Honey Bee Biology and Health
Clackamas Tree School 2016

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OSU Honey Bee Lab
• Dr. Ramesh Sagili

• Research, Extension, Education, Demonstrations, Field Days . . .
• Bee Informed Partnership

http://honeybeelab.oregonstate.edu/

Natural Resource Management: University of Michigan
Commercial Beekeeper: Western Canada 2013
Oregon State University: 2014–Present

Overview
• Honey Bee Biology and Behavior
• Threats to Honey Bee Health
• The Importance of Honey Bees
• Bee Friendly Practices

??? . . . Yes, Yes, and Yes but you get used to it
What is a Honey Bee?

- **Kingdom** – Animalia
- **Phylum** – Arthropoda
  - **Class** – Insecta
  - **Order** – Hymenoptera
    - **Family** – Apidae
      - **Genus** – Apis
      - **Species** – *Apis mellifera*

*Apis mellifera* = ‘Honey Bearing Bee’
Species of Honey Bees (*Apis spp.*)
All species of Honey Bees originate in the ‘Old World’
- Giant Honey Bee (*A. dorsata*)
- Asian Honey Bee (*A. cerana*)
- European Honey Bee (*A. mellifera*)

Native range of ‘European’ Honey Bee
20+ distinct races of *A. mellifera* with different physical and behavioral traits
- Productivity
- Brood Rearing
- Temperament
- ‘Swarminess’
- Wintering size
- Disease resistance

Imported to America in 1600s

*A. m. Lingustica* – Italians
- Yellow with prominent stripes
- Docile behavior
- Large wintering population
- Extensive brood rearing
- Prolific honey producers

*A. m. Carnica* – Carniolans
- Black or Ashy Grey
- Very Gentle
- More dynamic population
- Early buildup – ‘Swarmy’
- Good honey producers
- Exceptional pollen collection

‘Africanized’ bees-- *A.m. scutellata*
Native to tropical East Africa
26 research colonies, Brazil 1957
Rapid spread through S. + C. America
Present today in southern states

Highly Defensive!!!
Frequent Swarming
Dominant Genetics – Queen Breeding
Changes in Beekeeping Practices
Honey bees are an incredibly complex organism with high specialized behaviors and biology.

A colony consists of 10-50K+ individuals that function as a unit.

‘Hive Mind’

Honey Bees exhibit truly social behavior (Eusociality)

1. Cooperative Brood Rearing

2. Reproductive Division of Labor

3. Multiple Overlapping Generations

The ‘Caste’ of characters

Worker: Infertile Female (Diploid)

Queen: Fertile Female (Diploid)

Drone: Fertile Male (Haploid)

Each caste has a different development cycle

Eggs

The Honey Bee Life Cycle
Worker Bee

- 21 day development
- 4-6 week lifespan
- All non-reproductive colony tasks are carried out by workers
- Temporal Polyethism: Jobs change over lifespan depending on colony needs
- Young bees do ‘in hive’ tasks, older bees work externally

Tasks of the Worker Bee

Drones

- 24 day development
- Very large eyes
- Highly developed flight muscles
- No Sting
- Present spring through autumn
- Only leave colony for orientation and mating flights

Drones

Sole task is reproduction, but . . .

- The phallus breaks off and drone dies shortly after mating
- Drones are evicted from the colony as winter approaches
Queen

- Each Colony has only 1 queen
- She is vital, but not in charge
- Genetically identical to workers (same egg)
- 16 Days from egg to emergence

Queen Development

- Royal jelly has elevated levels of protein and fat
- Diet increases growth rate and size
- Increased nutrition develops the ovaries and glands

Seasonal population dynamics

Colonies size and behavior changes throughout the year in response to day length, environmental conditions and floral resources

Winter Dormancy: Clustering, Queen stops laying
Early Spring: 'Spring turnover', Intense brood rearing, Population building, Drone rearing
Late Spring: Rapid population growth, Foraging, Swarming
Summer: Maximum population, Intense foraging
Autumn: Consolidation, laying slows, foraging tapers off
Late Autumn: 'Winter bees emerge', drones evicted
Colony Reproduction -- Swarming

- Timing influenced by colony health, population, available resources, and environmental conditions
- Typically occurs in spring to early summer
- ~1/2 bees go with existing queen
- Scouts search for new nest site

