

# Honey Bee Diseases and Parasites

Dr. Richard Houseman/Assoc Professor of Entomology/University of Missouri

# *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

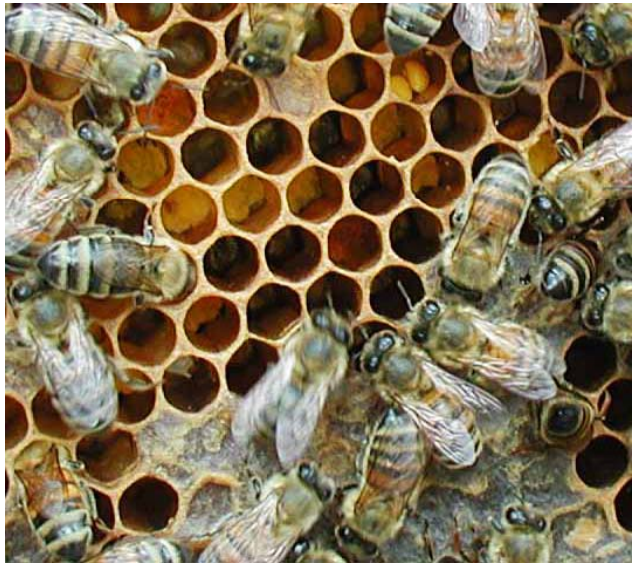
# *Apis mellifera*

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

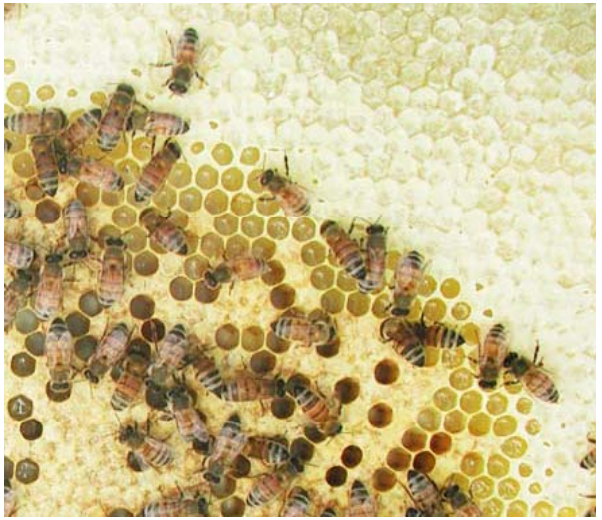
# Storage

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 hypopharyngeal 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$^{o}$F than 60$^{o}$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

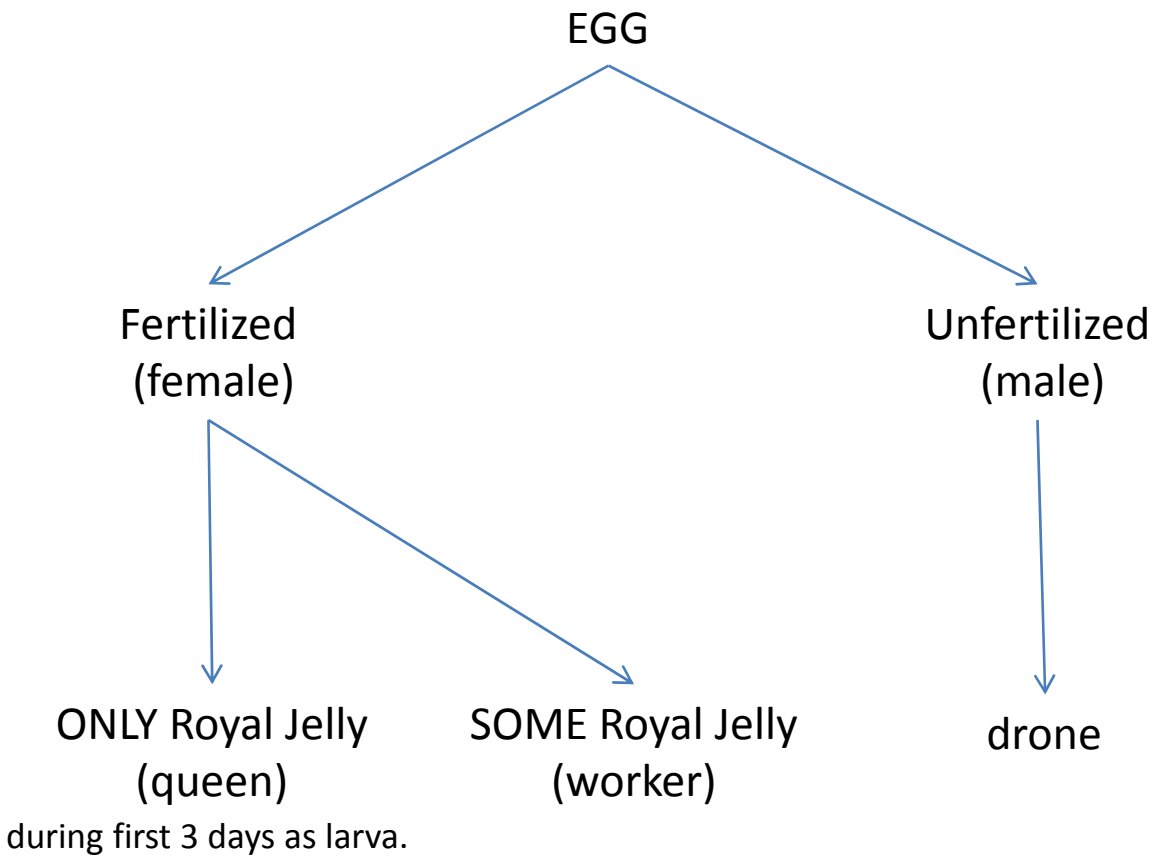
Fungi, viruses, protozoa, bacteria, insects, ….

