Honey Bee Diseases and Parasites

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Apis mellifera

Twenty-four different races. None native to US.
Social insects with division of labor among different “castes”
   Eggs, brood, workers, drones, queen
Egg laying, nest maintenance, defense, foraging according to caste
**Apis mellifera**

The most important commercial pollinating insect

Most fruit production dependent on this insect

Pollinate 3.5 million acres worth $14.6 billion per year

Studies show that every $1 spent on bees returns $25 to grower
Pollination

Use smell and vision to find flowers.
Hairy bodies covered in pollen as they sloppily fill corbicula and honey stomach
Structure of flower is adapted to these activities
Moving pollen from anther to stigma results in pollination
Storage

Pollen is brought back to the hive and stored in honeycomb
  The main protein source for brood
Nectar is processed into honey and stored in honeycomb
  Source of carbohydrates for brood and adult bees
Honey

House bees take nectar from foragers and place in honeycomb
Secretions from hypopharyngal glands added to nectar
Enzyme invertase changes sucrose to fructose/glucose
Wing fanning evaporates water
Foraging

Need nectar from 2 million flowers to produce 1 gallon of honey
Visit a wide variety of plants and over 130 different crops
One bee makes 12 or more trips per day and visits several thousand flowers
Factors inside and outside the hive affect activity
Foraging

*Outside*: temperature, wind, rainfall
Activity positively related to temp, negatively related to wind/rain
More foraging occurs near 90°F than 60°F
When windy, bees drop to ground to forage and avoid trees
Avoid wet flowers, even from sprinklers
Foraging

*Inside*: health of the queen, brood, workers

Strong colonies with many bees are the most healthy and active

*Average* hive has 50,000 bees in various stages of development

Colonies with few bees focus on brood rearing, have fewer foragers
Honey Bee Health

Pests, disease, age of queen all affect colony health
Fungi, viruses, protozoa, bacteria, insects, ....
Pests, diseases target specific stages of development
Development

Egg—larva$_1$—larva$_2$—larva$_3$—pupa—adult (3 types)
Development

EGG

- Fertilized (female): ONLY Royal Jelly (queen) during first 3 days as larva.
- Unfertilized (male): SOME Royal Jelly (worker) and drone.
Development

Time to develop varies by caste

All castes take about 3 days as egg and 6 days as larva

Pupal stage varies from 7-15 days depending on the caste

Total time: Queen (16 days), Worker (21 days), Drone (24 days)
Development

The hive environment is kept clean and temperature controlled to promote proper development

Leave the hive to deposit feces, other contaminants

Remove dead and diseased bees
Eggs and Larvae (Brood)

Eggs are laid in the bottom of cells by queen
Larvae c-shaped inside cells then capped at maturity
Pupae develop from mature larvae then molt into adults
Workers

20-60,000 sterile females in a healthy colony
Lifespan of 4-6 weeks in summer and 4-5 months in winter
Division of labor by age and needs of colony leads to three behavioral worker types
Workers

Nurse bees (1-12 days) grooming, feeding brood, cell cleaning
House bees (10-20 days) cleaning, building comb, storing pollen/nectar, guarding hive, controlling temp, undertakers
Field bees (20-40 days) collecting pollen/nectar/water
Drones

Fertile males not involved in nest maintenance activities
Mature 2 weeks after emerge and hang out in mating swarms
Are forced out of hives in late fall to conserve food resources
Die after mating with virgin females
Queen

The only fertile female in the colony
Can lay up to 1,500 eggs a day during height of season!
Produces many pheromones that elicit a response from other bees within the colony
Lifespan of 2-5 years
Parasites and Diseases of Brood

The most devastating diseases affect the brood
Must be identified and treated quickly
Healthy Brood

Uncapped brood will be pearly white and curled in the bottom
Sealed brood will have slightly bulging cap w/ dimple
Caps are all intact and uniform light brown color
American Foulbrood

Bacterial disease of brood caused by *Paenibacillus larvae*

Known as far back as Aristotle (350B.C.)

Vertical and horizontal transmission

Highly resistant spores transmitted in honey by nurse bees

Infect very young brood (<53h) who later die in capped cells
American Foulbrood

Spores germinate in midgut and bacteria massively proliferate to fill the entire digestive tract.

Bacteria penetrate gut lining and burst into organ cavity.

Dead larvae gooey (can pull into rope) then dry to a dark scale.

