initial sub lethal impacts of neonicotinoids
- These sub lethal effects, however, become lethal in the presence of the varroa mite, because the immune system is weakened and resistance is increasingly difficult
- Since the varroa mite is an external parasite, an important solution is to figure out how their presence can be detected by the bees and accordingly eliminated.
- For example, potentially changing the genetic traits of bees in order to recognize infected brood and prevent the furtherance of the infestation.



Cross-Breeding with Killer Bees

African

- **Idea:** African Killer Bees have stronger immune systems, and higher reproduction rates meaning they are less susceptible to CCD. They have been cross-bred with honeybees to create the hybrid Africanized bee.
- **Pros:** More defensive than honeybees
- **Cons:** More aggressive and dangerous than honeybee—sting can kill humans. More aggressive each other, and western honeybees (can take over honeybee hive)

Prevent the Varroa Mite

- Chemical Measures: Powdered sugar (Dowda method) can be sprinkled on the bees. Essential oils, especially lemon, mint and thyme oil, sugar esters (Sucrocide) in spray application, Oxalic acid trickling method or applied as vapour can all help eradicate the varroa mite

Ants: the new honeybee?

- Invertase is an enzyme honeybees use to break down sucrose (a disaccharide) into glucose and fructose (monosaccharides), in the formation of honey.
- Ants also have a high amount of invertase
- **Idea:** artificially breed ants to be able to pollinate crops and produce honey, if or when the population of honeybees continue to diminish
- **Estimated Budget:** \$6 million



BEE HAPPY!

