

Beneficial Microflora in Honey Bee Colonies

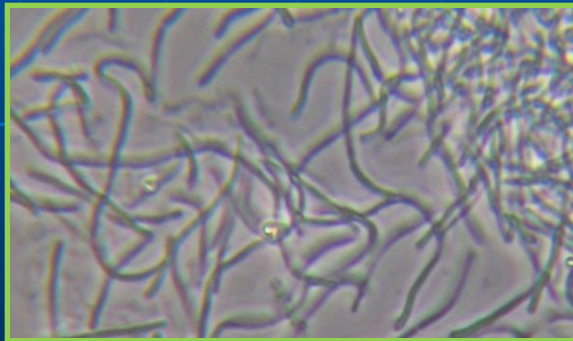


Diana Sammataro, Ph.D.

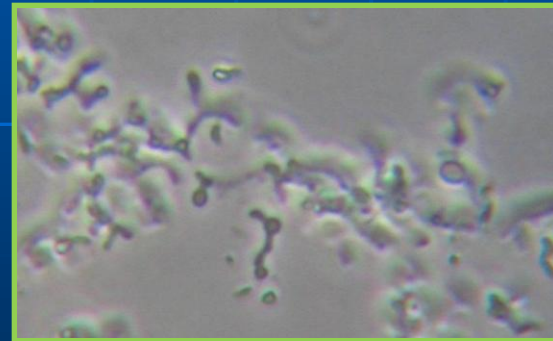


**USDA-ARS Carl Hayden Bee Research Center
Tucson, AZ**

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



***Lactobacillus* spp.**

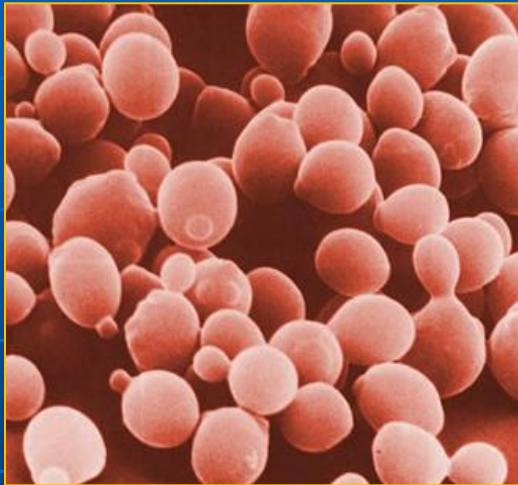


***Bifidobacterium* spp.**

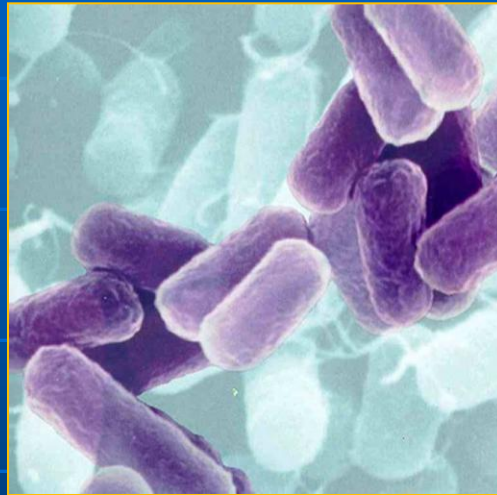
Photos by T. Oloffson

What are Microbes?