Pests, diseases target specific stages of development

# Development

Egg—$larva_1$—$larva_2$—$larva_3$—pupa—adult (3types)

# Development



# 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

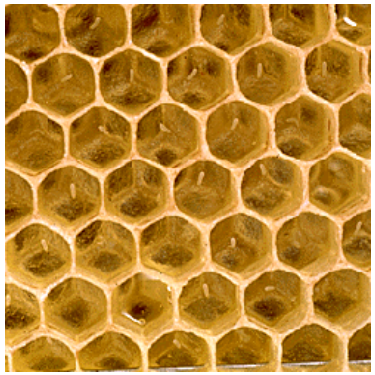
Remove dead and diseased bees

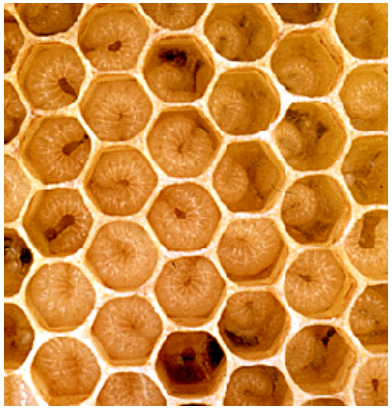
# Eggs and Larvae (Brood)

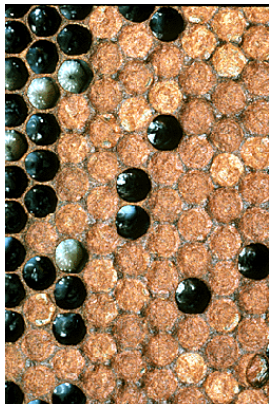
Eggs are laid in the bottom of cells by queen

