Disappearing Honey bees (*Apis mellifera*) in the Anthropocene

Spring 2014

Kaitlin Keenan

Introduction- Why honey bees?

- Honey bees began disappearing
  - Not necessarily dying
- Widespread colony loss
  - United States and Europe
- Causes?
- Ecological importance
  - Pollination
- Threats, conservation measures

Figure 1. Honey bee approaching flower. Available: www.idahohoneybee.com

Inside the Hive

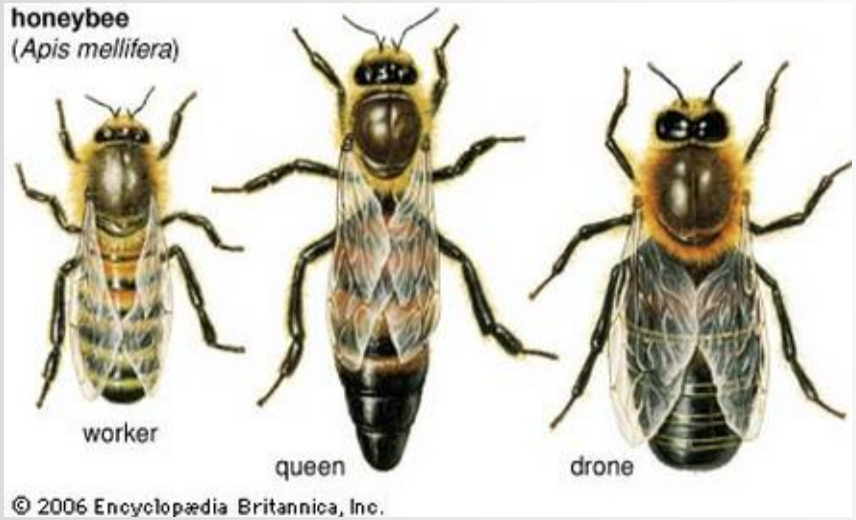

Figure 2. The worker, queen, and drone bees – difference in body type. Available: www.britannica.com

- A nest of 80,000 bees!
- Honey bees are social
  - Females - Workers
  - The queen – only sexually developed female
  - Males – Reproduction

Outside the Hive

Figure 3. Outside development of a honey bee hive. Available: stpeterealestateblog.com

What Makes them so Important?

- Vastly important to ecosystem health.
- Critical importance to the human diet.
  - 80 percent of our flowering crops
  - 33.3 percent of everything we eat (USDA, 2012).
- Dietary staples
  - Apples, broccoli, strawberries, nuts, asparagus, blueberries and cucumbers
- Alfalfa → Beef and dairy
- Economic impact
  - $20-30 Billion annually

Importance - continued

Figure 5. Red clover. Available: www.herrinhs.org

- Global food crops – 87
- Other insects cannot make up for the loss
  - Red clover (*Trifolium pratense*)
- Pollination services – Not just honey!
  - Majority to agriculture
- Medicinal purposes – honey bee venom used in drugs that help treat various illness

Table 1. Estimated Value of the Honey Bee to U.S. Crop Production, by Major Crop Category, 2000 Estimates

Crop Category (ranked by share of honey bee pollinator value)	Dependence on Insect Pollination	Proportion of Pollinators That Are Honey Bees	Value Attributed to Honey Bees[a] ($ millions)	Major Producing States[b]
Alfalfa, hay & seed	100%	60%	4,654.2	CA, SD, ID, WI
Apples	100%	90%	1,352.3	WA, NY, MI, PA
Almonds	100%	100%	959.2	CA
Citrus	20% - 80%	10% - 90%	834.1	CA, FL, AZ, TX
Cotton (lint & seed)	20%	80%	857.7	TX, AR, GA, MS
Soybeans	10%	50%	824.5	IA, IL, MN, IN
Onions	100%	90%	661.7	TX, GA, CA, AZ
Broccoli	100%	90%	435.4	CA
Carrots	100%	90%	420.7	CA, TX
Sunflower	100%	90%	409.9	ND, SD
Cantaloupe/honeydew	80%	90%	350.9	CA, WI, MN, WA
Other fruits & nuts[c]	10% - 90%	10% - 90%	1,633.4	—
Other vegetables/melons[d]	70% - 100%	10% - 90%	1,099.2	—
Other field crops[e]	10% - 100%	20% - 90%	70.4	—
Total	—	—	**$14,563.6**	—

Source: Compiled by CRS using values reported in Morse, R.A., and N.W. Calderone, *The Value of Honey Bees as Pollinators of U.S. Crops in 2000*, March 2000, Cornell University, at [http://www.masterbeekeeper.org/pdf/pollination.pdf].