Yeasts



Bacteria



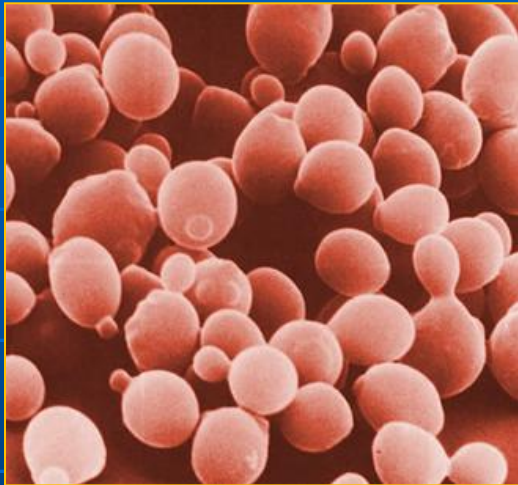
Fungus



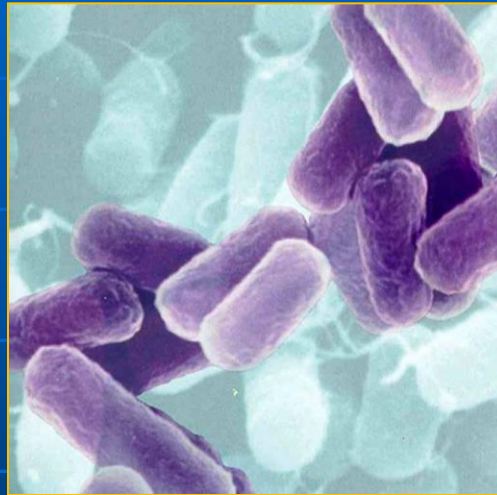
It has been estimated that there are between 10^4 and 10^8 microbes per gram of intestinal content typically found in healthy humans

Some are Beneficial

Yeasts



Bacteria



Fungus



Beer

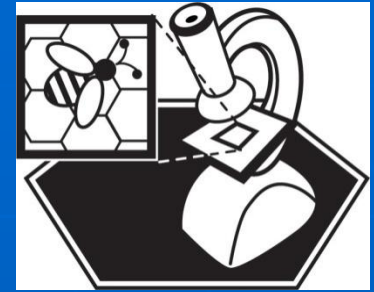
Lactobacillus (Yogurt)

Penicillin

Huge Diversity of Microbes

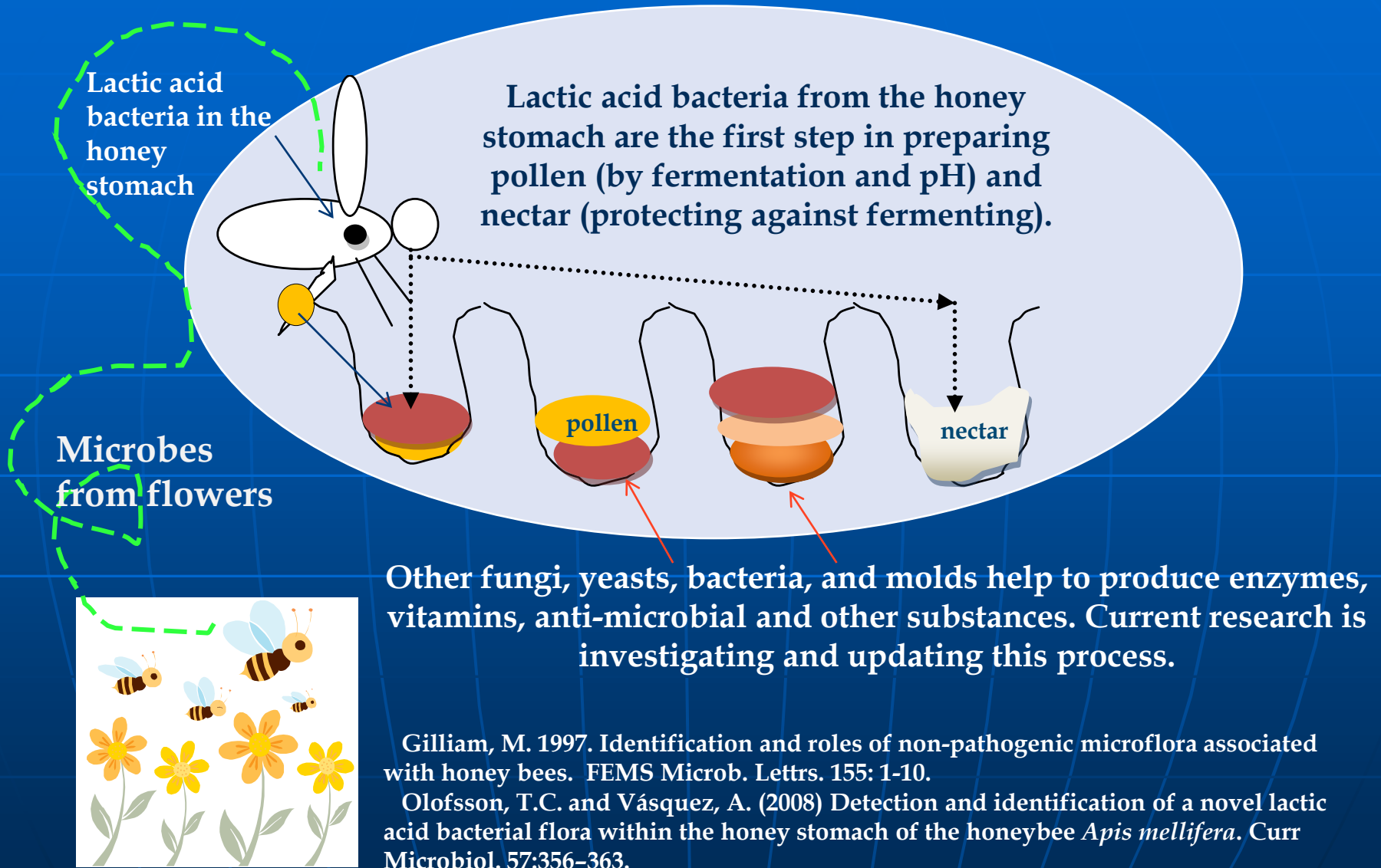
- Original work done by Dr. Martha Gilliam at Tucson Bee Lab
- Found mostly in digestive tract of all stages of bees
 - Adult emerging bees inoculated when they emerge
- Active in the conversion of pollen to bee bread
- Keeps uncapped honey from spoiling

