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Bees in the Balance

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Bees in the Balance

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Our grocery stores are packed with fresh fruits, vegetables, and nuts—but how do they get there? The answer is bees. Bees and bee-assisted pollination are responsible for almost one third of what we eat, as well as for the growth and reproduction of plant species across the globe (Kaplan, 2011; Shultz, 2007).

We all might know what bees are, but few recognize the magnitude of the importance they play in food production, and the possible losses that could occur if these populations of pollinators were to decline. Three-fourths of all plants depend on some form of pollinator intervention in order to reproduce, and over 90 common food crops—including most fruits, vegetables, nuts, and fibers— depend on bees specifically for pollination (Shultz, 2007; Tenebaum, 2010). Bees play an important role in the agricultural economy as well—their pollination is responsible for 15-20 billion dollars' worth of crops in the United States alone, and they are considered the most economically valuable pollinators worldwide (Johnson, 2010).

This could mean that if the domesticated bees used in agriculture were suddenly to disappear, one could face a bleak scene at the grocery store and on the kitchen table.

Figure 1. A bee in the process of pollination

Like many aspects of modern agriculture, humans have harnessed the role that bees play in food production—adapting bee's natural lifestyles and utilizing their efficiency as pollinators in order to maximize productivity. Bees are now trucked across the nation, shuffled from farm to farm in industrial-sized honeycombs in order to pollinate the nation's plants. While this certainly is not the rustic vision that many of us may have of beekeeping, the fundamentals of bee biology have not changed—being a beekeeper still means being in charge of a highly structured and complex society.

Bees' bodies are fine-tuned to capture pollen, and the bee hive is engineered to make the production of honey as streamlined as possible (Shultz, 2007; University of Georgia, 2011). When bee hives are healthy, they are constant centers of activity. They are filled with workers, non-reproducing females who maintain the health, cleanliness, and structural stability of the hive; drones, male bees who fly from hive to hive in the spring and summertime in order to reproduce; and the queen, the female bee in charge of producing the next generation (University of Georgia, 2011). Most of the activity in the bee colony at any given time is directed towards producing enough honey to survive the winter—when the bees cluster together in the hive in order to conserve heat and energy (University of Georgia, 2011). Winter is the most vulnerable time for bee colonies, when the larvae have begun to hatch and feed, but the new pollination season has not yet begun. However, if all goes well, the bee colony is continually being replenished by new generations of pollinators and producers (Shultz, 2007).

> "Honey bee health has been declining since the 1980s"

Farmers across the country could tell that something was amiss in the winter of 2006 when, instead of seeing fully-stocked hives ready for the next production season, they discovered that their bee populations had declined almost overnight, leaving no clues about where the bees went or what had caused their disappearance. This sudden and mysterious evaporation of the bees was dubbed Colony Collapse Disorder (CCD), and triggered an avalanche of research efforts across the country as scientists and beekeepers struggled to better understand the complex dynamics of bee health. The symptoms of a colony that has collapsed are striking—in the disease's first year beekeepers reported losses of between 30 and 90 percent of their hives (Kaplan, 2011). Within six months of its first appearance, Colony Collapse Disorder had claimed the lives of up to 80 percent of the nation's honeybees, and there was still no clear explanation for the disorder in sight.

Bee losses are not uncommon during the winter, when natural causes such as starvation and pests can cause 15 to 20 percent declines in hive population size (James, 2010). However, the symptoms and virulence of CCD quickly set in apart from other ailments. When bees become sick, they leave the hive to die so as not to endanger their siblings (Shultz, 2007). Thus, sightings of dead bees clustered outside a hive is usually an accurate indicator of illness. However, in the aftermath of CCD, not only were sick and dying bees absent from the areas nearby their hives, but few, if any, adult bees were present inside of the hives. One of the defining symptoms of CCD is a hive that, despite the presence of a queen, young larvae, and honey, seems to have experienced a disappearance of the majority of its adult bee population (Kaplan, 2011; United States Department of Agriculture, 2007). The unusually large magnitude of losses and the absence of direct signs of bee death set CCD apart from other diseases that have plagued bees in the past and left researchers wondering what confluence of factors could have occurred that was capable of wiping out the bees so rapidly.