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 transmisson

Highly resistant spores transmitted in honey by nurse bees

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

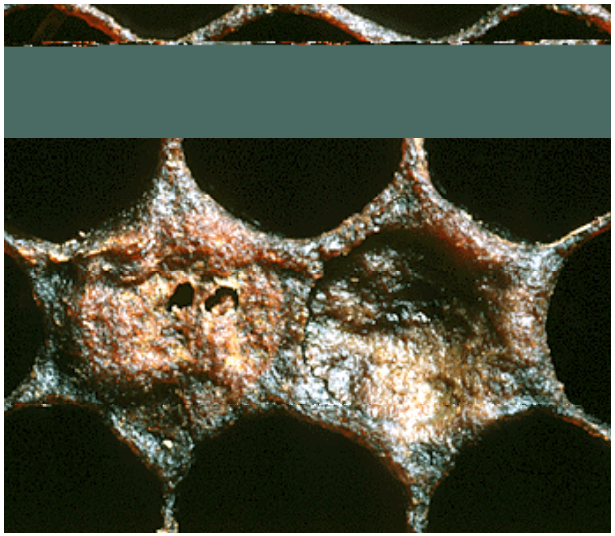
# American Foulbrood

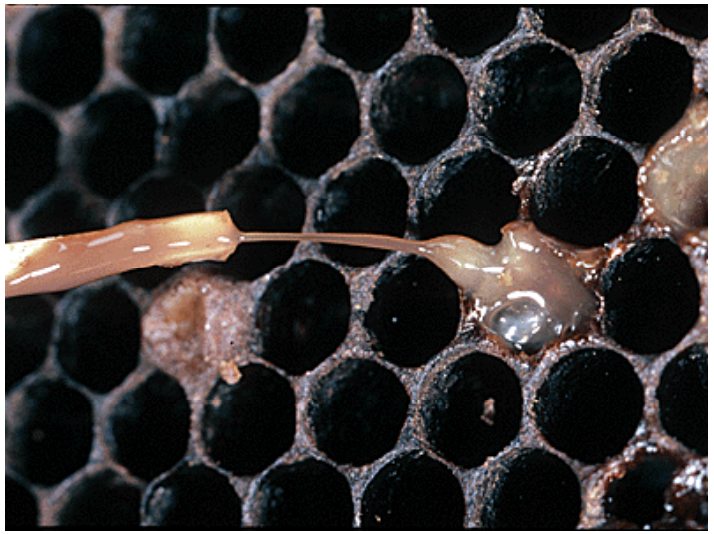
Spores germinate in midgut and bacteria massively proliferate to fill the entire digestive tract

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

Infects 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

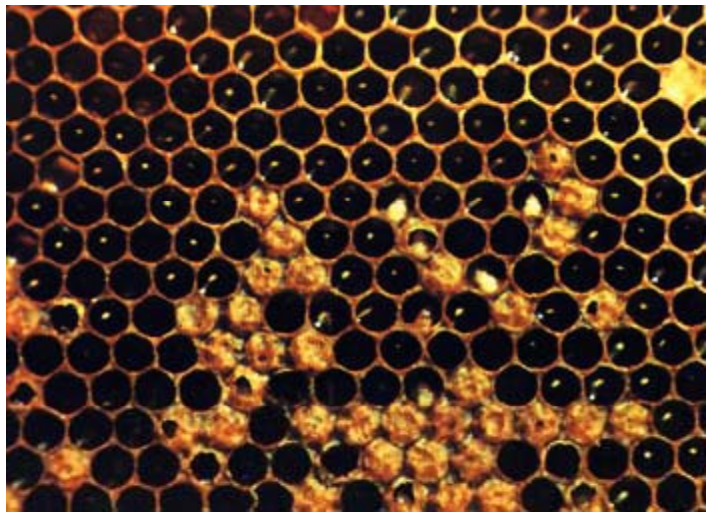
Head of infected larva lifted toward top of cell like a canoe

