Bees: Background and Biology

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Bee or Wasp

- Bees and wasps have a common ancestor, but the bee lineage diverged ~100 million years ago.
- Bees
  - Rounder, hairier body
  - Hairy legs
  - Feed exclusively on pollen and nectar
- Wasps
  - Body more slender and smooth
  - Legs have few hairs
  - Sometimes feed on nectar, but also predators or parasites of other insects, or scavengers

Wasps

Western Yellowjacket

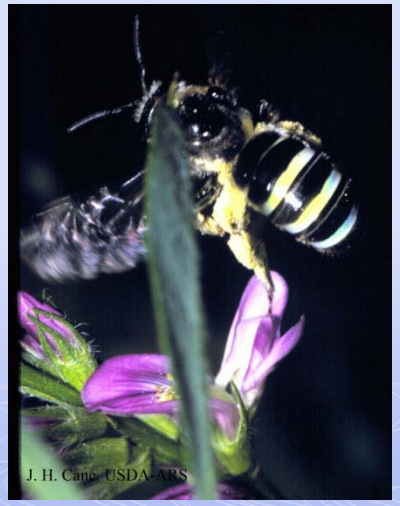
Bald-faced Hornet

Paper Wasps

Bees

Honey Bee

Bumble Bee



Alkali Bee

Alfalfa Leafcutting Bee

Importance of Bees

- Pollination
  - 75% of flowering plants require animal pollination.
    - 2/3 of crops
  - In 2000, $20 billion in N. A. agricultural production depended on bee pollination.
- Products
  - Honey
  - Wax
  - Royal jelly
  - Pollen
  - Propolis

	% Dependance on insects for pollination	Annual Value of Pollinator Services ($ millions)
FRUITS		
apples	100%	$1,502.60
almonds	100%	$959.20
cranberries	100%	$294.90
cherries	90%	$257.22
peaches	60%	$255.60
avocados	100%	$254.60
grapefruit	80%	$237.92
blueberries	100%	$151.30
VEGETABLES		
onion	100%	$735.30
carrots	100%	$467.50
cauliflower	100%	$233.50
squash	90%	$216.45
FIELD CROPS		
alfalfa	100%	$7,756.90
soybeans	10%	$1,649.07
cotton	20%	$1,072.14

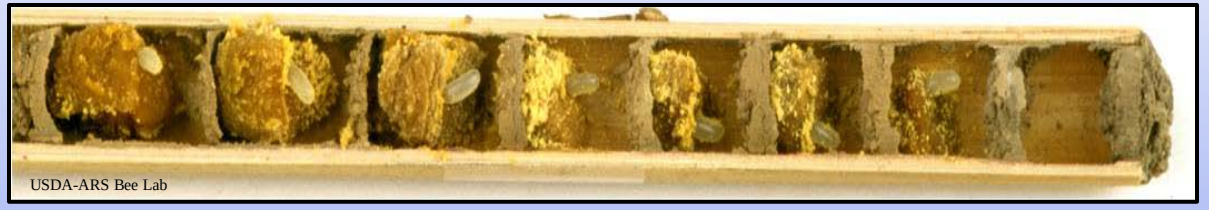
Bees

- ~19,000 named species worldwide
  - 30,000 species projected
- Most of these are solitary bees.
- ~900 species native to Utah.
  - Most in Utah are solitary; bumble bees and sweat bees are exceptions.

Comparison of Social Systems

- Blue Orchard Bee (solitary)
  - Live less than a year.
    - Active for a brief period.
  - Each female builds a nest and lays eggs.
  - Female never interacts with offspring.


USDA-ARS Bee Lab


USDA-ARS Bee Lab

Comparison of Social Systems

- Bumble Bee (social)
  - Queen builds nest in spring, lays first eggs.
  - First workers take over nest maintenance, brood care, foraging, etc.
  - In the fall, next year's queens are created.
    - Rest of colony dies.