Infected comb is discolored, smelly, with sunken, punctured caps.
American Foulbrood

Spreads between colonies via robbing, drifting bees, swarming, exchanging hive materials, combining colonies

Spores penetrate the wood of frames and supers

Colonies should be destroyed by burning or lye immersion
American Foulbrood

Terramycin used as a preventative feeding treatment 3x annually
  Mixed with powdered sugar and sprinkled over frames
  No treatment is considered 100% effective
  Reservoirs of spores in feral colonies and old equipment
European Foulbrood

Bacterial disease of brood caused by *Melissococcus pluton*
Recognized as different from AFB in the 1800’s
Transmitted in honey by nurse bees
Infests very young brood who die BEFORE cells are capped
European Foulbrood

Bacteria proliferate in gut but do not penetrate body cavity
Consume food in gut so larva dies from starvation
Larvae appear twisted along sides or bottom of cells, turn yellow,
then a brown rubbery scale

Rotten odor as with AFB but not gooey like AFB
European Foulbrood

Exposed, dry, scaly larvae are easily removed by bees
Otherwise healthy colonies usually survive
Terramycin (antibiotic) used as a preventative
Commensal bacterium being tested as a biological control
Chalkbrood

Fungal disease caused by *Ascosphaera apis*
Recognized since early 1900’s and found in CA in 1968
Spores eaten by brood who die after cell capped
Dead brood have dry, fluffy, cotton-like appearance
Chalkbrood

Dead brood removed by workers and left at hive entrance
Spores later brought back into hive on pollen
More common in spring and often disappears in summer
No available treatments for control
Sacbrood

A disease caused by the virus *Morator aetotulus*
Usually affects only a few scattered brood in the hive
Brood form watery sac and die shortly after cell is capped
Head of infected larva lifted toward top of cell like a canoe
Sacbrood

Caps of cells appear broken, sunken as in AFB
No chemotherapeutic recommendations
Requeening with resistant varieties to maintain strong colony
Small Hive Beetle

*Aethina tumida*

Predator of brood that also scavenges on pollen/comb in hive

Originally from Africa arrived in US in 1998

Adults emerge from the soil and lay eggs in hive
Small Hive Beetle

Damages honey and comb when defecates in hive
Mature larvae leave hive and pupate in soil
Soil insecticide treatments used as control strategy
Parasites and Diseases of Pupae
Varroa mite

A small mite *Varroa jacobsoni* historically found on *A. cerana*
Moved onto *A. mellifera* in eastern Russia and spread worldwide
Feeds on the hemolymph of bees in closed cells and adults
May cause malformation of legs, wings, body segments
Varroa mite

Female enters open cell of mature larva to hide--prefer drones

After cell is capped feeds and lays eggs on pupa

Development, mating occur inside cell

Females attach to emerging bees’ thorax later invade new cells
Varroa mite

Considered the most serious pest of honeybees worldwide. Hard to detect when in low numbers, screened bottom helps.

Apistan (fluvalinate) is the only legal material used in the US.

Treating with antibiotic terramycin seems to help.
Parasites and Diseases of Adults

Adult bees seldom get sick
Most don’t live long enough for incubation of diseases
Nosema

Fungal disease of adults caused by *Nosema apis*

Obtained from infected food or water

Invades the digestive tract of workers, drones, queens
Nosema

Inhibits digestion and causes dysentery
Infected bees defecate inside and on exterior of hive
Inhibits glands that make brood food and royal jelly
Egg production in queens slows down
Nosema

Organism always present and infects 20-30% of hives normally
Becomes a problem when bees unable to leave hive
More common after periods of stress (transport)
Nosema

Identification requires dissection to see spores in gut tissue, and chalky/milky white and swollen gut

Treatment consists of using fumigillin (Fumidil-B) in syrup
Colony Collapse Disorder

First reported in December 2006 in Pennsylvania
Hives strong then suddenly only queen and a few young workers
Lack of dead bees in or around the colony
Plenty of honey and pollen but delay in robbing or pest invasion
Colony Collapse Disorder

No single cause identified yet
Research looking at several potential causes
Especially considering *Nosema ceranae*
Nutritional health or stress of colonies may be associated
Colony Collapse Disorder

Israeli Acute Paralysis Virus is being considered
Was found in 96% of collapsed hives but also a few healthy
Considering the pesticide imidicloprid
Countries where outlawed still dealing with CCD
Tracheal mite

Very small parasitic mite *Acarapis woodi*
Attaches inside trachea and feeds on hemolymph of adult bees
Causes damaged/obstructed trachea and flight muscle atrophy
Lowers flight efficiency and reduces thermoregulatory ability
Tracheal mite