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



Gilliam, M. 1997. Identification and roles of non-pathogenic microflora associated with honey bees. FEMS Microb. Lettrs. 155: 1-10.

Olofsson, T.C. and Vásquez, A. (2008) Detection and identification of a novel lactic acid bacterial flora within the honey stomach of the honeybee *Apis mellifera*. Curr Microbiol. 57:356-363.

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
- **Yeasts**
 - Help synthesize B-vitamins

Most Recent Microbes: Honey Stomach Bacteria



Novel lactic acid bacteria (LAB) found **IN** honey stomachs; belonging to the genus *Lactobacillus* (8), *Bifidobacterium* (4) and the family *Pasteurelaceae* (1)

13 new LAB bacteria now identified

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

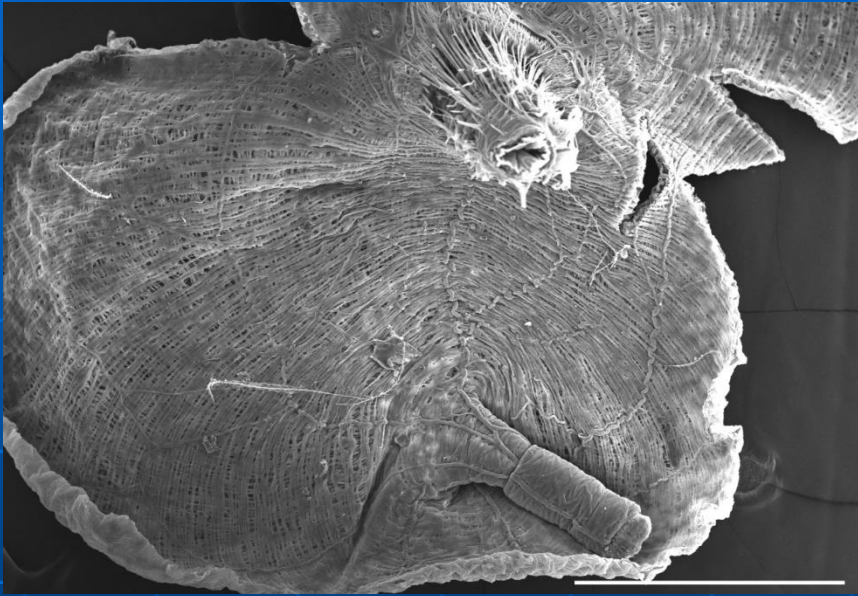
❖ Vásquez ,A., Olofsson, T.C. and D. Sammataro. 2009. *A scientific note on the lactic acid bacterial flora discovered in the honey stomach of Swedish honeybees*. *Apidologie*, 40:26-28.

