



Colony collapse disorder in honeybees & contemporary suggestions for its origin



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Background of honeybees

The three main parts of a honeybee are a head, thorax, and abdomen:

- Head: contains compound eyes, antennae, and feeding structures.
- Thorax: contains hind and forewings, legs, and muscles involved in movement.
- Abdomen: consists of seven segments and contains female reproductive organs in the queen, male reproductive organs in the drone, and the stinger in both workers and queen.

Honey bees, also known as *Apis mellifera*, are social creatures and live within colonies with a queen, thousands of female workers and a few male drones. The adult bees collect flower pollen to make honey and store it for the cold winter when flowers are scarce. Worker bees communicate with other worker bees, conveying information about the type of nearby nectar source, distance and direction from the hive using "dances". They also communicate within the colony using sound, queen pheromones and alarm pheromones.

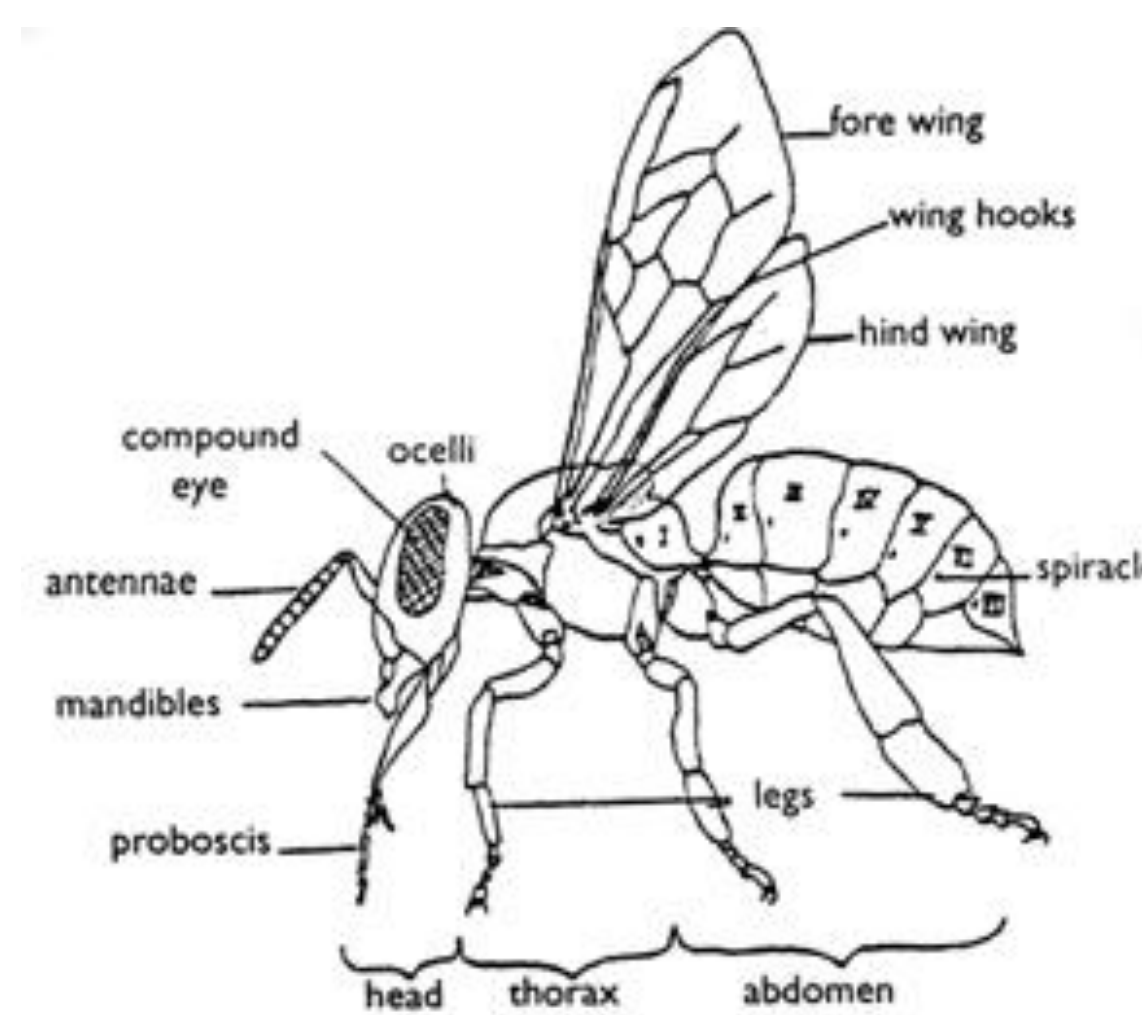


Figure 1. The anatomy of the *A. mellifera*, also known as the Western or European honeybee.