Comparison of Social Systems: Honey Bees

- Considered “highly social.”
- Queen can live for multiple years.
  - Functions are reproduction and colony cohesion.
- Workers do all colony maintenance, brood care, protection, foraging, etc.
- Drones only purpose is mating.
- New queens produced when current queen ages or when colony is ready to split.

Brief History of Honey Bees

- Bees date back ~100 million years ago.
- Ancestor was probably a sphecid wasp.
  - Bees evolved specializations for pollen collection and consumption.
  - Bee evolution coincides with evolution of flowering plants.
- Honey bees evolved at least 40 million years ago.
  - Early evolution of social behavior
  - Little change in 30 million years
- Genus Apis: 5 species
  - *Apis mellifera*, *A. dorsata*, *A. laboriosa*, *A. cerana*, *A. florea*

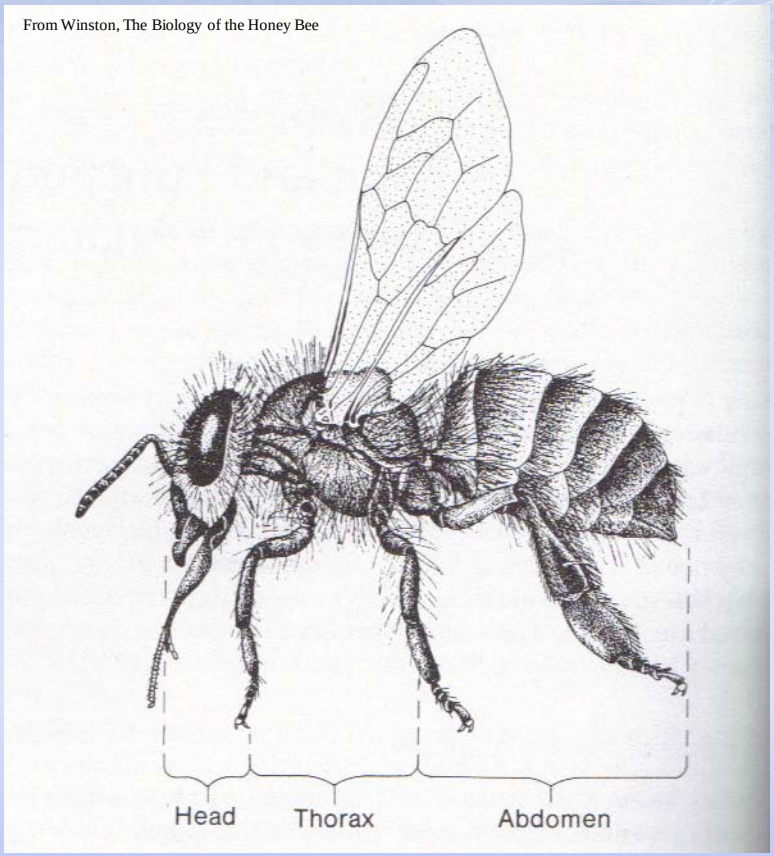
Natural Distribution of Honey Bees

From Winston, The Biology of the Honey Bee

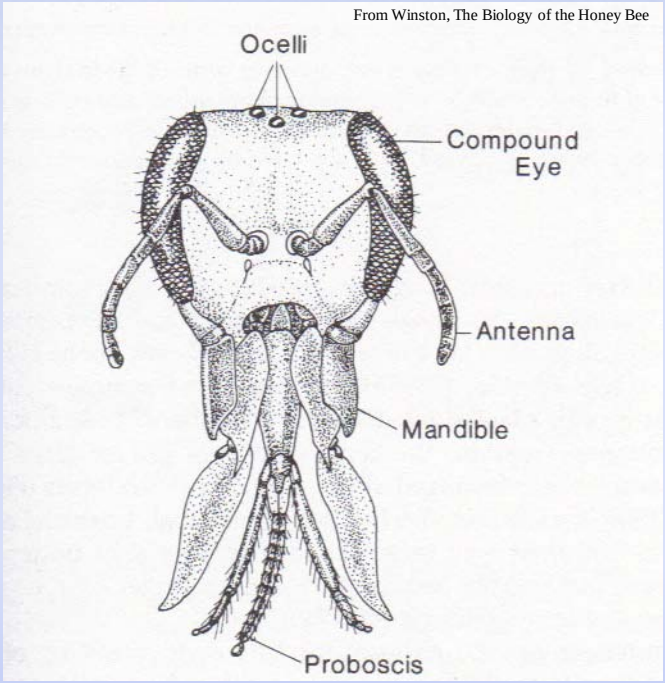
At least twenty different races (subspecies) across Africa, Europe, and western Asia.