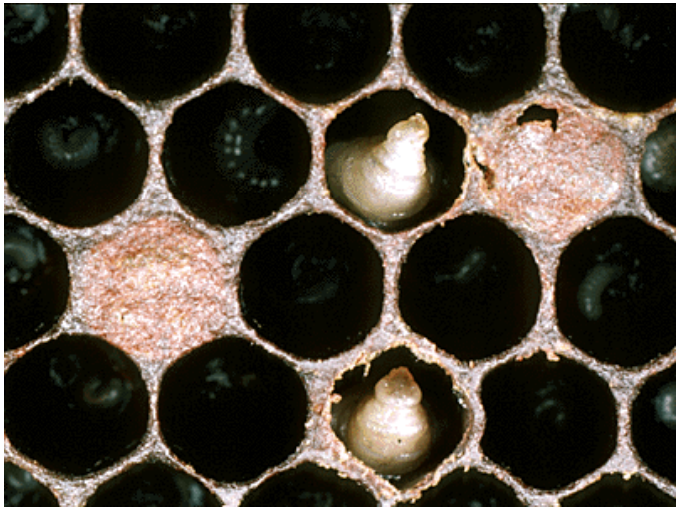
# Sacbrood

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

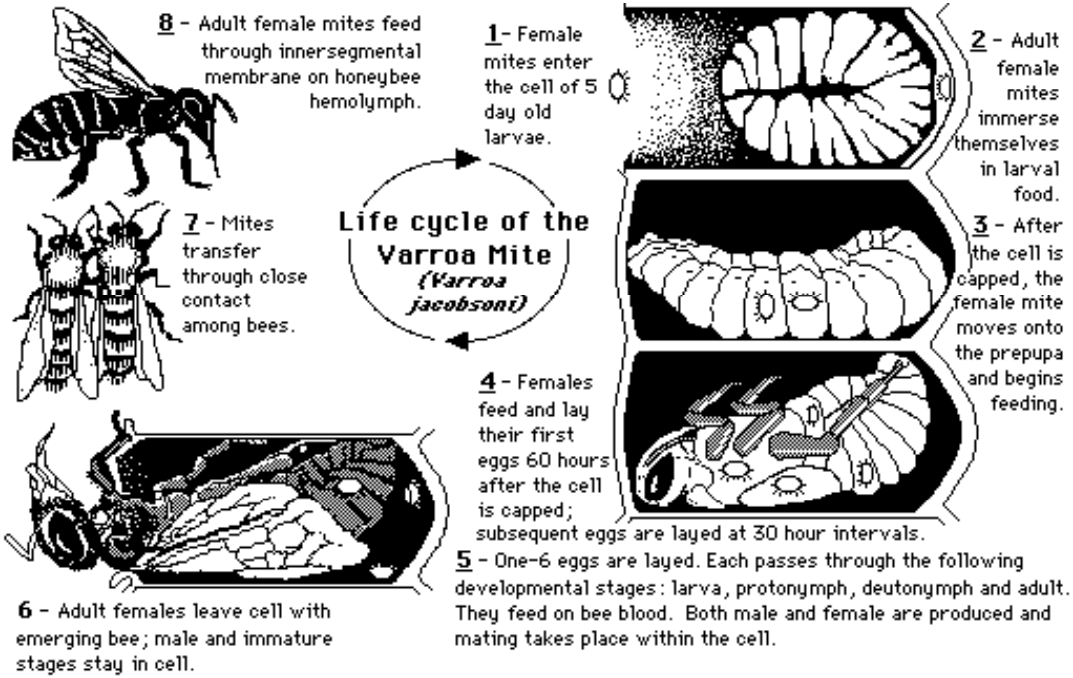
# Varroa mite

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

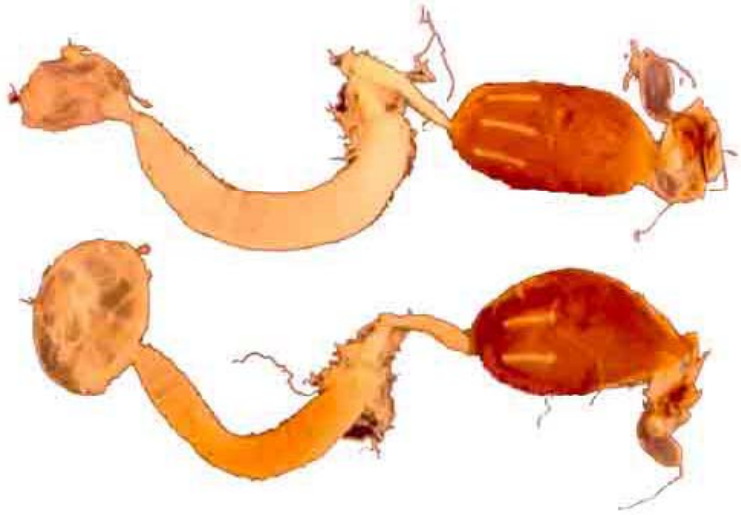
Most don’t live long enough for incubation of diseases

