



HONEY BEE PROCEEDINGS

June 5-7, 2022

2022 ANNUAL CONFERENCE

**College of Veterinary Medicine
Kansas State University**



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Honey Bee Basics

Kristen Clark, DVM, MPH, DACVPM



HONEY BEE MEDICINE



KRISTEN CLARK, DVM, MPH, DACVPM, & HOBBYIST BEEKEEPER

OUTLINE

- Why Honey Bees Matter
- Veterinarians and Honey Bees
- Bee Basics
- Honey Bee Diseases & Conditions
- Resources for Veterinarians





WHY HONEY BEES MATTER

U.S. HONEY BEE INDUSTRY

- 2019 U.S. honey production was 157 million pounds valued at over \$339 million (USDA National Ag. Statistics Service)
- Beeswax is second most important hive product economically
 - Candles, leather, wood polishes, cosmetics, pharmaceuticals



U.S. HONEY BEE INDUSTRY

- Most important contribution of honey bees to agriculture? Pollination!
 - Contribute \$15 billion to U.S. crop production
- Many crops wouldn't exist without the honey bee at bloom time
 - Almonds (100% dependent)
 - Blueberries and cherries (90% dependent)
- Also important for apples, cranberries, melons, broccoli, and more!



Project Apis m.



U.C. Davis Department of Entomology & Nematology

POLLINATOR PROBLEMS

- Both wild and managed pollinator populations are declining
- Habitat loss and degradation
- Non-native species and diseases
- Pesticides
- Climate Change



A decorative wavy line in yellow and white on the left side of the image.

VETERINARIANS AND HONEY BEES

THE VETERINARY FEED DIRECTIVE (VFD)

- January 1, 2017
- Food and Drug Administration
- Antimicrobial resistance
 - Serious threat to One Health
 - CDC annual estimates (United States):
 - At least 2.8 million human illnesses
 - 35,000 deaths
- As of January 1, 2017, all water-soluble, medically important antimicrobials administered to food producing animals in drinking water require a veterinary prescription, and all medically important antimicrobials administered to food producing animals through feed require a VFD.

I'M A VETERINARIAN. WHY SHOULD BEES MATTER TO ME?

- Honey bees are considered food producing animals (minor species)
- VFD final rule requires veterinarians to issue all VFDs within context of valid veterinarian-client-patient-relationship (VCPR)
- Beekeepers required to obtain VFD from licensed veterinarian for use of medically important antimicrobials in bees
- **Veterinarians will be asked to visit apiaries, examine hives for signs of disease, and prescribe appropriate treatments**
- **In collaboration with state apiarists and extension specialists, veterinarians also have an opportunity to provide education and professional services to beekeepers on biosecurity, disease recognition and management, and more**