SEM of Honey Stomach

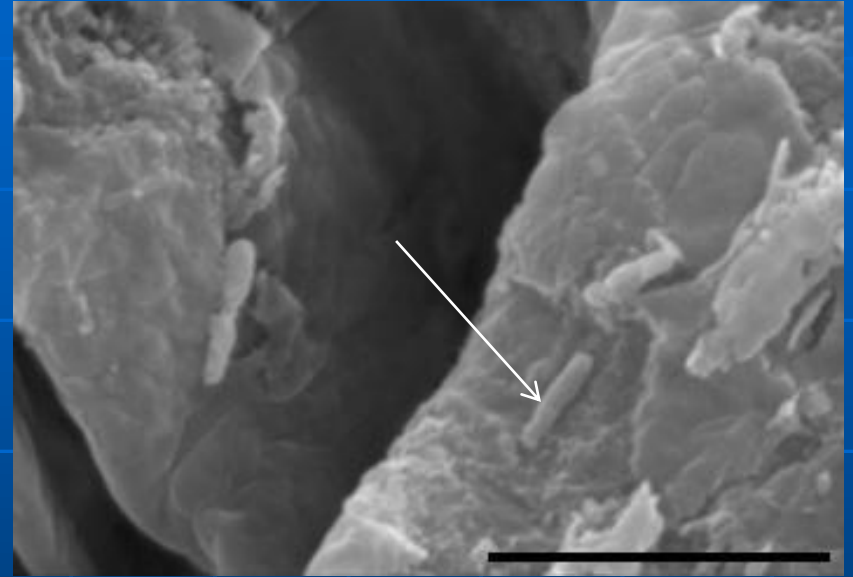


Sammataro and Cicero. 2009. Functional morphology of the honey stomach wall of European honey bees (*Apis mellifera* L.); in review Ann. Entomol.

Interior of Honey Stomach

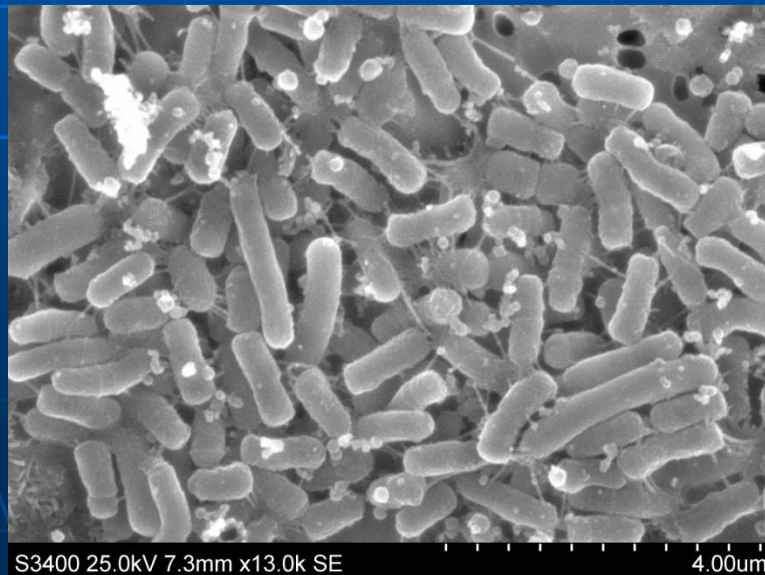
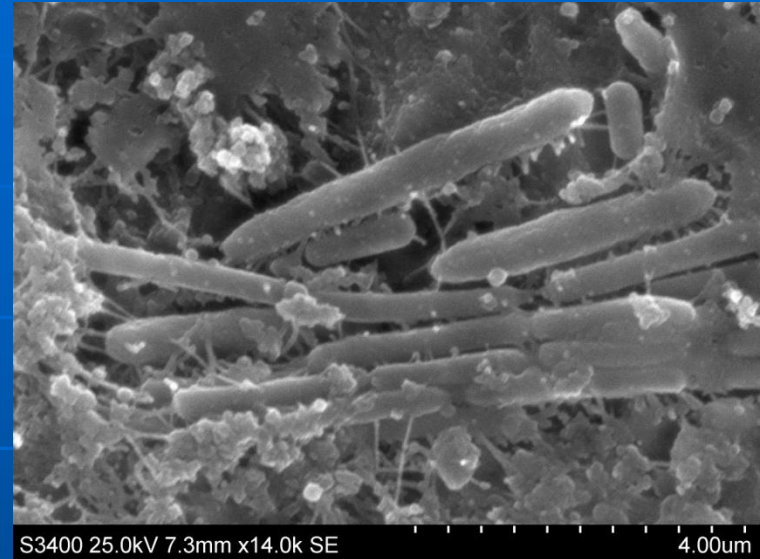
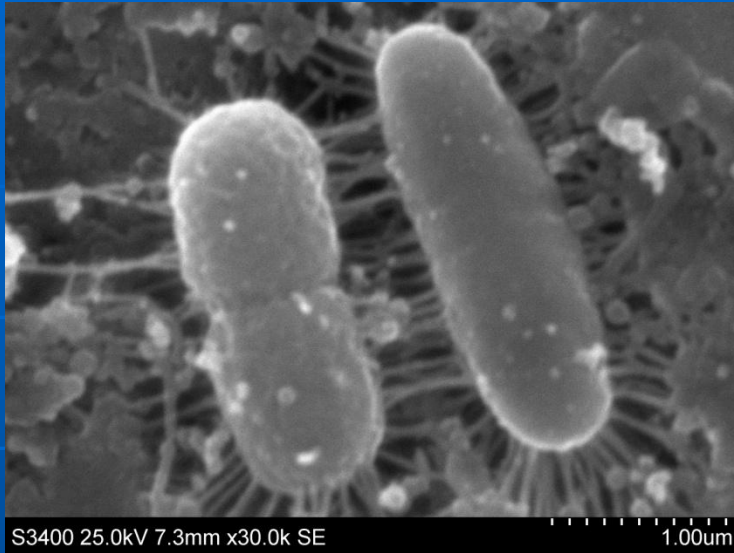