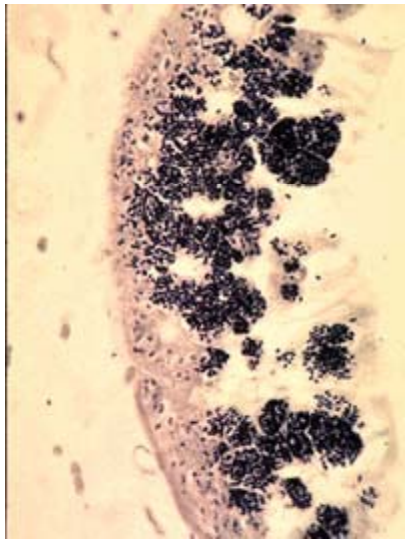
# Nosema

Fungal disease of adults caused by *Nosema apis*

Obtained from infected food or water

Invades the digestive tract of workers, drones, queens





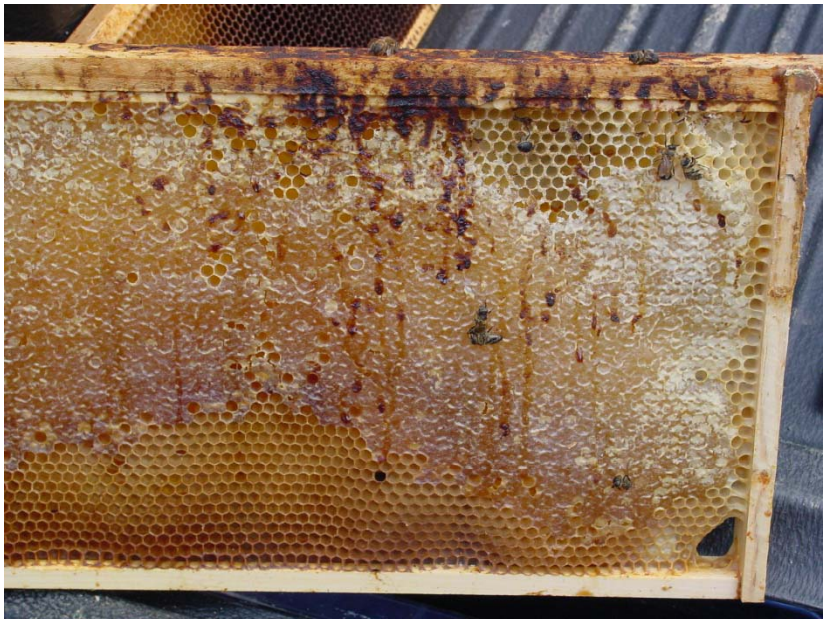
# Nosema

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

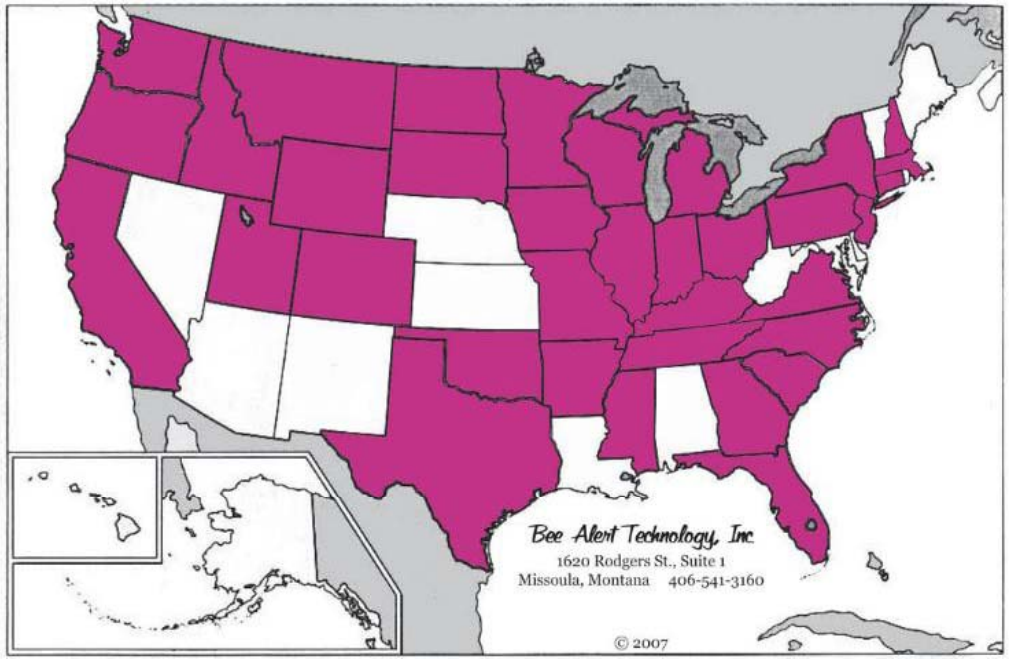
# Colony Collapse Disorder

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