Form & Function

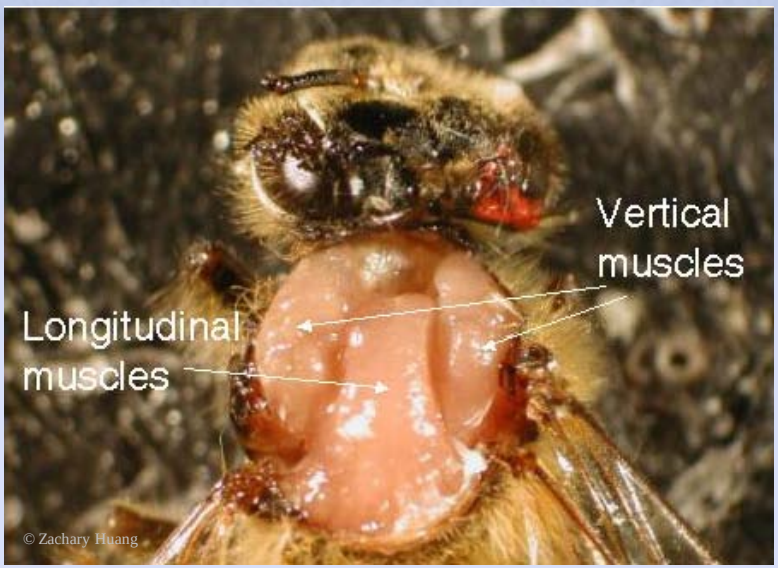
- Head
  - Eyes
  - Antennae
  - Mouthparts
- Thorax
  - Legs
  - Wings
- Abdomen
  - Sting
  - Internal systems