Figure 4. Honey bee crop value. Available: cornell.edu

Threats – What's causing this?

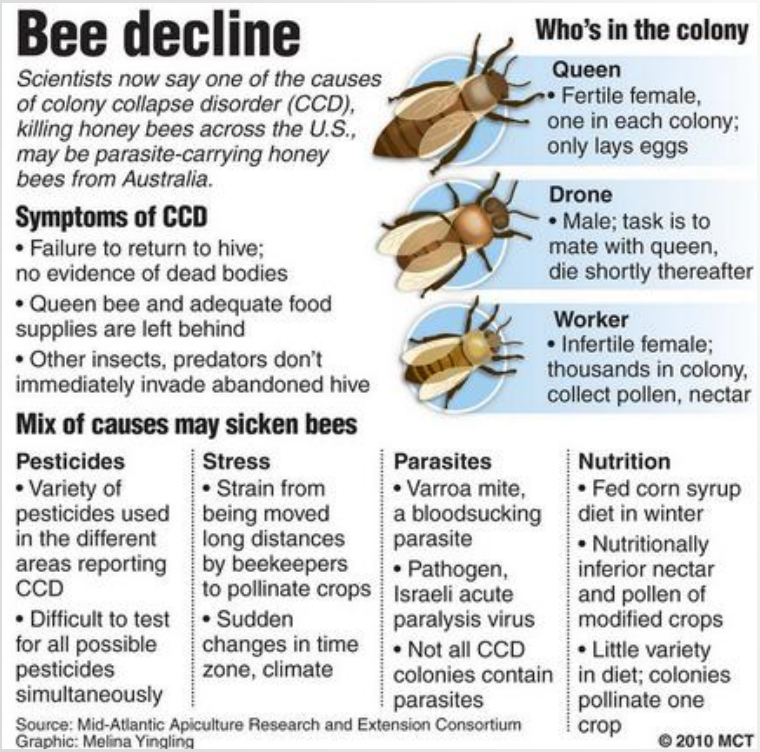

Figure 6. Causes of bee decline. Available: occupymonsanto.wordpress.com

- Colony collapse disorder – 2006
- Parasitic Varroa mite (*Varroa destructor)*
  - Deformed Wing Virus (DWV)
- Pesticides – Herbicides used on crops
- Nutrition – More susceptible to disease and parasites
- Genetic diversity
- Climate change
- Radiation

Colony Collapse Disorder (CCD)

- Main symptom of CCD: Very low or no adult honey bees present in hive (workers disappear)
  - A live queen
  - No dead honey bee bodies present
  - Still honey in the hive
  - Immature bees (brood) are present → unusual
  - *Varroa* mites, a virus-transmitting parasite of honey bees, have frequently been found in hives hit by CCD.
- Not the first time
  - Disappearances in the 1880s, the 1920s, and the 1960s.
  - No way to know if they are related.

Life cycle of the Varroa mite

- It is not known if the Varroa mites are directly involved or if the viruses that Varroa mites transmit (similar to the way mosquitoes transmit the malaria virus) are causing CCD (Kaplan, 2013).

