view online: **ag.umass.edu/resources/pollinators/varroa**

Apiary Design
using ecological principles

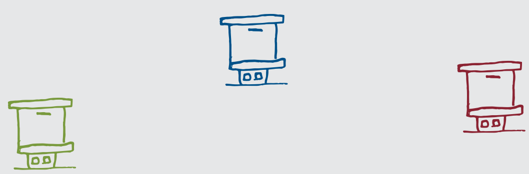
Through decades of research on human and animal health, we know a lot about how diseases spread, change and cause damage (a field known as *disease ecology and evolution*). **Recently, researchers have begun to explore how principles of disease ecology and evolution might apply to honey bees.**[1]

They ask: do these principles help to explain why *Varroa* mites remain so prevalent and destructive? Could they help us to design better apiaries? Below are some key ecological principles, and what they mean for bee parasites and diseases.

Virulence-Transmission Trade-off

Avirulent

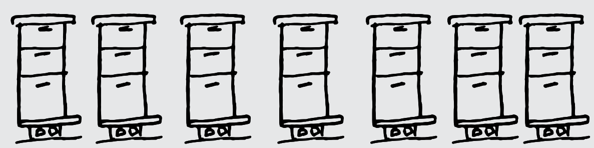
Disease grows/reproduces slowly and **causes less damage to host**



When hosts are **far apart and genetically diverse**, diseases do not spread easily. To be successful, a disease needs to keep a host alive long enough for the host to produce offspring or for it to randomly encounter another host. The disease therefore evolves to be avirulent.

Virulent

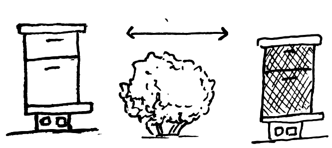
Disease grows/reproduces rapidly and **kills host**



When **similar hosts are clustered together**, a disease can rapidly kill one host and move on to another, so it will evolve to be more virulent.

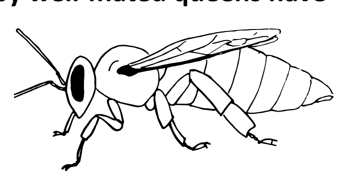
1. Reduce Population Density

When numerous organisms are clustered together, diseases spread more easily, and become more virulent. For honey bees, this operates both at the **colony level** (number of workers within a colony) and the **apiary level** (how colonies are clustered). Studies have found that **apiaries with smaller, more dispersed colonies have lower mite levels and higher overwintering survival.**[2]



2. Maintain Genetic Diversity

Diseases and parasites spread more easily when hosts are genetically homogeneous. For honey bees, genetic diversity is impacted by both the diversity of genetic stock in an apiary, and the number of drones that mate with each queen. Research shows that **colonies headed by well-mated queens have lower infestations of AFB, chalkbrood and Varroa.**[3]

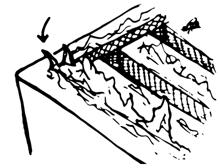


Ecological Immunity

Ecological immunity refers to the way that **animal behavior can impact disease outcomes.** For instance, animals can self-medicate by consuming or collecting anti-microbial compounds. They can also remove infected materials and individuals from their home. For social organisms like honey bees, these behaviors not only protect individuals, but also defend the whole colony against disease. This is referred to as "social immunity".

3. Support Social Immunity

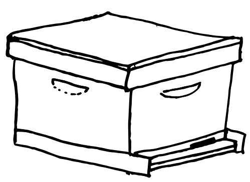
Examples of honey bee social immunity include removing sick or dead bees from the hive, and lining the nest with antimicrobial tree resin, called propolis. **Studies have shown that hives lined with propolis have lower microbial loads and reduced incidences of AFB and chalkbrood**.[4]



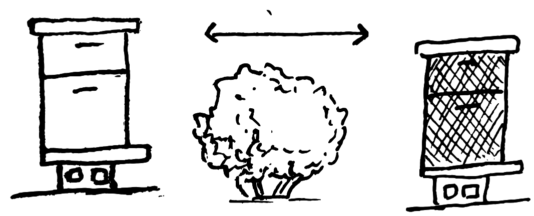
Summary of Design Strategies

Reduce Population Density

Keep hives small by splitting or allowing to swarm

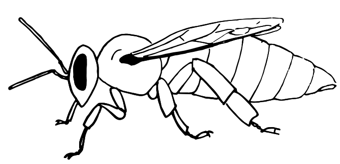


Space hives > 10' apart ***and/or*** paint different colors



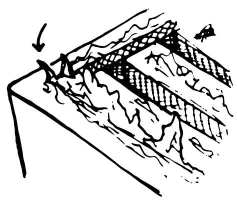
Maintain Genetic Diversity

Maintain diverse genetic stock. Buy from trusted queen breeders. Use *Varroa*-tolerant stock

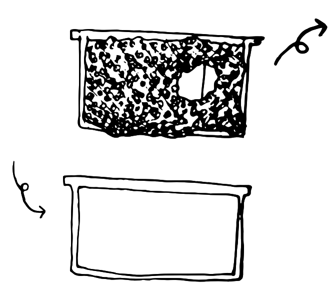


Support Social Immunity

Leave propolis and/or scratch hive interior to encourage propolis production



Remove old frames and replace them with new ones



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