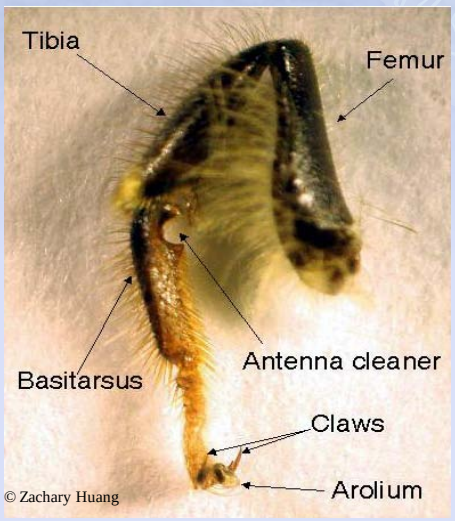


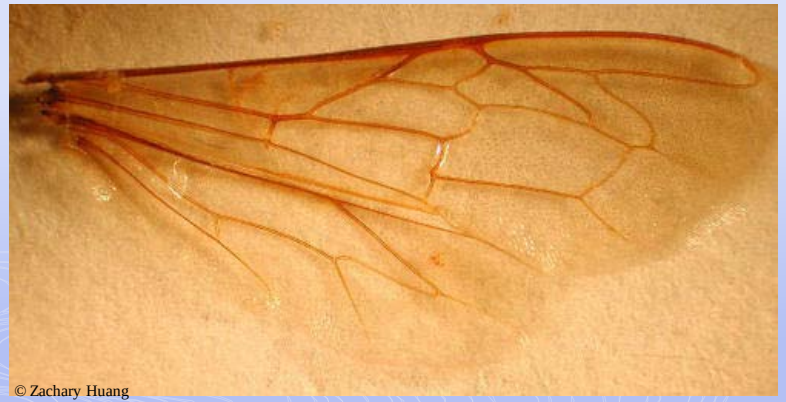
Form & Function: Head

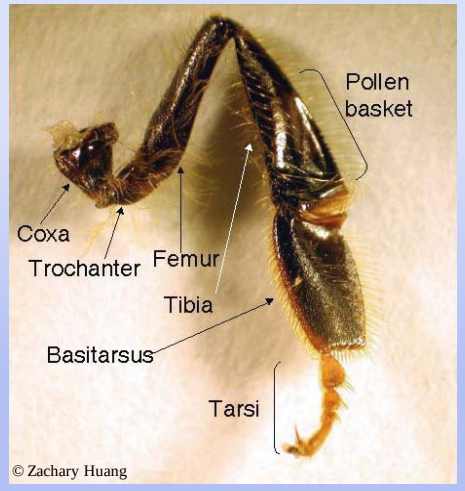


Form & Function: Thorax

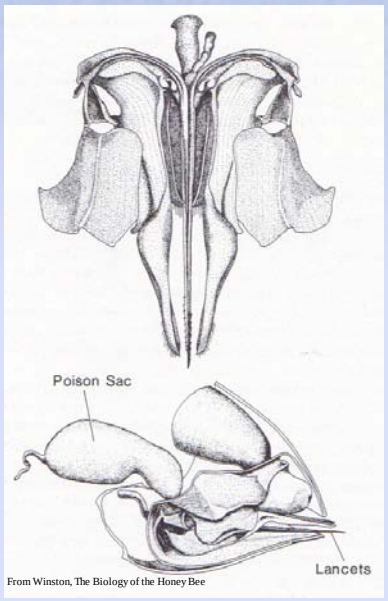


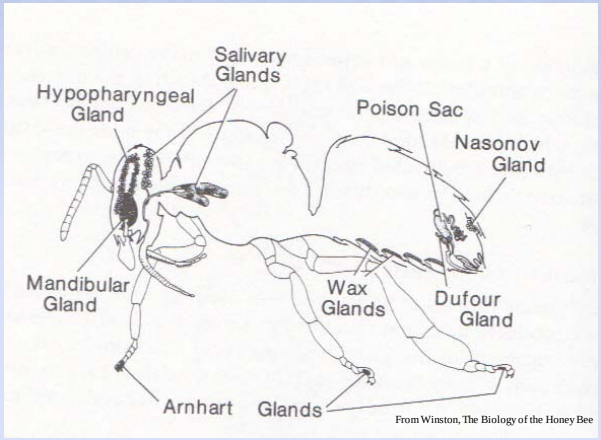




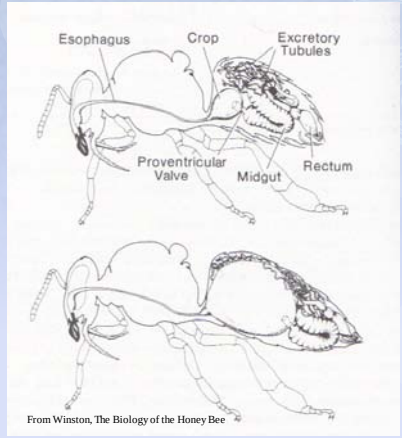


Form & Function: Abdomen



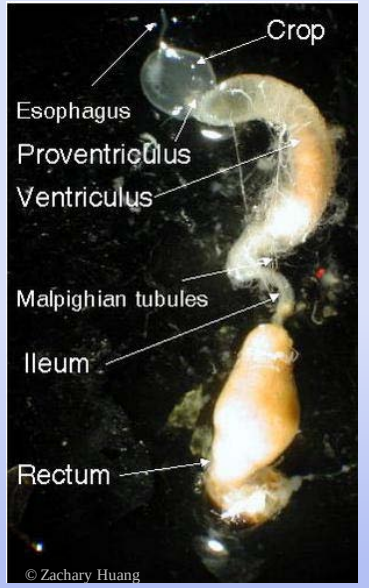


Glandular System



Sting

Wax Glands



Digestive System

Life Cycle

egg

larva

pupa

adult

Sex Determination

- Queens can control the sex of their offspring.
  - Unfertilized eggs become drones.
  - Fertilized eggs become females (workers or queens).