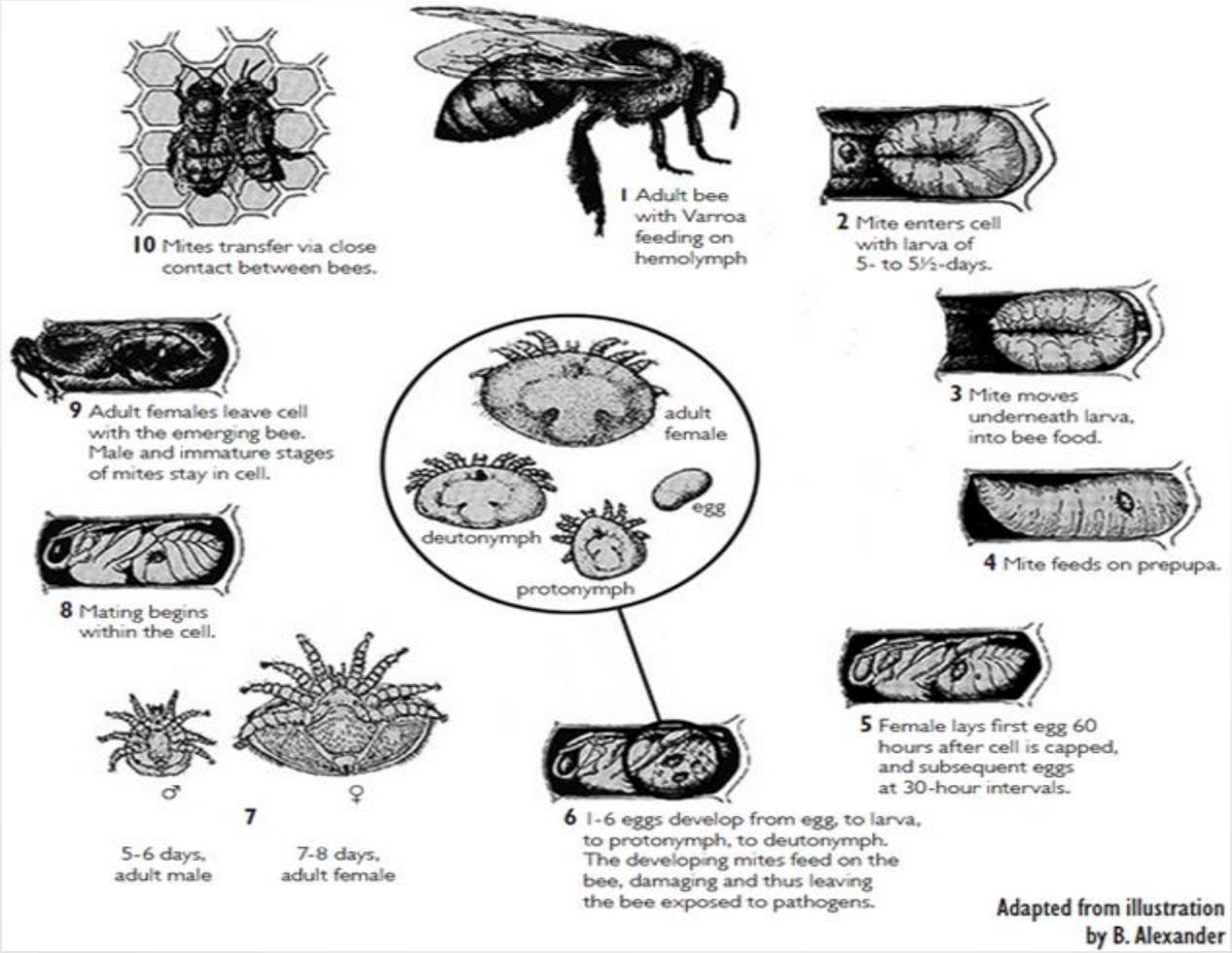

Figure 7. Life cycle of the Varroa mite on honey bees. Available: www.extension.org

Deformed Wing Virus (DWV)

Figure 8. Unhealthy honey bee with a mite infestation and DWV. Available: www.sweetbeez.org

Figure 9. Example of a healthy honey bee. Available: www.care2.com

Pesticide Usage

- Increasing use of chemical pesticides and herbicides
  - Ingest during their daily pollination rounds.
- Commercial beehives subjected to direct chemical fumigation at regular intervals
  - Wards off destructive mites.
- GMOs
  - Generate pollen with compromised nutritional value from genetically modified crops?
- Chemicals, fumigation, and GMOs→"tipping point"
  - Stress to point of collapse
- Organic colonies
  - Not experiencing the same CCD (according to the non-profit Organic Consumers Association).