Honey bee health has been declining since the 1980s

"Yearly losses are still higher than expected"

as new pathogens, pests, and environmental factors have threatened individual and colony health (Kaplan, 2011; Kaplan, 2008; Anderson, Sheehan, Eckholm, Mott & DeGrandi-Hoffman, 2011; Gale Science in Context, 2011). The most common factors used to explain these fluctuations in population size are mites, pesticides, disease, and overall lifestyle changes. The most virulent bee mite is the Varroa, which entered the United States in 1987 (Kaplan, 2011; Tenebaum, 2010). Varroa mites threaten bee populations by sucking out bees' circulatory fluid and spreading viral disease (Tenebaum, 2010). They are very destructive when they attack, capable of wiping out up to half of an entire bee hive (Public Broadcasting Service, 2009). While the mite population has been kept stable with the use of chemicals combined with bee adaptation, mites can still be prevalent in many colonies and in some cases become immune to the chemicals used to exterminate them (PBS, 2009; Tenebaum, 2010).

Unfortunately, the cocktail of chemicals—including those used to kill the Varroa mites—used in and around bee hives may be weakening their immune systems and exposing them to other risks (Tenebaum, 2010). Perhaps the most dangerous chemical threat to bees are the pesticides used on the plants that they pollinate, which may stress their immune systems or cause them to become disorientated and prevent them from returning to their hives (Kaplan, 2011; Shultz, 2007; Tenebaum, 2010). Pesticide use can affect all levels of hive functioning as well, with some kill bees as they are in the process of pollination, whereas other kill bees and larvae after they eat infected pollen (Gale Science in Context, 2011). Even if pesticide use itself is not explicitly harmful to bees, contact with pesticides may stress bee populations enough that they cannot cope with other stressful pathogens and environmental factors (Tenebaum, 2010; Gale Science in Context, 2011).

Figure 2. An example of some of the crops that depend on bees for pollination

One such disease that has potentially been linked with Colony Collapse Disorder is Israeli Acute Paralysis Virus (IAPV) (Tenebaum, 2010). IAPV was first discovered in the United States in 2002, and has since evolved several distinct lineages in California, Maryland, and Pennsylvania (Shultz, 2007). However, the sources of IAPV are a mystery as well. While the disease has also been found in bee populations in Australia and China—both exporters of bees and bee products to the United States—it is unclear how the disease took root in North America (USDA, 2007; Shultz, 2007). Bees are especially vulnerable to viral diseases such as IAPV due to their lifestyle. Bees are very social creatures whose males travel from hive to hive, share