Interior of HS



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:

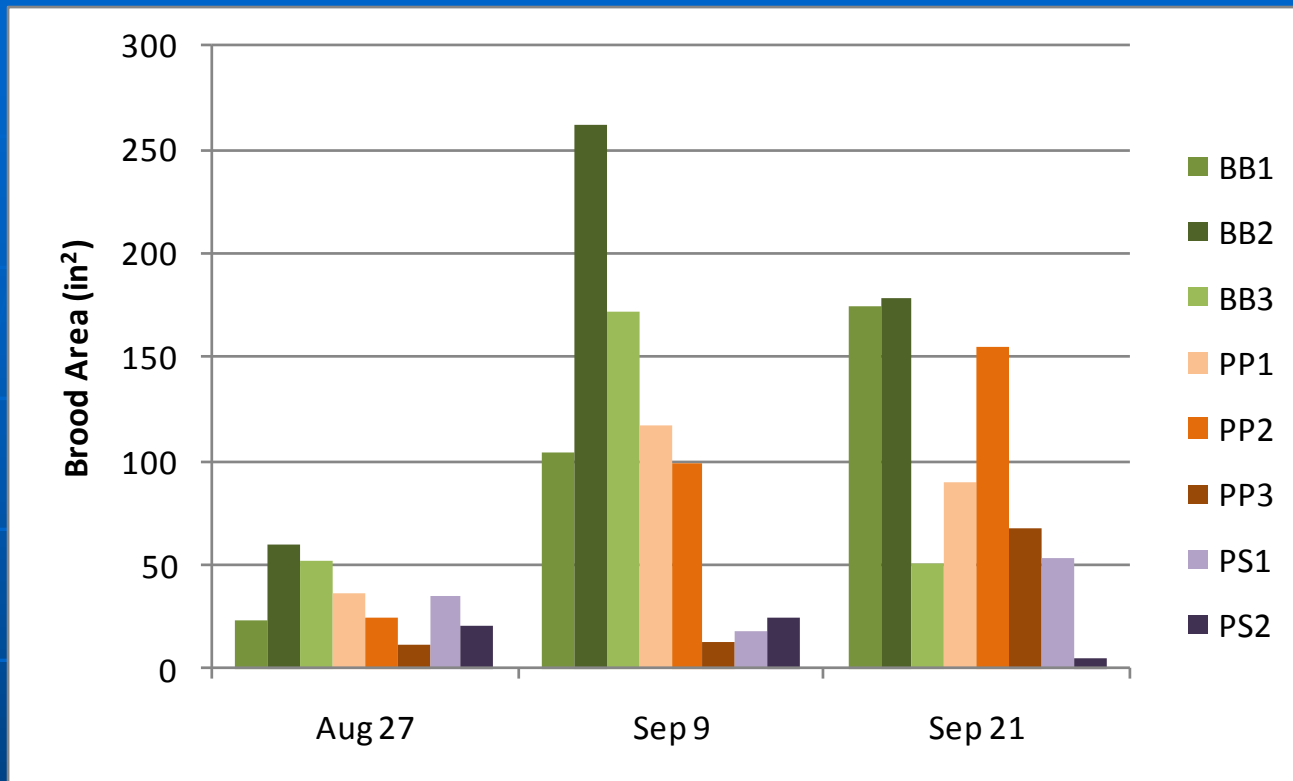
What happens when you limit Nutrition?