worker drone queen

Castes

- Dependent on nutrition.
  - Queens receive royal jelly.
    - Royal jelly is produced by glands on workers' heads.
  - Workers receive royal jelly followed by nectar & pollen.

Summary of Bee Development (in days)			
Brood Stage	**Queen**	**Worker**	**Drone**
Egg	3 (fertilized)	3 (fertilized)	3 (unfertilized)
Larva	5.5 (royal jelly)	6 (rj + nectar/pollen)	6.5 (rj + nectar/pollen)
Pupa (capped)	7	12	14.5
Total	**16**	**21**	**24**

Table adapted from MAAREC, Basic Bee Biology for Beekeepers

Worker Life Cycle

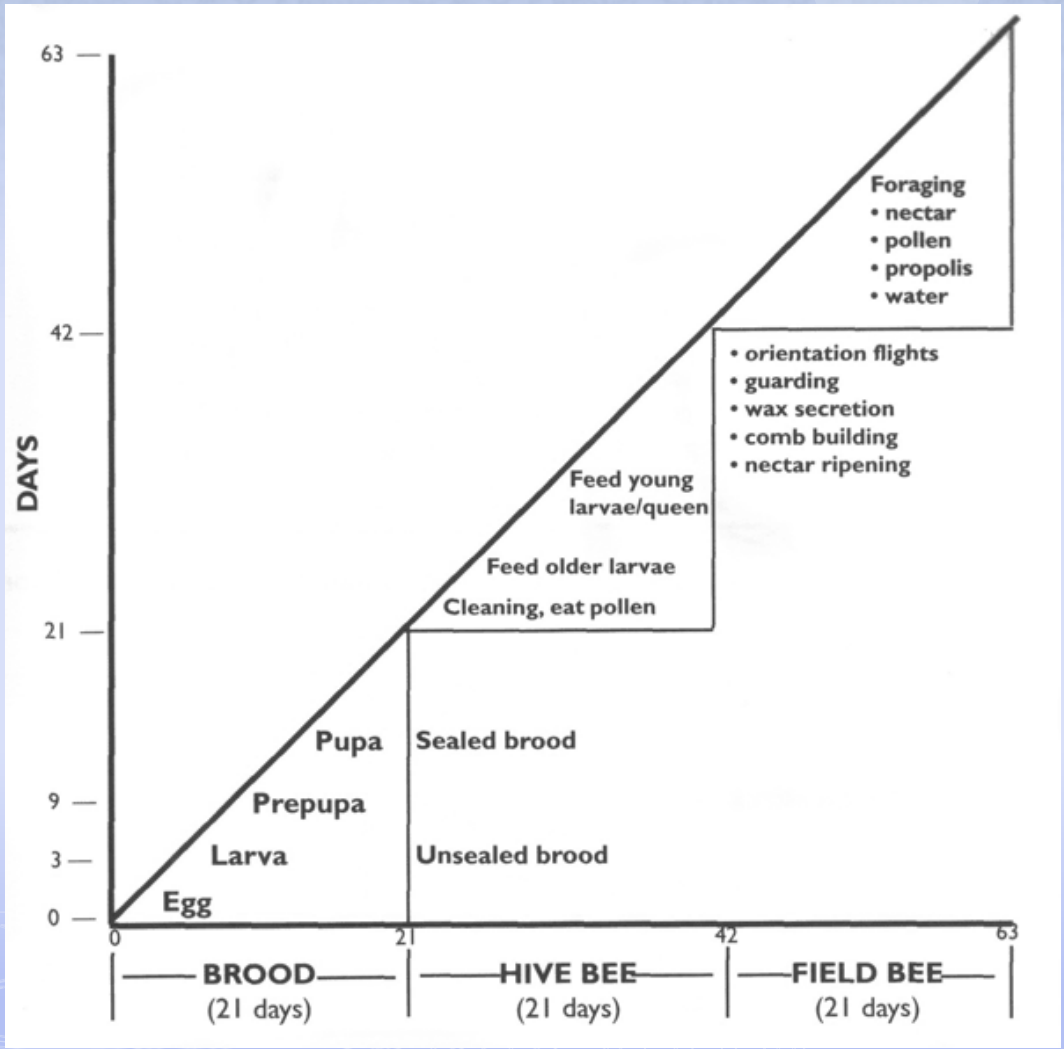


Figure from USDA

Age-related activities

- First 2 days:
  - cell cleaning
- 3-10 days:
  - queen care
  - nursing (feeding young)
  - wax work
- 15-20 days:
  - wax work
  - nectar processing
  - guarding
  - undertaking
- 21-35 days
  - foraging (water, nectar, pollen, propolis)
  - colony defense (soldiering)

Adapted from cyberbee.net

In-hive tasks first, progress toward riskier tasks.

Nest Design

- Cavity sealed with propolis.
- Parallel combs separated by bee space (3/8”).