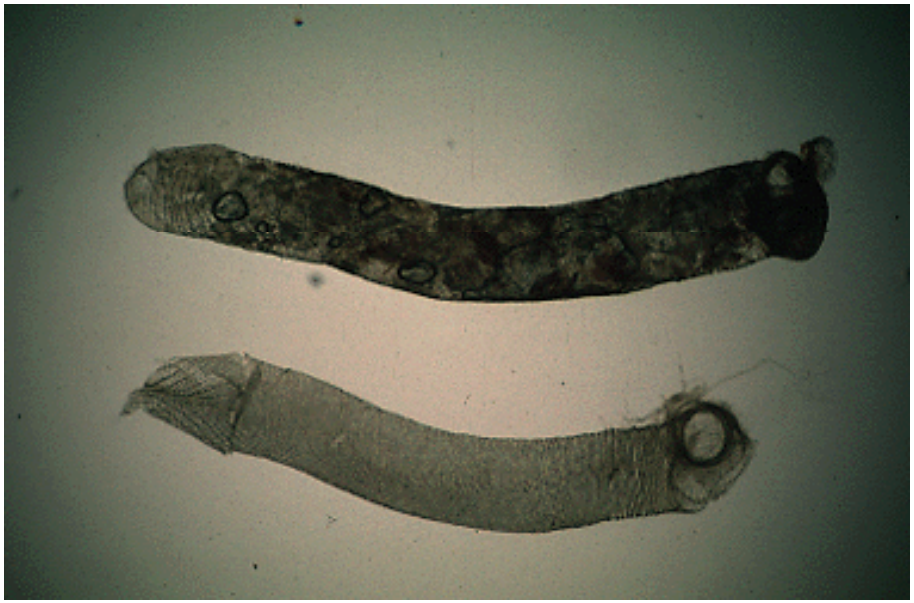
# Tracheal mite

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



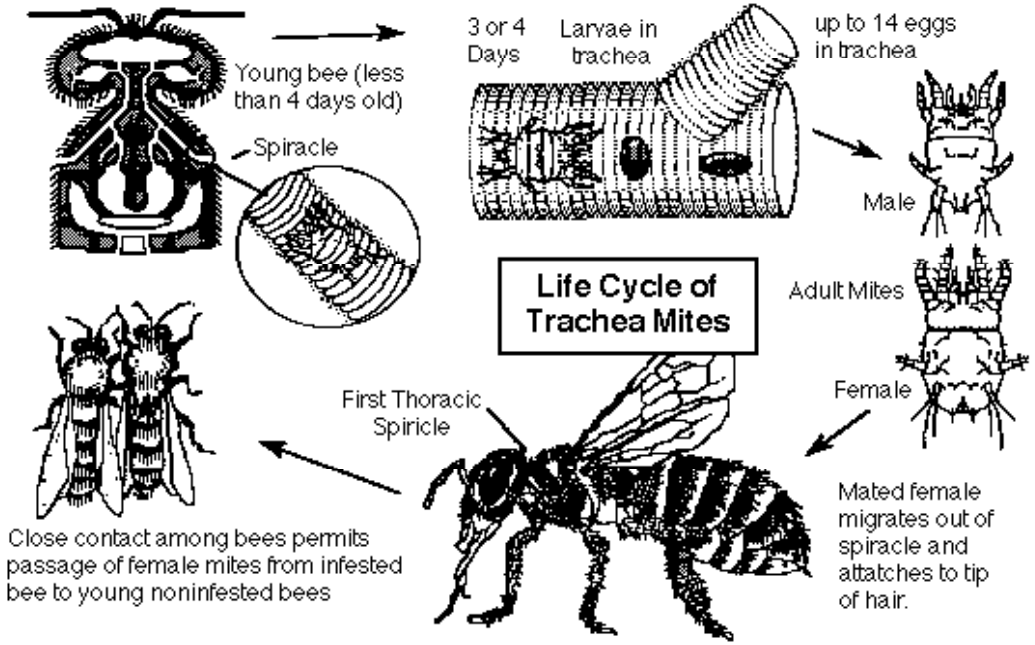
# Tracheal mite

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

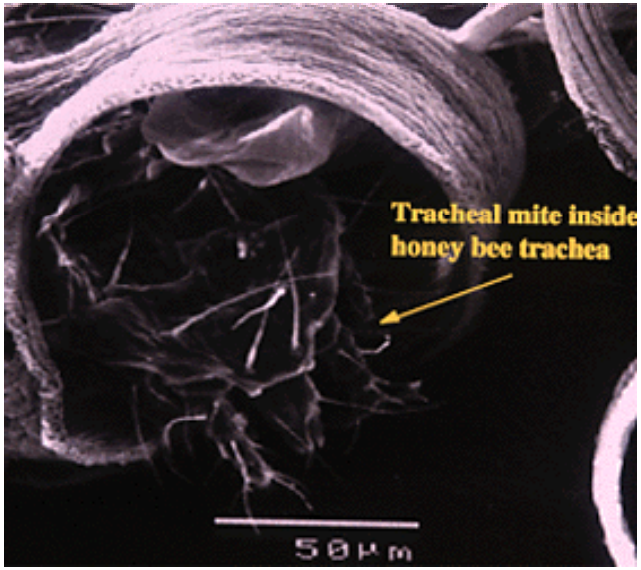


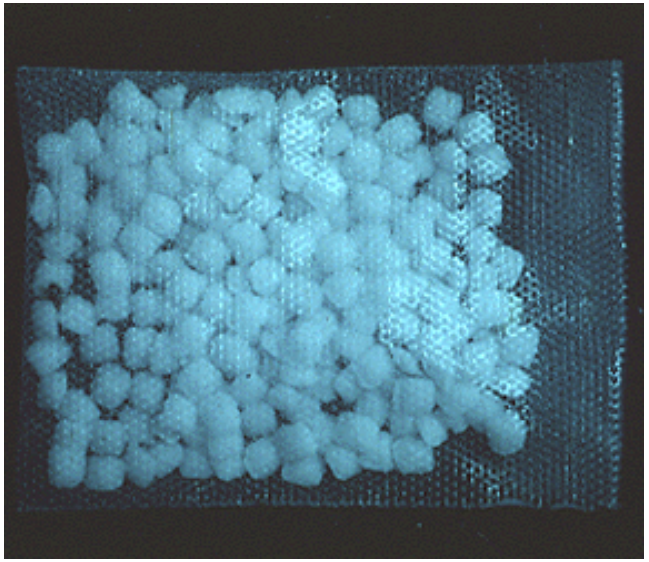
# Tracheal mite

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