Nutritional Stress

- Less nutrition = more susceptible to disease
  - Carbohydrates → Sugars in nectar/ honey
  - Protein → Pollen
- Contributing to CCD
  - Well nourished = less susceptible to *Nosema ceranae* (parasite) than poorly nourished bees.
  - States with the largest areas of open land have significantly higher honey production.
    - Habitat loss affecting honey bee
    - Correlation between CCD and states ratio of open land relative to developed areas

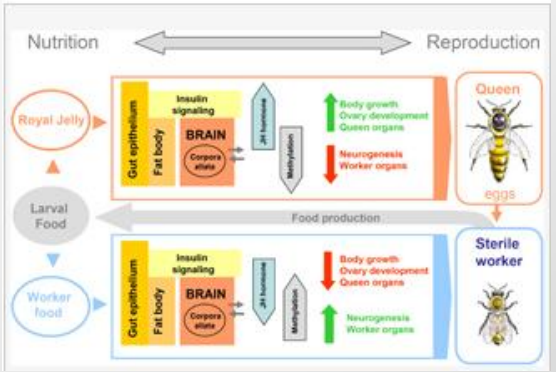

Figure 10. Honey bee nutrition. Available: www.biotechniques.com

Genetic Diversity

- Enormously important
- High number of mates for the Queen bee
  - Increased diversity of worker genotypes within a colony, which has been shown empirically to present significant adaptive advantages that result in higher colony productivity and survival.
- Diversity improves (USDA, 2012):
  - Thermo-regulation
  - Disease resistance
  - Worker productivity

Climate Change

- Exaggerating the growth rates of pathogens
  - Mites, viruses and fungi that are known to take their toll on bee colonies.
- Unusual hot-and-cold winter weather fluctuations in recent years
  - Accustomed to more consistent seasonal weather patterns.
- Plants blooming at different times → Affecting synchrony (genetic/env. cues) between bees and plants?

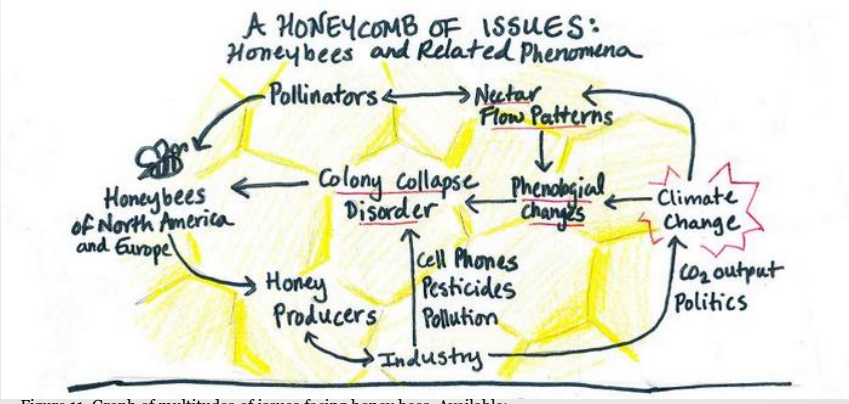

Figure 11. Graph of multitudes of issues facing honey bees. Available: biol315honeybees2012amina.blogspot.com

Increased Radiation

Figure 12. Are cell phones killing honey bees? Available: www.1800mobiles.com

- Increases in atmospheric electromagnetic radiation
- Growing numbers of cell phones and wireless communication towers
- The increased radiation given off by such devices may interfere with bees' ability to navigate.
- Germany's Landau University found that bees would not return to their hives when mobile phones were placed nearby.
- Further research is currently underway.

Honeybee losses in the United States

- More than half our bees
  - 1940's = 5.9 million colonies
  - Today → 2.5 million
- Increasing need for pollination services
  - Human populations
- Pathogens, pests, and mites
  - Transportation and extra stress
- Annual losses from the winter of 2006-2011 averaged about 33 percent each year
  - 1/3 → CCD
- The winter of 2011-2012 was an exception, when total losses dropped to 22 percent
  - Consistent 2-3 years necessary
  - Warmer winters

CCD Research – Pathogens and Parasites

- *Nosema* (pathogenic gut fungi), Israeli Acute Paralysis Virus, DWV, Varroa mites
  - Possible causes of CCD.
- U.S. Agricultural Research Service (ARS) research → no one pathogen of any class directly correlates with the majority of CCD incidents
- A higher total pathogen load of viruses and bacteria correlates with CCD than any one specific pathogen (Kaplan, 2013).