BEE BASICS

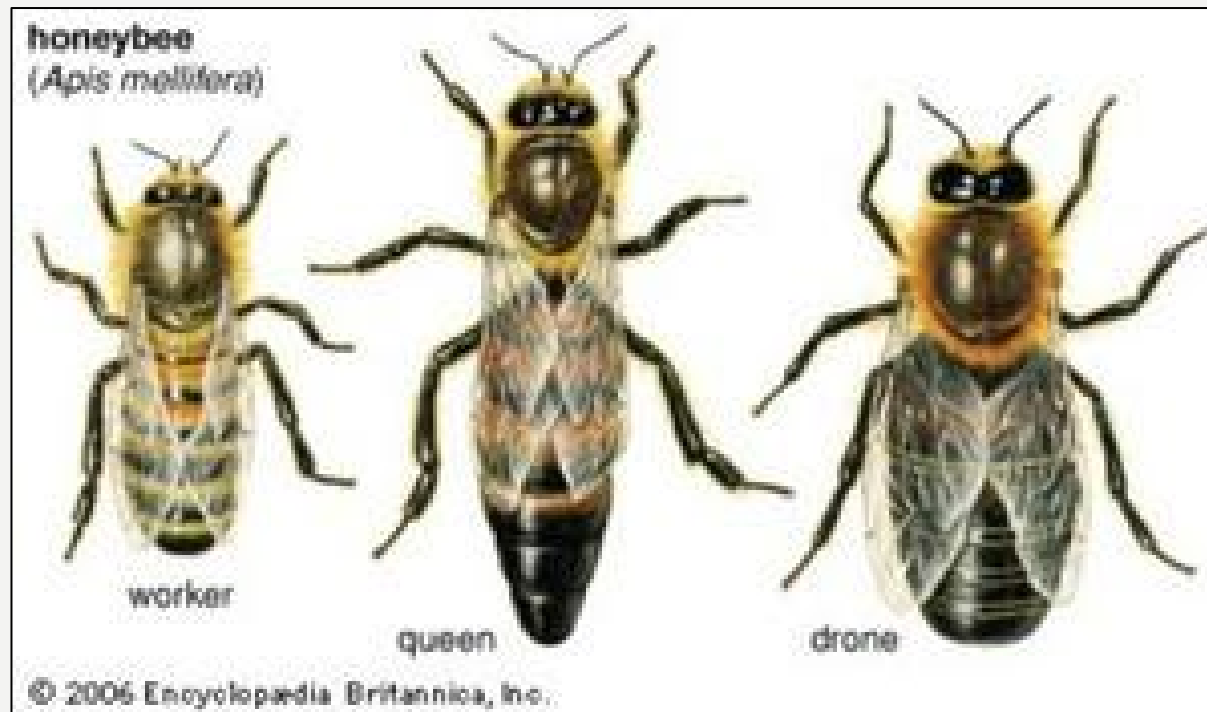
EQUIPMENT AND TERMINOLOGY

- Apiary
- Hive or colony
 - Langstroth hive most common
- Brood box or “deep”
- “Super”
- Frame
- Foundation
- Smoker
- Hive tool
- Beekeeper protection



TYPES OF BEES

- Within the colony, there are three types of bees based on function:
 - Worker
 - Queen
 - Drone

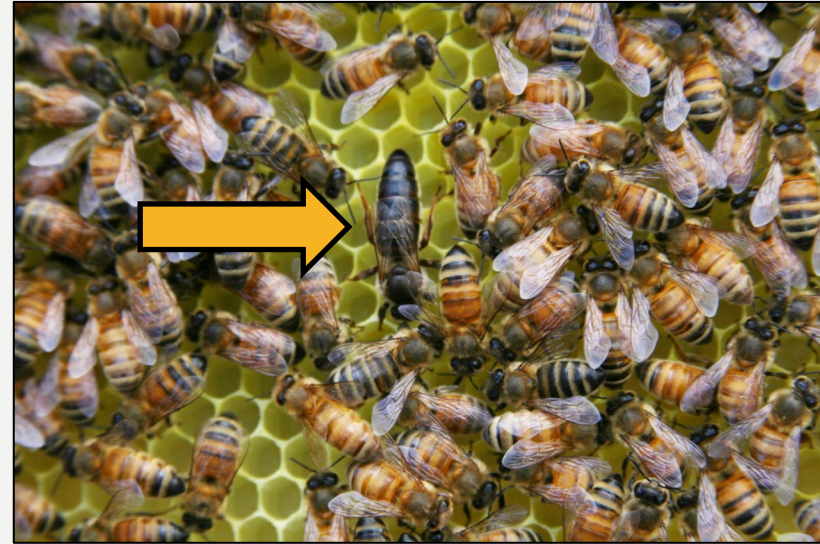


WORKER

- Female bees that perform the vital work of the colony
- Variety of functions:
 - Providing for the queen's needs
 - Cleaning cells in the comb
 - Nursing larvae
 - Producing wax and forming it into honey comb
 - Guarding and defending the hive
 - Removing dead bees from the hive
 - Cooling the hive or heating the brood
 - Carrying water
 - Gathering and transporting pollen
 - Collecting nectar
 - Sealing (capping) honey
 - Scouting for resources
- Incapable of laying fertilized eggs that can become queens or other worker bees
- Only capable of laying unfertilized eggs that become drones but this is suppressed in the presence of a laying queen
- Lifespan varies with time of year: 5-6 weeks during the spring and summer, five months or longer during the inactive winter period