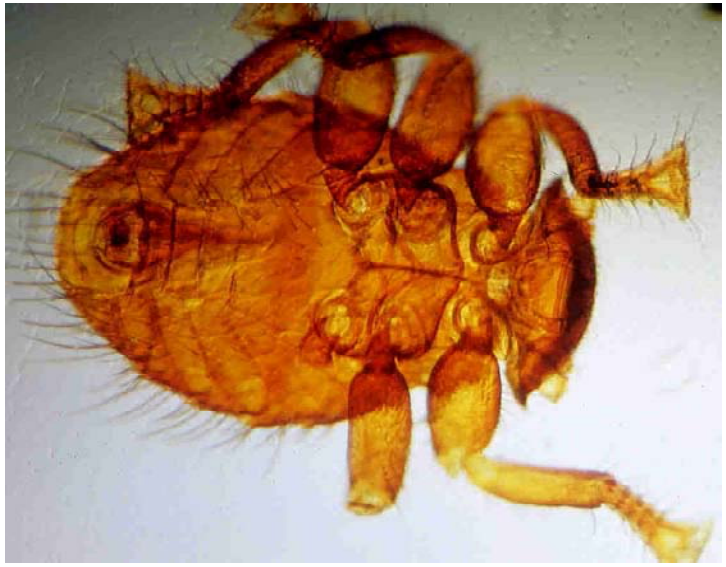
A wingless fly *Braula coeca*

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

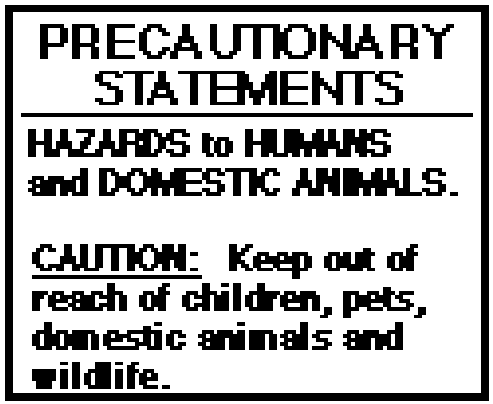
Kill rates vary above normal die off of 100 bees/day

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 that spray solution

# Dr. Maryann Frazier of Penn State

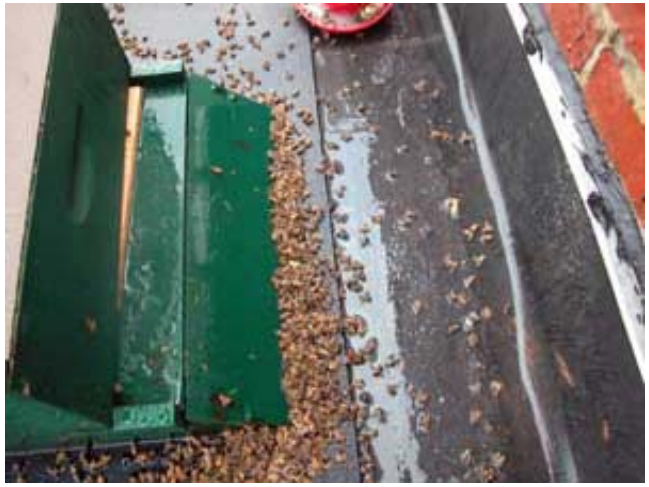
