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

From Winston, The Biology of the Honey Bee
Form & Function: Head

From Winston, The Biology of the Honey Bee

© Zachary Huang
Form & Function: Thorax

- Vertical muscles
- Longitudinal muscles

- Tibia
- Femur
- Basitarsus
- Antenna cleaner
- Claws
- Arolium

- Pollen basket
- Coxa
- Trochanter
- Femur
- Tibia
- Basitarsus
- Tarsi
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.

<table>
<thead>
<tr>
<th>Brood Stage</th>
<th>Queen</th>
<th>Worker</th>
<th>Drone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egg</td>
<td>3 (fertilized)</td>
<td>3 (fertilized)</td>
<td>3 (unfertilized)</td>
</tr>
<tr>
<td>Larva</td>
<td>5.5 (royal jelly)</td>
<td>6 (rj + nectar/pollen)</td>
<td>6.5 (rj + nectar/pollen)</td>
</tr>
<tr>
<td>Pupa (capped)</td>
<td>7</td>
<td>12</td>
<td>14.5</td>
</tr>
<tr>
<td>Total</td>
<td>16</td>
<td>21</td>
<td>24</td>
</tr>
</tbody>
</table>

Table adapted from MAAREC, Basic Bee Biology for Beekeepers
Worker Life Cycle

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)

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).
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

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
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.

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

- Managed Pollinator Coordinated Agricultural Project
  - www.beeccdcap.uga.edu/

- USDA National Agricultural Library
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