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



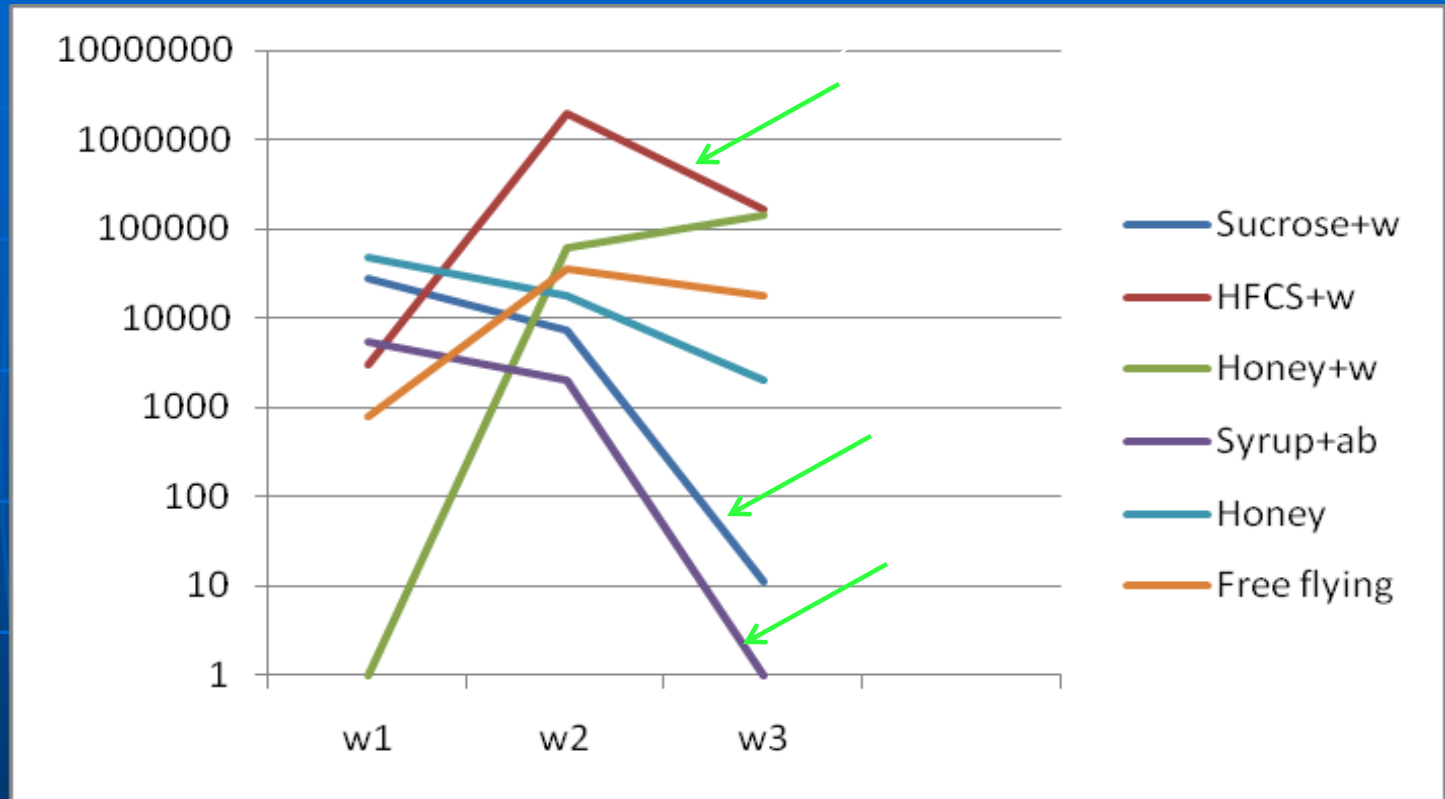
After 6 weeks, colony declines:
lack of bacteria?



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.

(Treatments: PS = non-pollen protein supplement; PP= pollen patty; BB= Frames of bee bread). M. Weiss, Master's Thesis.

Preliminary Caged Bee Study on Effect of Diet on LAB



Olofsson, Vasquez, Fries, Sammataro et al. 2010. **Symbiosis between lactic acid bacteria and honey bees.** Nature, in review.

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)