Background of CCD

In the US the *A. mellifera* is the primary pollinator of all crops; however, in recent decades this bee species has dramatically declined in population size. Colony Collapse Disorder (CCD) was discovered in 2006 as beekeepers observed their seemingly healthy bee hives suddenly were abandoned without any apparent reason. All the adult bees simply vanished, causing a total collapse of the bee colony.

CCD currently represents a huge concern for beekeepers and farmers who rely on these little creatures for pollination of crops. It is simple; without honeybees fruits, nuts, field crops and vegetables will not grow as these plants require pollination to set fruit. Already, the United States has lost nearly one third of all honeybee colonies.

Various theories on the causation of CCD include:

- Pesticide exposure.
- Invasive parasitic mites.
- New immune-targeting diseases.
- Stresses from beekeeping practices.

Honeybee Decline

Colony collapse disorder (CCD) has affected at least half of all U.S. commercial honeybee colonies. Honeybees pollinate more than \$15 billion in crops each year in the U.S.



Symptoms of CCD

- Failure to return to hive; no evidence of dead bodies
- Rapid losses and in large numbers
- Queen bee and adequate food supplies are left behind
- Insects and predators don't immediately invade abandoned hive

Types of bees in colonies

Worker • Infertile female; clean hive, nurse feeding larvae, guard hive	Drone • Male, no stinger; task is to mate with the queen, die shortly after mating	Queen • Fertile female, only one in each colony; function is to lay eggs
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Source: Mid-Atlantic Apiculture Research and Extension Consortium MCT

Pesticides

Certain commonly used pesticides have been suggested as the cause of CCD; specifically a linkage to a class of pesticides called neonicotinoids. The most widely used of these in the US is imidacloprid. It is used as a seed coat and can show up in plant tissues (pollen and nectar) in low doses. Ultimately, the concern of using imidacloprid does not lie in the relative toxicity level, but rather in the long-term chronic effects that it may have on honeybees. One of the principal effects of imidacloprid on honeybees is a loss of learning ability (Decourtye, Lacassie, and Pham-Delegue 2003). Learning ability in bees is considered critical for the hive to continue thriving (Stankus 2008). The use of neonicotinoid pesticides varies widely by region, but the occurrence of CCD is fairly uniform.

Table 1: Usage of neonicotinoids on outdoor and indoor crops for commercial use, total active substance treated area (ha) (this figure is calculated by multiplying the basic areas by the number of times the area is treated), although registered for use in the UK there is no information on the use of acetamiprid as survey data was collected prior to acetamiprid products being approved for use in the UK

	2000	2001	2002	2003	2004	2005	2006
Imidacloprid	346,813	347,058	540,207	540,546	777,890	783,054	770,053
Clothianidin							43,224
Fipronil				87	87	562	562
Thiacloprid		51	5,934	6,154	8,980	9,338	14,636
Thiamethoxam						1,213	1,213

Table 2: Usage of neonicotinoids on outdoor and indoor crops, total weight applied (kg)³

	2000	2001	2002	2003	2004	2005	2006
Imidacloprid	25,404	26,562	30,216	30,486	41,031	43,916	82,254
Clothianidin							5,980
Fipronil				52	52	124	124
Thiacloprid		5.6	682	790	1,165	1,213	1,677
Thiamethoxam						5.4	5.4

Stress

Stress compromises the immune system of social insects and may disrupt their social system, making colonies more vulnerable to disease.

These stresses could include:

- High levels of infection by the varroa mite
- Poor nutrition due to overcrowding of the beehive.
- Pollination of crops with low nutritional value
- Exposure to limited or contaminated water supplies.
- Migratory/transportation stress because of increased needs for pollination.

Disease

There are two mites that significantly impact the honeybee. They are *Varroa destructor* and *Acarapis woodi*. *A. woodi* is a very small mite that lives in the tracheal tubes of the adult worker. It is also associated with additional bacterial infections (Stankus 2008). *V. destructor* is by far the more important mite and more strongly associated with CCD. *V. destructor* is a mite that primarily infects the brood while it is still capped off in the comb. When out of the comb such as when the colony is overwintering and there is no brood left the mite infests the adult worker bee piercing the exoskeleton on the back and sucking hemolymph (Bowen-Walker, Martin, and Gunn 1996). Infestation by *V. destructor* affects bee size, weight, population, time of emergence, lifespan and the learning ability. (Stankus 2008).