Swarms are generally very docile

Swarms

- ~1/2 bees remain in hive
- Multiple virgin queens emerges and battle

- 1 virgin survives to mate and head new colony

Colony architecture

Parallel 2-sided combs separated by the ‘bee space’

Hexagon cell pattern = greatest cell to comb ratio
Colony Configuration
Roughly spherical broodnest
Band of pollen surrounding brood
Honey around perimeter
Homeostasis: Maintain 30-35 Celsius

Communication mechanisms
- Pheromones
  - Queen
  - Brood
  - Alarm
  - Homing
  - Dancing

Queen Pheromone
- Induces queen retinue behavior
- Promotes colony morale
- Suppresses desire to raise new queen
- Inhibits the development of worker ovaries (laying workers)

Brood Pheromone
- Stimulates brood feeding behavior
- Promotes pollen foraging
**Homing Pheromone**

- Aids in orientation of workers
- Released from the exposed Nasanov gland
  - Back of honey bee’s abdomen

  ![Nasanov Pheromone](image)

- Particularly prominent after swarming

**Alarm Pheromones**

- Mandibular alarm pheromone
  - 2-heptanone
- Sting gland alarm pheromone
  - Isopentyl acetate

 ![Don’t eat bananas in the bee yard](image)

**The Sting**

**Defensive Behavior**

Bees only sting once
Barbed sting and poison sac detaches
Bees die within a few minutes of stinging

~1 % of the population has anaphylactic reaction to being stung

**Dance Language of the Honey Bee**

- Round dance: food nearby (< 100 m away)
- Waggle dance: food further (> 100 m away)
  - Communicate distance and direction
  - Better food source -> more vigorous waggling
  - Trophallaxis (Giving a taste)
The Waggle Dance

Honey Bee Vision

Bee Magnetism

• Bees ‘+’ charge
• Flowers ‘-’ charge
• They become “attracted” to each other while in close proximity.

What do bees forage for?

• **Pollen**: Provides protein, lipids, minerals
  Essential for larval growth and young bee development

• **Nectar**: Carbohydrate source
  Evaporated and turned into honey

• **Propolis**: ‘Bee glue’ from plant resins
  Structural uses and immune function

• **Water**: colony ventilation and cooling
Foraging stats

• Foraging is the last job of a bee's lifespan (~3 weeks)
• Foraging radius of several miles
• Flight speed up to 25 mph
• A forager can travel over 500 miles in a lifetime
• Foragers carry half their body weight in nectar

Pollen Foraging

• Essential to for brood rearing and healthy young bees
• Stored as ‘bee bread’ in the colony
• Need diversity of flowers for complete nutrition
• Flower ‘fidelity’ during foraging flights

Flower Fidelity

Nectar → Honey

• Nectar is mostly water: 10-40% sugar
• Enzymes breakdown nectar to simple sugars
• Evaporation: fanning by bees
• Capped when <18% moisture content
• Honey will granulate, but it will never spoil
• Honey characteristics vary by floral source
Propolis- ‘Bee Glue’

- Plant resin rich in polyphenols
- Used in the colony to seal cracks and help airflow
- Also important in colony immune system
- ‘Mummification’ of large debris

Questions?

Why are the bees dying???

Bees face a multitude of threats

- Pesticides
- In Hive Chemicals
- Parasites
- Poor Nutrition
- Viruses
- Lack of Genetic Diversity
- Migratory Stress
Varroa Mite
External parasite – visible without microscope
Native to Asian Honey Bee (A. cerana)
Shifted Host to A. mellifera
Arrived in USA in 1987—changed bee industry
Globally present in honeybees around the world . . . Except Australia
Varroa mites are the biggest management challenge facing beekeepers and left untreated result in near 100% colony mortality

Varroa mite biology
• Feed on hemolymph (bee blood)
• 10 day brood cycle in capped cells
• Preferential reproduction in drone brood
• Phoretic on adult bees
• Spread between colonies: Robbing, Drift, Foraging
• Vector of viruses

Viruses
- Deformed Wing
- Chronic Paralysis
- Sacbrood

Nosema
- Gut pathogen of adult honey bees
- Disrupts protein metabolism
- Energetic stressor of adult bees
- Reach highest levels in winter and early spring

Dysentery
**Brood Diseases**

**American Foul Brood (AFB)**
*Paenibacillus* bacteria
Extremely contagious – spores
Antibiotic resistance

**European Foulbrood (EFB)**
*Melissococcus plutonius* bacteria
Associated with environmental and nutritional stress
Not as severe as AFB
May respond to antibiotics

**Pests**
- Small Hive Beetle
- Wax Moth
- Rodents
- Bears

**Beekeeping Chemicals**
Wax is fat soluble as are most chemical . . .
Making honey combs chemical sponges
Beekeepers apply chemicals and antibiotics
Impact of chronic residual exposure is largely unknown
Approximately 1 Billion pounds of pesticides are used annually in US

Bees can’t read

How are bees exposed to pesticides?