Female mite crawls into spiracle of adult bee < 4 days old
Female feeds and lays a few eggs in spiracles
Offspring hatch develop, mate, migrate out of spiracle onto hairs
Female mites crawl into spiracles of other young bees
Tracheal mite

Widespread throughout N.America and Europe
Identification possible only by dissection/examination of trachea
Treatment using menthol packets in overwintering hives
Wax Moth

Medium-sized drab miller-type moth *Galleria melonella*
Fall season threat to stored comb in frost-free conditions
   Lays eggs on the outside of hives
Small, newly hatched larvae enter hive through cracks
Tunnel throughout comb making cocoons and silken mess
Bee Louse

A wingless fly *Braula coeca*

Hitch rides on thorax of bees but not attached
Do not feed on the bee itself but steal their food
Lay eggs in cappings and larvae tunnel under cappings
No real damage or treatment recommended
Other Pests

Skunks, bears, mice
Ants, termites
Pesticides

Bees are very susceptible to many kinds of pesticides
Kill rates vary above normal die off of 100 bees/day
Low toxicity = 200-400 bees/day
Moderate toxicity = 500-1000 bees/day
High toxicity = >1000 bees/day
Pesticides

Several toxic active ingredients, most highly toxic

azimphos methyl, carbaryl, esfenvalerate

A few are relatively non-toxic (2,4-D, aldicarb)

Formulations affect toxicity as well as active ingredient

Dust or microencapsulated are more toxic than spray solution
Dr. Maryann Frazier of Penn State

2008 studies examining beehives for pesticide residues

“What we have found in terms of pesticides is really unprecedented. We have found high levels of pesticides in the wax, in the pollen, and in the bees themselves—beyond the level that was expected when the chemicals were introduced and approved for use. In a total of 108 pollen samples analyzed, 46 different pesticides were identified. We’ve found as many as seventeen different pesticides in one pollen sample from one colony. We’ve identified as many as twenty-four pesticides in one sample of bees. And then there’s the issue of the interactions of these chemicals—things the manufacturers are not required to test.”
Symptoms of Pesticide Poisoning

Sudden reduction in activity at hive entrance while interior activity appears normal may indicate fast-acting toxin.

Large number of dead bees at hive entrance that have been expelled by house bees indicates a slow-acting toxin.
What are the options?

Cooperation between beekeeping organization and farmers
Legal recourse, compensation if large number affected
Small beekeepers can realistically only identify source and prevent future contamination
Anticipate applications and protect bees accordingly
Pesticide Protections

Place hives on hilltops to minimize exposure to drift
Check for bee activity and don’t apply when flying
Mow attractive ground blooming flowers before treating
Don’t drain pesticides into standing water or leave puddles
Move hives before spraying or cover with wet burlap prior to spraying and keep covered for 2-3 days
Pesticide Protections

Don’t apply systemic pesticides before bloom
Don’t spray during bloom (Carbaryl as a bloom thinner is toxic)
Use less toxic formulations like granules, solutions, emulsifiable concentrates instead of more toxic microencapsulateds, dusts, or wettable powders
If using highly toxic insecticides, keep bees out for 48-72h
Hive Strength

Common recommendation for disease is to keep hive strong
Get disease because it’s weak or get weak because of disease?
Beekeeper tactics have goal of increasing strength of hives
Must regularly evaluate hive strength
Evaluating Hive Strength

How do you know if you have healthy number of bees?

Need method to evaluate number of bees indirectly during pollination season
Evaluating Hive Strength

Inspect at least 10% of hives periodically
Look for: egg laying queen, large numbers of workers, empty supers on top for honey storage
Weak colonies have small numbers of bees, usually grouped together, and mostly located on central frames
Evaluating Hive Strength

Count bees entering hive entrances on a sunny day
DON’T stand in front of the hive entrance
At least a dozen bees should be seen at any one time (15 sec)
Look at the pollen loads on the bees’ hind legs
Evaluating Hive Strength

While wearing protective equipment, inspect the inside of hives. When top inner cover is lifted, there should be dozens of bees. When top super is lifted, there should be hundreds of bees between frames in both supers.
Evaluating Hive Strength

When frames are removed, you should see brood, pollen, honey and many bees on the frames.

During pollination season you want 9-10 frames of bees with at least 5 frames of brood and brood covering >50% of the frame.

Hundreds of bees should be on frames with brood.
Summary

Honeybees are our most important pollinator. Many kinds of pathogens, parasites, predators affect most stages of bee development. Strong hives are important to maintain health. Pesticide contamination always a threat.
The Bottom Line

Strong colonies with good, laying queens and room to store honey will be the healthiest, and the best pollinators.
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