2008 studies examining beehives for pesticide residues

*"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

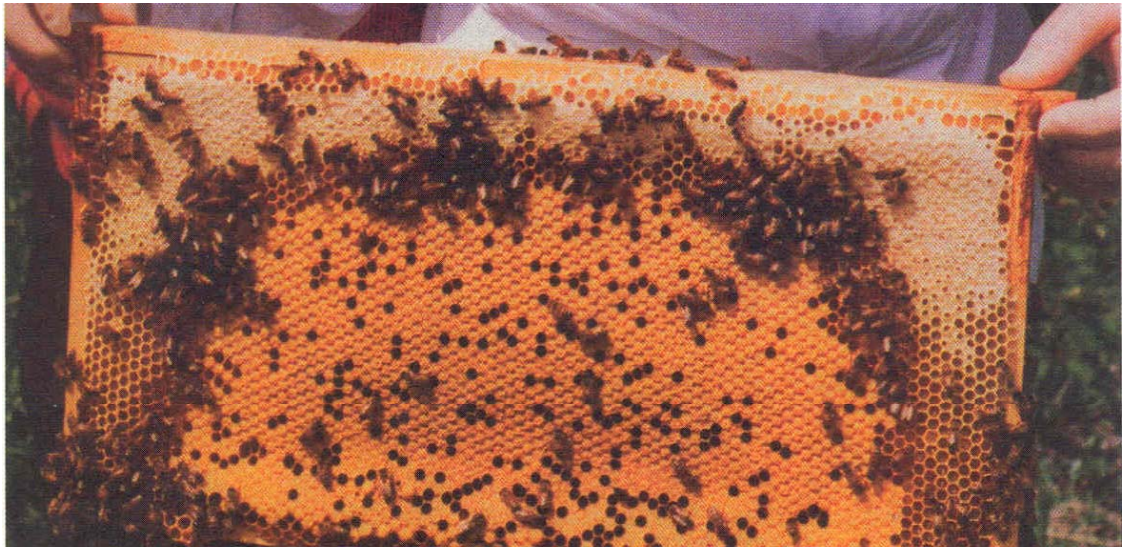
When top super is lifted, there should be hundreds of bees between frames in both supers

# 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


Contact information:

Dr Richard Houseman

housemanr@missouri.edu

573.882.7181