CCD Research – Environmental and Management stressors

- Management stressors
  - Poor nutrition
  - Apiary crowing and increased migratory stress (transportation)
- Environmental stressors
  - Pollen and nectar scarcity
    - Low nutritional value
    - Compromised value – Lethal or sub-level pesticide usage
  - Limited access to water
- → No “smoking gun”. ARS Researchers have concluded that no one factor is the cause of CCD. Most likely, CCD is caused by multiple factors.

Conservation needs

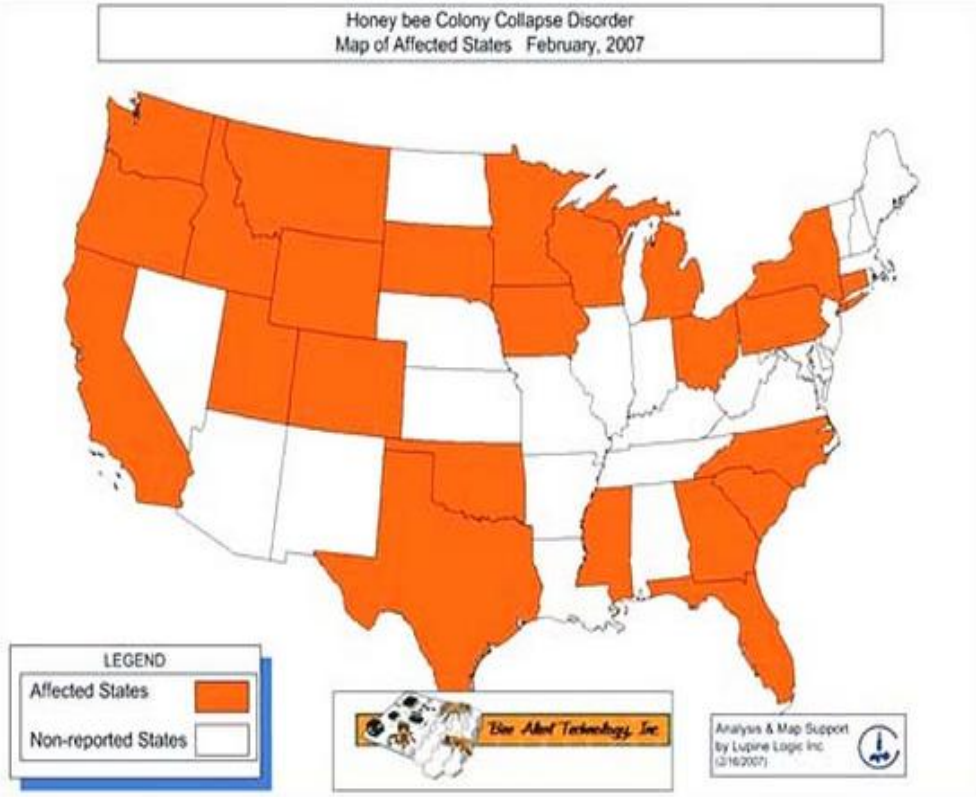

Figure 13. Map of U.S. states affected by CCD. Available: www.treehugger.com

Federal and state efforts

- Actions to maximize nutritional foraging for honeybees
- Protect bees from pesticide-treated fields (USDA, 2012).

Time and money

- Politicized decisions → lengthy process
- Increased collaboration needed
  - Governments, scientists, beekeepers, and others who are directly related to this conservation issue.

Research and communication→ Bee richness and abundance

- Accurate and timely reporting,
- Monitoring, and enforcement of policies (USDA, 2012).
- Continued research in order to develop definite threats and reason for population declines.

Conclusion

- Conservation and restoration measures are rarely simple
  - Complex problem → Combination of stressors
  - State and government agencies, along with researchers, beekeepers, farmers, politicians and the public need to work together to find a viable solution to this challenge
- Dire effects on ecosystems worldwide that are reliant on their pollination.
  - If the population's demands are not met we will likely see the affects cascade through ecosystems, putting dismal constraints on food production.
- This challenge serves as an example of the possible results environmental degradation and shifting climates may have on species worldwide.

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