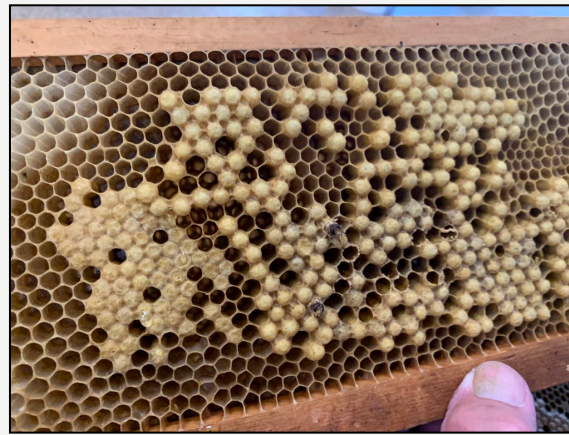
QUEEN



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- Each colony generally contains one queen
- Fertile female of the hive and the sole source of fertilized eggs that become worker bees
 - Can lay up to 2,000 eggs per day during peak production
- Largest bee in the hive with long, tapered abdomen
- Colony will only produce new queens when it prepares to reproductively split by swarming, when the old queen has died, or to replace a failing queen
 - Many queen cells will be created → First one to emerge will kill the remainder and fight with other emerged queens so that only one remains
 - One to two weeks after hatching, virgin queen will go on several mating flights where she will mate with 10-20 drones, storing the sperm for use over her lifetime.
- Colony can only function normally when a queen is present and laying well

DRONE



Dr. David Schmitt



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- Only male bees in the hive and are haploid (having only one chromosome set) because they arise from unfertilized eggs
 - Queens and workers are diploid because they arise from fertilized eggs
- Large, thick bodies
- Perform no functions inside the hive—sole duty is to search for and mate with virgin queen bees on their mating flights
 - If fortunate enough to mate, endophallus is removed in the process and the drone dies
- Drones are made whenever the colony has sufficient resources
 - Can have hundreds of drones in summer but are kicked out of colony before winter so they don't consume precious resources

BROOD

- Young, developing bees
 - Eggs
 - Larvae
 - Pupae



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- Eggs laid in cells in colony → after 3 days, egg hatches, and a larva emerges → larvae are fed and grow over the next 6 days → cell containing the larva is capped (open top sealed over by worker bees with porous wax) → larva then matures to a pupa inside the capped cell (**capped brood**) → eventually emerges from the cell as a bee
- Total days spent as brood:
 - 16 for queens
 - 21 for workers
 - 24 for drones
- Colony will contain brood most of the year but egg laying ceases in late fall or early winter and in times of stress



Kris Fricke

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DIET



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- Entirely from flowers!
- Floral nectar = carbohydrates
- Prefer fresh nectar when available, but store it in cells for when there are no available flowers
 - To prevent nectar fermentation, bees dry the nectar to below 18% water content = HONEY
- Pollen provides source of protein, vitamins, fats, and minerals
 - To store pollen, bees pack it into cells, add nectar, and ferment into storable substance called bee bread

HEALTHY HIVE

- Queen is laying enough eggs
- Workers can raise enough brood to replace the workers that are dying
- There are enough members of each age of worker to perform all the necessary tasks of the colony



Max Pixel



HONEY BEE PROCEEDINGS

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Honey Bee Maladies and How Veterinarians Can Help

Kristen Clark, DVM, MPH, DACVPM





HONEY BEE DISEASES AND CONDITIONS

BEE DISEASES

- Bacterial
 - American foulbrood (AFB)
 - European foulbrood (EFB)
- Viral
 - Paralytic viruses
 - Sacbrood
- Microsporidial
 - Nosema
- Fungal
 - Chalkbrood
- Parasitic
 - Parasitic Mite Syndrome (PMS)
 - Tracheal mites
 - Small hive beetles
- Other
 - Idiopathic Brood Disease (IBD)
 - Malnutrition
 - Pesticide toxicity



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BEE DISEASES

- Only two diseases (AFB and EFB) are commonly treated with antibiotics
- Other diseases can appear similar to AFB and EFB
- Colonies can be infected with multiple diseases at the same time