- Three types of cells, but majority are worker cells (also used for food storage).

From Delaplane, First Lessons in Beekeeping

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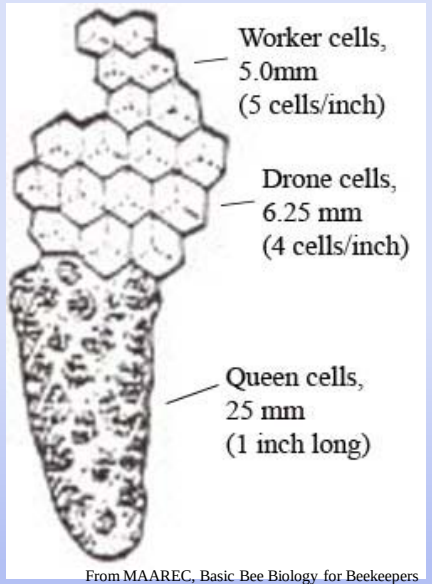


From MAAREC, Basic Bee Biology for Beekeepers

Communication & Orientation: Workers

- Alarm pheromones
  - Mostly from mandibular glands
  - Production increases as bee ages.
  - Major role in colony defense
  - May be masked by smoke.
- Nasonov (scent) gland
  - Orientation to home, food, water
- Dance Language
  - Communicates direction and distance of resources (food, water, potential new home, etc.)

Communication & Orientation: Queen Pheromones

- Mandibular gland secretions
  - Responsible for:
    - Inhibition of rearing of replacement queens
    - Sex attraction
    - Swarm stabilization
    - Stimulation of foraging, brood rearing, and queen care
  - Workers disperse this over queen's body during grooming.
  - Workers pick up by antennal contact with queen and spread throughout colony via food transmission.