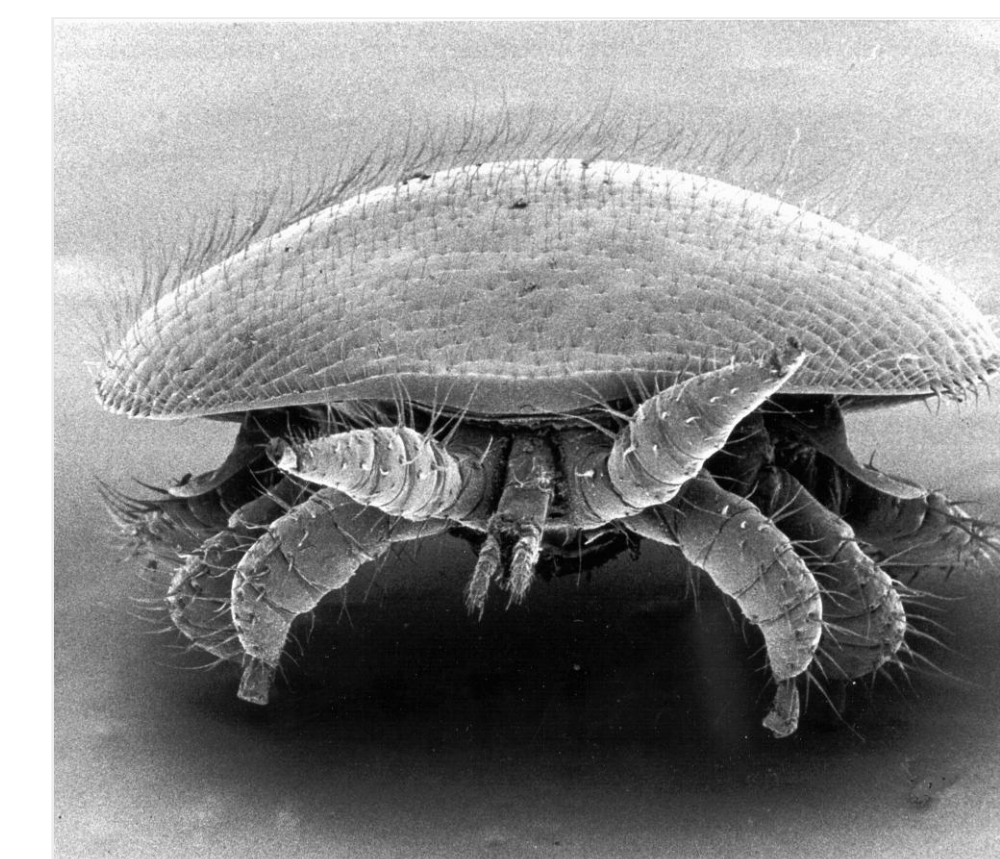


Figure 2. *Varroa destructor* is small mite that has spread throughout the world. It became one of the most infamous pests in recent beekeeping history.

Viruses affecting honeybees are more diverse; at least 15 serious strains exist. Strongly associated with *Varroa* mite infestation is deformed wing virus (DWV). DWV is usually spread by the mites to developing larvae who develop small non-functional wings. The resulting adult can crawl but not fly. It has also been shown that the learning ability of bees may be affected (Stankus 2008).

A 2007 study looked at samples from 51 separate colonies, all of them mobile. In all 25 hives suffering from CCD they found Israeli acute paralysis virus (IAPV) and they found the virus in only one healthy hive. This strongly correlates IAPV with CCD (Cox-Foster, Conlan, Holmes, et al.); however, the causal relationship of IAPV to CCD is currently under study (Cox-Foster 2008).

Conclusion

Clearly, CCD is an important disease. It is currently a major area of study across the world. At this point we are just beginning to understand the possible mitigating factors to CCD and how they may interplay with each other. The coming few years will likely be hard ones on the beehive and agricultural industries. While the current research has proven somewhat daunting, there is an interesting twist to this story: organic beekeeping movement has faced far fewer problems with collapsing beehives than strictly commercial ones.

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For further information

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