BACTERIAL DISEASES: AMERICAN & EUROPEAN FOULBROOD

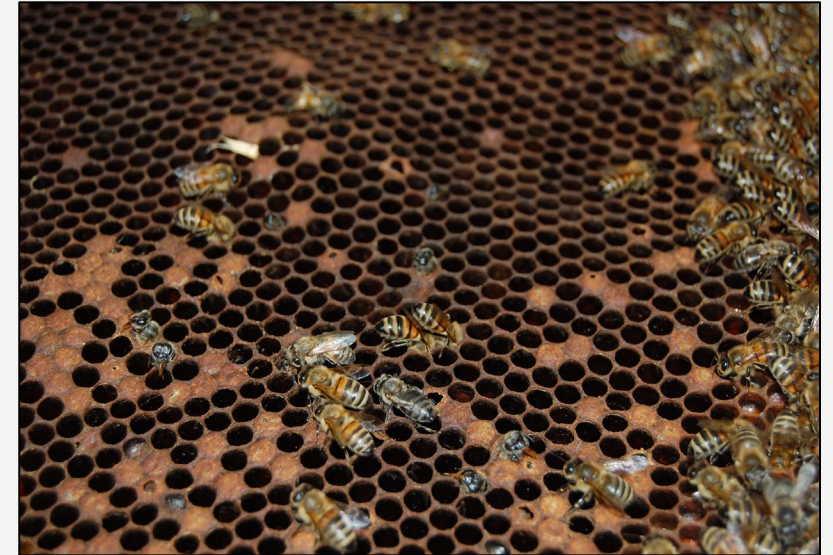
- Two significant honey bee diseases
- May require veterinary intervention as both may be treated with antibiotics
- Both have worldwide distribution
- Name originated due to foul smell arising from decay of infected brood but AFB and EFB are not closely related

AMERICAN FOULBROOD (AFB)

- Cause by *Paenibacillus larvae*, a spore-forming bacteria
- Usually only affects pre-pupal and pupal stages of development
- Infective, vegetative state of bacterium is susceptible to antibiotics
- Spores
 - Not affected by antibiotics
 - Resistant to temperature changes and chemicals
 - Can persist in honey and the environment for up to 70 years
- **REPORTABLE DISEASE IN SOME STATES**

AFB VISUAL INSPECTION FINDINGS

- Foul odor—often compared to dirty gym socks
 - Can often be smelled from a few feet away
- Shotgun brood pattern
 - Indicative of any disease affecting brood—not pathognomonic for AFB
 - Indicates that brood are dying before they are capped
- Perforated caps
 - Sunken and discolored
 - Perforations with irregular edges
- Pupal tongues
 - Kills bees at specific developmental stage
 - May die with developing proboscis exposed = ‘pupal tongue’
 - Characteristic of AFB but not always present
- Larval scale
 - Bottom of cell and difficult to remove



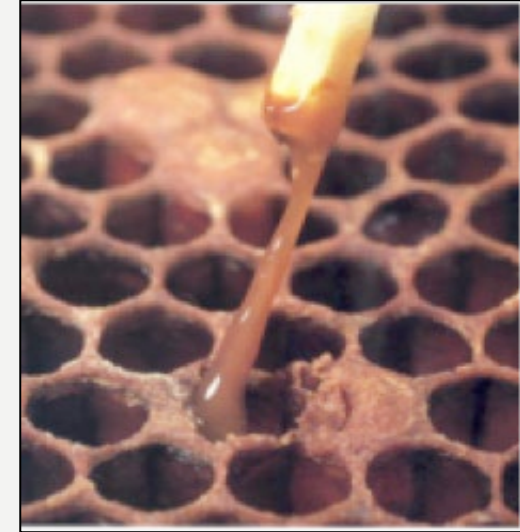
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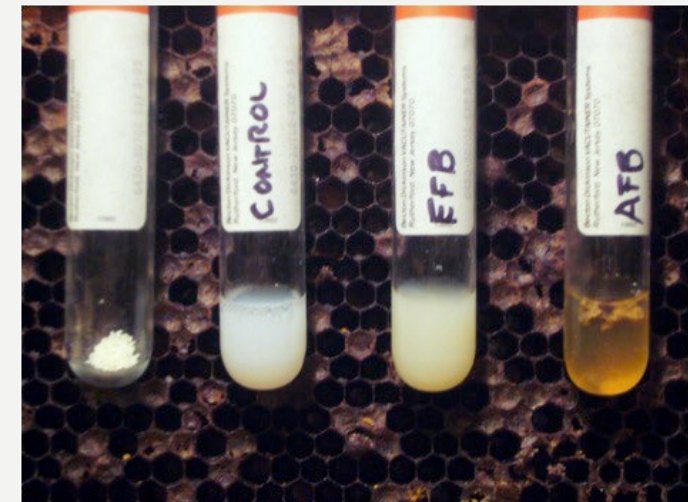
The Management Agency, National AFB
Pest Management Plan, New Zealand

