Beneficial Microflora in Honey Bee Colonies

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Our Website: http://gears.tucson.ars.ag.gov

*Lactobacillus* spp.  
*Bifidobacterium* spp.

Photos by T. Oloffson
It has been estimated that there are between $10^4$ and $10^8$ microbes per gram of intestinal content typically found in healthy humans.
Some are Beneficial

- Yeasts: Beer
- Bacteria: Lactobacillus (Yogurt)
- Fungus: Penicillin
Huge Diversity of Microbes

- Original work done by Dr. Martha Gilliam at Tucson Bee Lab

- Found mostly in digestive tract of all stages of bees
  - Adult emerging bees inoculated when they emerge

- Active in the conversion of pollen to bee bread

- Keeps uncapped honey from spoiling
Social Insects and Diseases

- Social insects evolved mechanisms to fight diseases:
  - **Microbial**: Some microbes fight bad ones
    - Very long association, 25-40 million year old microbes in bees in amber
  - **Genetic**: Hygienic behavior
  - **Social Behavior**: Thermoregulation
  - **Physical barriers**: Cuticle
  - **Nest components**: Propolis
  - **Humoral**: components in hemolymph such as antibodies and enzymes
  - **Cellular immunity**: Hemocytes (phagocytes or white blood cells)
    - and other immune responses
How Microbes Work for Honey Bees

Lactic acid bacteria from the honey stomach are the first step in preparing pollen (by fermentation and pH) and nectar (protecting against fermenting).

Other fungi, yeasts, bacteria, and molds help to produce enzymes, vitamins, anti-microbial and other substances. Current research is investigating and updating this process.


Schematic by D. Sammataro
Microflora in Bee Food

- **Bacteria Produce:**
  - Antibiotics
  - Fatty acids and Enzymes that help digest
    - Starches, Proteins, Sugars and Cellulose
- **Penicillium** (a mold)
  - Also produce amylases to break down starches
- **Yeast**s
  - Help synthesize B-vitamins
13 new LAB bacteria now identified

All *Apis* species have the same LAB as well as some novel phylotypes

SEM of Honey Stomach

proventriculus

esophagus

Interior of Honey Stomach

Photos by J. Cicero, UA
Sample Bacteria from Honey Stomach

Photos by J. Cicero, UA
What factors influence microbial populations?

- Diet?
- Antibiotics?
- Pesticides?
- Wax contaminants?
- Genetics?
Feeding Experiment:
What happens when you limit Nutrition?

Bee Bubble, colonies fed only artificial diet plus syrup.....

After 6 weeks, colony declines: lack of bacteria?
Brood area (in²) of colonies maintained in a closed foraging arena with different in-hive protein sources. On August 27, all colonies were receiving non-pollen protein supplement. On September 9, some colonies were supplied with either frames of bee collected pollen and bee bread or pollen patties.

Preliminary Caged Bee Study on Effect of Diet on LAB

How do microbes affect bee health?

- A reduction of beneficial microbes could cause nutritional deficiencies, resulting in:
  - Increased incidence of disease (chalkbrood)
  - Supersedure of queens
  - Reduced colony growth
What good is this information?

- Tells us what microflora are there and when
- Tells us who is doing harm, and who is beneficial
- Gives us insight into how to manage the complex microbial communities found in honey bee colonies
Collaborations:

- Dr. Kirk Anderson (Microbial Ecologist, Tucson)
- Dr. Mark Carroll (Chemical Ecologist, Tucson)
- Drs. Vásquez and Olofsson, Lund Un., Sweden
- Dr. Jay Yoder, Wittenberg Un. (OH)