

2018-2020: Beginning in 2018 we see a recurrence of Colony Collapse Disorder (CCD) emerging, and leading to the extinction of bees as a species by 2020. Though there is no immediate catastrophic consequence of CCD, news of it has quickly become global. Countries are now trying to figure out how to move forward, making food models, taking steps towards alternative pollination research, and looking at current policy. In the past, bees have been viewed as an economic resource and rather than an important aspect of the environment, causing their environmental needs to be overlooked. The over reliance on bees is starting to sting.

Before 2020

Scientist

My name is Dr. Franklin Bronwin. As part of my duties in studying the prolonged collapse of all bee species across the planet earth and the repercussions of such a collapse, I am recording a written (read:typed) account of our findings up to this point. Our is that, in addition to our continued research, the recording of journals by each member of our team here at Research Station 0219 will help us make connections between findings we may not have noticed or thought of prior.

Before analyzing the systems that utilize bees in their entirety, it is highly important to look back at each piece of the system and understand what it is that is happening. We will start with pollen. At the most basic level, pollen is the male half of a plant's reproductive material. Pollen takes on a similar role to that of the human sperm, capable of fertilizing the female ovule contained within a plant, therein helping to create the fruits and vegetables that act, in many cases, as a seed transference device to propagate the plant species. While there exist some plants who are capable of self-fertilizing, meaning they do not necessarily need to spread their pollen to fertilize and create new plants, many flowering plants require the aid of other forces or creatures to spread their pollen and thereby reproduce. For some, the force of wind is enough to release pollen from the plant, causing the pollen to float in the breeze to other plants which it will then fertilize. Otherwise, plants need pollinator creatures, such as our bees.

Bees are an interesting creature in many respects. One piece of "pre-collapse" media contained a quote that, while the source media has been lost, remains as an example of how interesting the creatures were: "According to all known laws of aviation, there is no way a bee should be able to fly. Its wings are too small to get its fat little body off the ground. The bee, of course, flies anyway because bees don't care what humans think is possible."

In terms of our study of pollination, bees, and their related interactions, we see another interesting occurrence. Pollen acts as a major source of food for bees. The pollen contains a number of crucial nutrients for bees, and it is from this and the nectar of flowers that honey, that once-widely available commodity, is made. The bees, in terms of their relation to plant reproduction, now have symbiotic impetus to travel flower to flower and collect pollen with their bodies. In their search for sustenance, the bees are unknowingly (or knowingly, we cannot see into the brain of a bee) perpetuating the reproduction of thousands of plant species.

This brings us to the system of bee-driven pollination. Each bee flies to a flower or pollen source, lands and vibrates its body so as to collect as much pollen as possible onto its body and legs. When the bee feels as though it has collected enough pollen, it alights and makes for the next flower or source it deems as full of pollen for the taking. On this new surface, the bee alights and repeats the process of vibrating and collecting. In doing so, some of the pollen it had collected from the first source is exchanged with new pollen, and this foreign pollen goes on to

fertilize the female ovule of the new plant. Once satisfied, the bee returns to its hive with a bounty of nutritious pollen. The bees are fed and the plants are put through another stage of the reproduction cycle.

In times past, this is how the process was supposed to have worked., and bees had emerged as by far the most productive pollinators, and quickly dominated our agricultural market. Instead, we saw the rapid collapse of bee hive populations due to Colony Collapse Disorder (CCD). This affliction was caused by a number of factors affecting the bees together, weakening them and destroying hives. Among all contributing factors, there were that played a heavy role in the downfall of bees. The first were Varroa Destructor Mites, a small parasitic being that invaded hives and spread exponentially. A pregnant female Varroa Mite would work her way into a hive to the cells where bee pupae were kept. Before the pupae were sealed in to grow, the mite would latch on to a pupa where it would drink fluids from the pupa to sustain herself. She would lay eggs on the pupa, which continued as a source of food for the mother and her children, and the sealed cell would act as protection from other creatures. It is important to note that the pupa would not be killed in this process, only weakened. This is because the mites needed the pupa to chew out of the cell when its development was finished. Otherwise, the mites would be trapped in the cell and die out. After escaping with the weakened pupa, the mites would spread to new cells and their numbers would grow exponentially.

The next important contributor to Colony Collapse Disorder was the continued use of neonicotinoids. The chemical was found in many pesticides and was used in the treating of plant seeds to combat predatory insects and mites. The chemical, similar in composition to nicotine, would spread through a plant's pollen, petals and leaves, lying in wait for a creature to come into contact with it. In such quantities, the substance was relatively harmless to human consumers, but to insects it acted as a powerful nerve agent that would normally disorient their bodies and minds. For bees, coming into contact with the pollen would detrimentally impact their ability to navigate, and would at times lead to the bees getting lost after not being able to locate their hive and their eventual death by elements or predator creatures. In larger quantities, the neonicotinoids could cause immediate death in insects and bees, as the amount of nerve agent was too much for their bodies to handle.