AFB DIAGNOSIS: FIELD TESTS

- Matchstick/rope test
 - Positive test is characteristic of AFB, negative test doesn't rule it out (larvae must be in appropriate stage of decay)
 - Insert matchstick, toothpick, or similar object into cell with discolored/oozing cap and slowly pull it out
 - Decaying products in cell will form viscous string that will rope out ≥ 2 cm
- Holst milk test
 - Positive test suggestive of AFB, negative test doesn't rule it out
 - Need two test tubes of highly diluted milk
 - Add infected larvae or content from rope test to one tube (other tube serves as control) → incubate both tubes in pocket or warm cup of water for 10-20 min, occasionally shaking both tubes → if milk changes to transparent, brownish fluid, this suggests AFB
- Field ELISA Test
 - Manufactured by Vita Europe, available from most U.S. bee supply companies



Ipswich & West Moreton
Beekeepers Association



Randy Oliver, ScientificBeekeeping.com

AFB DIAGNOSIS: LABORATORY TESTING

- Send brood samples to USDA Agricultural Research Service (ARS) laboratory in Beltsville, MD
- See USDA-ARS Bee Research Laboratory website for more details on specimen submission
 - <https://www.ars.usda.gov/northeast-area/beltsville-md/beltsville-agricultural-research-center/bee-research-laboratory/>

AFB TREATMENT

- **Many states require that colonies diagnosed with AFB be immediately destroyed**
 - Always follow state regulations
 - Burning most common method
 - Recommended even if not required by state due to persistence of spores
- Three types of antibiotics are FDA-approved to control AFB
 - Oxytetracycline (resistant strains exist)
 - Tylosin
 - Lincomycin
- Antibiotics not effective against spores—used for mild infections or to prevent infection from worsening or spreading
 - Treatment should occur even if only a single infected cell is detected
 - Still burn frames with infected brood → sterilize boxes and move bees to clean/new equipment → treat colony and all other colonies in that bee yard



Agriculture Victoria

EUROPEAN FOULBROOD (EFB)

- Caused by *Melissococcus pluton*, a non-spore-forming bacteria, but infection is associated with variety of bacterial strains
- Only affects the honey bee larval stage and is more contagious than AFB
- More commonly affects stressed colonies
- May resolve spontaneously if stress is reduced and honey bee health is improved
- Less severe than AFB but can still cause devastating brood loss
- In recent years, has shifted its pathogenicity in U.S. → no longer spontaneously clears and likely to persist in hive

EFB VISUAL INSPECTION FINDINGS

- Shotgun/patchy brood pattern
- Poor colony buildup in spring—diseased larvae may be difficult to detect without thorough inspection
- Discolored larvae (yellow or brown)
- Twisted or corkscrew-shaped larvae
- Visible trachea in larvae
- No scale is formed—dead larval bodies are easily removed
- Often a “sour milk” odor
- Yellow royal jelly around larvae



EFB DIAGNOSIS

- EFB and AFB share many visual characteristics
 - EFB should be a differential when signs of AFB/EFB are observed but characteristic tests (rope test and Holst milk test) are negative for AFB
- Commercial field test is available from Vita Europe (similar to AFB)
- Laboratory testing also available
 - Send brood samples to USDA Agricultural Research Service (ARS) laboratory in Beltsville, MD
 - See USDA-ARS Bee Research Laboratory website for more details on specimen submission
 - <https://www.ars.usda.gov/northeast-area/beltsville-md/beltsville-agricultural-research-center/bee-research-laboratory/>

EFB TREATMENT

- Oxytetracycline and tylosin have been used to treat EFB; however, ***oxytetracycline is the only drug FDA approved for EFB***
- If infection is mild (<10% of brood infected), beekeeper may employ watchful waiting: infected frames are marked and colony is re-inspected in a week to identify if infection is spreading or improving
- In severe infections, recommended to remove frames with diseased brood and replace with new comb in addition to treatment with antibiotics
- Since the bacteria that causes EFB does not have a spore form, frame and equipment destruction is not required
 - Frames can be reused after several months of storage or sterilization with bleach solution