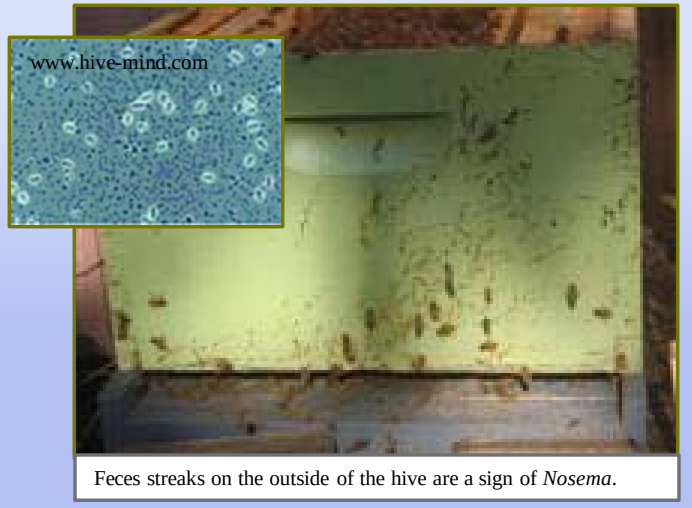
Reproduction

- New queens go on mating flights.
  - Mate with multiple drones.
  - Store enough sperm for a lifetime of reproduction.
- Drones mate once, then die.
  - Drones that don't mate are evicted from the colony.
- Colony-level reproduction = swarming

Honey Bee Losses

- Parasitic mites
  - Varroa
  - Tracheal
- Queen failure
- Diseases
  - Nosema apis and N. ceranae (microsporidia)
  - Viruses
    - Deformed Wing Virus (DWV)
    - Israeli Acute Paralysis Virus (IAPV)
  - American foulbrood
- Nutrition problems
- Pesticide exposure
- Poor hive management
- Colony Collapse Disorder

Varroa mite on honey bee



Feces streaks on the outside of the hive are a sign of *Nosema*.

Honey Bee Losses

- Since 1869, 18 discrete episodes of unusually high colony mortality documented internationally
- Colonies in decline since 1940's
- Losses have increased since introduction of tracheal and Varroa mites in 1980's
- Colony Collapse Disorder first recognized in 2006-2007
  - 1/3 losses attributed to Colony Collapse Disorder
- Managed and feral colonies affected

Current Research Highlights
CCD Descriptive Study

- CCD is either contagious or results from exposure to a common risk factor.
- Secondary co-infections, high virus loads
  - Either exposed to more pathogens or immunodeficient
- N. ceraneae not a major contributor.
- IAPV not highly correlated with CCD.

vanEngelsdorp D, Evans JD, Saegerman C, Mullin C, Haubruge E, et al. (2009) Colony Collapse Disorder: A Descriptive Study. PLoS ONE 4(8): e6481.doi:10.1371/journal.pone.0006481

Honey Bee Losses
CCD Steering Committee Report

- Research to determine causes:
  - Sublethal effects of two common miticides (fluvinate, coumaphos)
  - Synergistic effect of pesticides (neonicotinoids, fungicides, surfactants, miticides)
  - Confirmed links between poor colony health and inadequate diet and long distance transportation

Honey Bee Losses
CCD Steering Committee Report

- Research on control methods and preventative measures:
  - ARS Area-wide Project on Honey Bee Health
  - CSREES-funded Cooperative Agricultural Project (CAP)
  - Key accomplishments to date:
    - Varroa mite resistant bee stocks
    - Comb irradiation to reduce pathogen levels
    - Alternative pollinators
  - Progress being made toward:
    - New pest and pathogen detection capabilities
    - IPM strategies for controlling Varroa mites
    - Comprehensive Best Management Practices for beekeepers

Resources

- Colony Collapse Disorder Progress Report, CCD Steering Committee, June 2009
  - www.extension.org/mediawiki/files/c/c7/CCDReport2009.pdf
- Managed Pollinator Coordinated Agricultural Project
  - www.beeccdcap.uga.edu/
- USDA National Agricultural Library
  - http://riley.nal.usda.gov/nal_display/index.php?info_center=8&tax_level=2&tax_subject=10&want_id=1322&topic_id=1006

Resources

- eXtension.org's Bee Health Community
  - http://www.extension.org/bee%20health
- Mid-Atlantic Apiculture Research and Extension Consortium
  - http://maarec.cas.psu.edu/
- *The Biology of the Honey Bee*, Mark L. Winston
- *First Lessons in Beekeeping*, Keith S. Delaplane
- www.UtahPests.usu.edu
  - Fact sheets, slide shows