- Direct Spray
- Pollen & Nectar
- Wax Residues
- Water Sources?

Pesticides

- Neonicotinoids
- Fungicides
- Herbicides
- Other Insecticides

Bee Kill Incident
Acute Bee Kill

Table 2: Prevalence of Pesticides found in all samples (n=101) analyzed for the National Honey Bee Disease survey

- 8 Fungicides
- 1 Herbicide
- 1 Insecticide
- 3 Miticides
- 13 pesticides detected
- 1 bee bread sample

Average Total Pesticides Detected Per Field By Crop

Poor Nutrition
Floral Diversity VS. Monocrop

**Colony Collapse Disorder (CCD)**
- Colony Collapse Disorder—a *specific condition* in which neither dead or alive adult bees are present in the colony
- Rapid Decline
- Capped brood and food stores, queen are present
- No Robbing Behavior

CCD causes remains largely unknown but *honey bee mortality does not necessarily equal CCD*
Why should you care about bees?

Honey Bees are the backbone of agriculture

1/3 of our food supply is dependent on honey bees for pollination

Courtesy: Dr. Caron

Do you like to eat?

1/3 of our food supply is dependent on honey bees for pollination

http://www.mnn.com
Pollination without bees

Importance of Bee Pollinators

- Bees: critical for food security and functional ecosystem
- Bees pollinate more than 90 different crops
- Managed honey bee colonies in the U.S.: 2.7 million
- Native bees: ~4000 species (U.S.) and 900 in the PNW
- Native bees are subject to many of the same threats as managed honey bees

Value of Bees

~$500 Million in Oregon
~$20 Billion Nationwide
~$216 Billion Worldwide

Major Pollination Routes in the US
1.6 million honey bee colonies employed for almond pollination

**Almond Pollination**

**Honey bee pollination in Oregon**

Major crops dependent on bee pollination:
- Blueberry
- Cherries
- Pear
- Apple
- Cane berries
- Cranberries
- Strawberries
- Clover
- Meadowfoam
- Vegetable seeds

Want to help Bees?

Plant More, Spray Less

Support Beekeepers: Buy Local Honey

What’s good for bees is good for all
Providing forage for bees WILL save them

**Beneficial options**
- Conservation cover
- Hedgerows
- Insectary strips
- Covercropping

“Farm the Best, Conserve the Rest”

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**Examples of some bee friendly plants**

**Trees**: Black locust, tulip tree, basswood.

**Hedgerow plants**: Willow, partridge pea, acacia.

**Flowers for the landowner**: Milkweed, tansy phacelia, clover, mustard

**Flowers for the homeowner**: Lavender, borage, rudbeckia, sunflowers.

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**Planting Resources**

[Image of Project Apis m.]

[Image of Xerces Society]
Spraying
- Use active ingredients with least impact on bees,
- Consider formulation,
- Label guidelines only apply to honey bees,
- Don’t spray on plants in bloom,
- Spray at night, when dry and still.

Pest Control
- Organic Approved Pesticides (Damaging)
  - Pyrethrins = VERY toxic to bees
  - Spinosad = VERY toxic to bees
- Less damaging
  - Insecticidal soap
  - Horticultural oil
- Least damaging
  - Insect repellents (e.g. garlic, citrus oils)
  - Kaolin clay
  - Pheromone traps
  - Mating disruptors

- Helpful practices
  - Floating row covers
  - Fruit bagging
  - Crop rotation and diversity
  - Resistant varieties

PNW 591
Publication from OSU Bee Lab
Available free online

Bee Saving Steps you can take...
- Plant a variety of flowers that bloom throughout year
- Consider natives
- Set Mower Height to Leave Clover and Dandelions
- Leave an Area that is Mulch-Free and Wild for Native Bees
- Minimize Chemical Use
Thank You!

Questions?