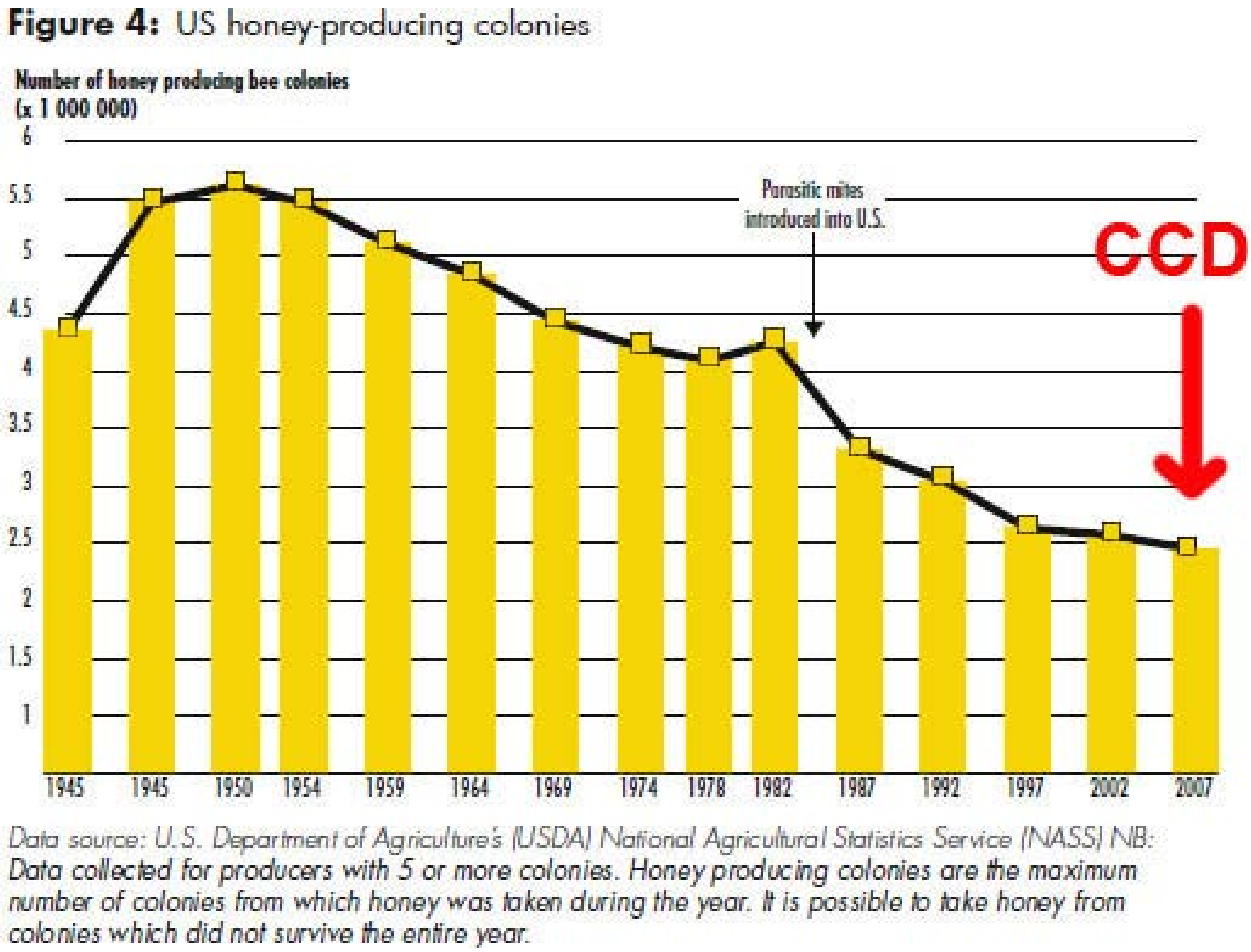

Figure 3. Data showing the number of honey producing bee colonies in the United States over time

numerous environmental niches, and use communal food supplies—all practices that promote the transmission of parasites and disease (Anderson, Sheehan, Eckholm, Mott & DeGrandi-Hoffman, 2011).

However, there are some artificially imposed components of the honey bee's lifestyle that increase their vulnerability to colony collapse as well. Commercially-reared honey bees are exposed to transportation-induced stress as they are trucked

across the country, often in overcrowded conditions (Kaplan, 2011; Johnson, 2010; Anderson, Sheehan, Eckholm, Mott & DeGrandi-Hoffman, 2011).

Farming practices themselves may also endanger bees. Bees consume pollen for its high protein content, and obtain sugar and amino acids from nectar, which they convert into honey to eat during the winter (Shultz, 2007; Tenebaum, 2010; Lansing State Journal, 2011). In order to have a diverse diet, bees need to pollinate a wide variety of crops. However, the restricted diet imposed by monoculture farming practices can threaten bee health—another factor making them vulnerable to disease (Shultz, 2007; Tenebaum, 2010). The nutritional content of the crops themselves can also have an effect on the promotion of healthy

hives. The exclusive pollination of crops with limited nutritional value or crops that have low levels of nectar or pollen deprive bees of valuable nutrients (Kaplan, 2011; Johnson, 2010).

The more scientists learn about the complex chemical and environmental interactions occurring in and around bee hives, the more they conclude that CCD is more likely to be caused by a confluence of many factors (Tenebaum, 2010; Johnson, 2010). This means that controlling the disease, and promoting bee health in general, will require a profound understanding of how bees interact with the different biotic and abiotic components of their environment. However, preliminary research efforts—combined with a natural decline in the virulence of the disease—are demonstrating that hope may be on the horizon. Since CCD's first appearance in 2006 the bee population has begun to rebound, but yearly losses are still higher than expected (PBS, 2009; James, 2010). The efforts of beekeepers and researchers may be playing a role. In order to help revive their damaged colonies, beekeepers are adapting another of the bees native biological processes-swarming—and using it to split healthy colonies (James, 2010). This practice takes advantage of bees' natural tendencies to divide their colonies once they reach a certain capacity in order to increase the total number of healthy hives.

These practices, along with long-term research should help bring the bees back from the brink of danger and help prevent future episodes of widespread colony collapse. Some possible solutions, such as reducing pesticide use or reducing its toxicity and changing the chemicals used to control mite populations, have already been suggested and may help stabilize the bee population for future generations (Gale Science in Context, 2011). If scientists are unable to understand the effects that lead to widespread bee death, the losses to agriculture and plant diversity could be enormous, showing that even civilizations of tiny insects can have a profound effect on the world around us.

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