AFB & EFB LOOK-ALIKES

- Idiopathic Brood Disease (IBD) & Parasitic Mite Syndrome (PMS)
- May not require antibiotics for treatment
- Specific etiologic agents unknown but thought to be caused by multiple viruses and found in presence of secondary bacterial infections



IDIOPATHIC BROOD DISEASE (IBD)

- Visual inspection findings
 - Shotgun/patchy brood pattern
 - Larvae may turn yellow but retain 'C' position
 - Larval death in pre-pupal stage—sticking straight up parallel to the cell
 - Larvae appear melted and gummy
 - Larvae eventually melt into dark gray
 - Perforated cappings
 - May form a loose scale
 - Often a foul odor (but different from EFB and AFB)
- Diagnosis
 - Pupal tongue not present
 - Rope test negative
 - No definitive field or laboratory test available
- Treatment
 - Mixed results with antibiotic treatment
 - Removing diseased frames and re-queening can be helpful

PARASITIC MITE SYNDROME (PMS)

- Varroa mites (*Varroa destructor*) are ectoparasites with worldwide distribution
- In the U.S. since 1987
- **Number one killer of honey bees!**
 - Feed on fat body tissue
 - Target larvae that are about to be capped → move to bottom of cell and feed off larva once cell is capped → mites mate inside the cell and mature → once bee emerges from the cell, it will already have female mite offspring on it
- Cause larval or pupal death and can transmit a multitude of viruses and other pathogens (deformed wing virus, acute bee paralysis virus)
- PMS caused by viruses transmitted by the varroa mite
 - Exhibited in severely infested colonies
 - Most commonly seen late season in colonies where mites have not been actively managed
 - Deformed wing virus (DWV) is likely the major pathogen causing disease in PMS



Wikipedia



Entomology & Nematology Dept.
University of Florida

PARASITIC MITE SYNDROME

- Visual inspection findings
 - Shotgun/patchy brood pattern
 - Melted larvae
 - Bees dying on emergence from cells with tongues sticking out
 - Guanine crystals on walls of cells (mite fecal deposits—appear as white spots)
 - Adult bees exhibiting deformed wings
 - Chewed pupae
 - Uncapped pupae (eyes visible)
 - Visible mites
- Diagnosis
 - Regular monitoring for mites (techniques vary)
- Treatment
 - Integrated pest management: active monitoring paired with physical, mechanical, and chemical controls, as needed
- Resource: Honey Bee Health Coalition <https://honeybeehealthcoalition.org/varroa/>



Wikipedia



Cox's Honey

OTHER BEE DISEASES & CONDITIONS

- Viral
 - Paralytic viruses
 - Sacbrood
- Microsporidial
 - Nosema
- Fungal
 - Chalkbrood
- Parasitic
 - Tracheal mites
 - Small hive beetles
- Other
 - Malnutrition
 - Pesticide toxicity
 - Colony Collapse Disorder



RESOURCES FOR VETERINARIANS

WHERE CAN I LEARN MORE?

- Textbooks:
 - **Hot off the press!** Honey Bee Medicine for the Veterinary Practitioner. www.wiley.com/buy/9781119583370. Wiley Press, 2021.
 - Honeybee Veterinary Medicine: *Apis mellifera* L. by Nicolas Vidal-Naquet. First Edition 2015. 5m Publishing.
- Web Module:
 - USDA-APHIS National Veterinary Accreditation Program Module 30: The Role of Veterinarians in Honey Bee Health: <https://nvap.aphis.usda.gov/BEE/bee0001.php>
- Web-based Resources:
 - Honey Bee Veterinary Consortium <https://www.hbvc.org/>
 - Honey Bee Health Coalition <https://honeybeehealthcoalition.org/>
 - Bee Informed Partnership <https://beeinformed.org/>
 - American Veterinary Medical Association: “Honey Bees 101 for Veterinarians” <https://www.avma.org/KB/Resources/Pages/Honey-Bees-101-Veterinarians.aspx>

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Time for Q&A!

**THANKS FOR
ATTENDING!**



PRACTICE MANAGEMENT PROCEEDINGS

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Honey Bee Basics – Part 2

Kristen Clark, DVM, MPH, DACVPM





PRACTICE MANAGEMENT PROCEEDINGS

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Honey Bee Maladies and How Veterinarians Can Help – Part 1

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Notes