The final contributing factor to CCD that I will be discussing in my journal for the day is mono-cropping and agricultural deserts. In the central plains and western coast of the (former) United States, farmers typically grew one crop over countless swaths of land. Called mono-cropping, the growing of a single type of crop made for easier care, cultivation, and field rotation for the farmers. For the bees, however, such large sections of land dominated by plants such as wheat and soybeans was troublesome. Wheat is pollinated through wind alone and soybeans are one of the aforementioned self-pollinating plants, so bees are left in the lurch. Additionally, because mono-cropping is the cultivation of a single plant, there were generally no flowering plants or plants that required bee cultivation, so any hives within these large ranges of territory were in danger of starvation. Across California, the cultivation of large amounts of almond trees called for the use of roughly thirty percent of all pollinator bees in the (former) United States, so hives would be sent across the country to assist in the pollination of the large amount of crop. During the fall and winter, however, this land became a wasteland for bees, endangering a large percentage of all bees to starvation.

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The birds are chirping, there is a nice cool breeze drifting through the trees, and more importantly the bees are buzzing. Millions of colonies are still flourishing with what appears to be no threat of collapse. However, sometime in the middle of the year a silent killer arose. This silent killer was known as colony collapse disorder, which causes adult bees to simply vanish from their hives leaving behind the queen, immature bees, and even food. In just a couple months, the amount of healthy bee colonies dropped significantly. In the last two years, beekeepers have recorded high levels of colony loss, and in 2020 that number rose to a loss of 100%. Foods like almonds, apples, berries, soybeans, squash, wheat, and other agricultural resources did not make it to market. The bees did not pollinate the plants which consequently became sterile, or non fruit producing. This posed a large threat to the already tepid stability of nature, and to humanity.

Instead of putting a stop to the use of toxic neonicotinoid pesticides which were causing CCD, farmers continued strong use of them deeming it necessary to protect our food supply. It was totally disregarded that we have been poisoning bees with no intention of finding an alternative solution. Rates of collapse were increasing by the day, but use of these pesticides continued. The decision not to alleviate neonicotinoid use was swayed by the fact that crops would be destroyed by pests. So either we continue killing the bees who provide pollination for vital and nutritious food or lose crop production due to pests. The situation was a lose-lose with one loss being greater than the other. Due to the amount of healthy, thriving bees being so high, no predicted disaster was foreseen. Unfortunately this disaster became the reality.

Another contributor to colony collapse was our selfish use of land without taking into consideration the habitats we were disrupting. Urban development and intensive farming greatly diminished habitats that were important for pollination. If a colony loses its habitat, it loses its food source, which is vital for survival. Pre-bee-apocalypse, nearly all wildflower meadows were mowed down, which reduced many pollination habitats including flowers, meadows, trees, and lakes and streams. If we had halted intensive farming and relied more on wildlife to weed out pests, we would not have had to rely on pesticides that contributed to widespread colony collapse as heavily. We basically eradicated these natural solutions to pests and came up with an artificial solution that only made a bad situation worse. Urban infrastructure is another culprit that affected the disappearance of the bee population; 'Green infrastructure' was a fantastic idea, but unfortunately evolved too, the damage was done and no bandaid was going to fix it. The construction of many buildings, towns, and cities we inhabit would not have been possible if not for the devastation of a natural habitats.

The evolution of global climate change undoubtedly contributed to the loss of bees impacting the bees' winter seasonal emergence and nesting behavior. Additionally, bees' reliance on consistent flowering and blooming of plants is crucial for their survival. Climate change impacted the timing of flowering, leading to a need for adaptation of bees. Specific plants could be in bloom at an inconvenient time for the bees as they may not be active yet. This also contributed to a loss of food and nutrients for bees.

When the widespread collapse became evident to the public, panic ensued. Nobody was prepared for such a devastating and sudden loss; there was no plan to initiate in the event of something of this magnitude. News of this extinction was all over the media, and the public had questions and demanded answers. Alternatives to bee pollination were immediately investigated; there are other valuable pollinators, but after losing bees the total amount of pollinators has been diminished. Insects other than bees that provide pollination became extremely important, but the quality and effectiveness of their pollination is less than that of bees. Additionally, taken into

consideration is the natural habitat of pollinators; bees have been moved around in order to provide pollination where we needed it, but this was not previously sustainable, and would not be sustainable for other insects.