Spring Management of Honeybees
Part 1 – Population Dynamics, Varroa

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Spring Issues for Overwintered Colonies

- Nutrition management
- Mite management
- Swarm management
- Increases
The Honeybee’s Diet

- Nectar – predominately water and plant sugars that is processed by bees into honey
  - Is the carbohydrate source in their diet
- Pollen – composition varies by plant
  - Is the protein source in their diet

The Honeybee’s Diet - Nectar

- Sugar concentrations vary as from 9% sugars up to 55% (the dandelion flow). The low concentration plants tend to be ignored when other higher concentration plants are blooming which is what we all experience with bees at times
The Honeybee’s Diet - Pollen

• Composition varies by plant
  – Is the protein source in their diet (along with amino acids, lipids and vitamins)
• Bees mix it with regurgitated nectar and pack it into the cells
  – Ferments into “bee bread”
  – Fed to worker and drone larvae (after day 3),
  – Consumed by adult bees also

What is Going on in the Hive

Factors influencing early spring colony growth

• The beginning adult population determines how much brood can be fed and kept warm. If the adult population is small in mid-winter, brood rearing will begin very slowly.

• A shortage of honey stores inside the hive can limit brood rearing. Throughout early spring, brood rearing will consume more stores than what is available for the bees to forage.
Factors influencing early spring colony growth

- The number of days of suitable foraging weather influences the intensity of brood rearing.
- Fresh pollen and a little nectar encourages brood rearing. When rain and cold temperatures keep the bees inside, stores must be available inside the hive.
- How much nectar and pollen is available on the days the bees are able to forage also influences brood rearing. Blooming is sporadic in the early spring.

What is Going on in the Hive

Varroa Population

Varroa History – know thy enemy

- **Varroa jacobsoni**
- **1904** - first descriptions as an ectoparasite of the eastern honeybee (*Apis ceranae*)
- **1950s** - Movement of *A. mellifera* by humans into areas where *A. cerana* is endemic in the 1950’s enabled *V. destructor* to transfer to *A. mellifera* (mainland Asia)
Varroa History – know thy enemy

• 1987 – V. destructor first found in the US in Wisconsin

• 2000 – discovery that Varroa jacobsoni is a complex of two different subspecies that parasitize eastern honeybees
  – Varroa jacobsoni
  – Varroa destructor – females are larger and less spherical than V. jacobsoni

V. Jacobsoni and V. destructor are reproductively isolated

Varroa mobility

• Varroa mites are highly mobile
  – drifting of infested adult worker and drone adult bees
  – movement of swarms
  – bees robbing weakened colonies
  – movement of infested colonies for wintering and crop pollination
  – the shipment of package bees and queens

Varroa History – know thy enemy

• A. mellifera did not evolve with varroa and as a result has very limited mechanisms to cope
  – Apis ceranae
    • has shorter worker brood cycle (18 days)
      – so mites only reproduce in drone brood (22 days)
    • exhibits hygienic behavior
    • Carries another mite that is even more destructive than varroa
      – Tropilaelaps clareae - absolutely fatal if introduced in Apis mellifera colonies
        » Requires year round brood production for survival
Testing for Mites

- Powdered sugar roll or alcohol wash
  - Sample size: 300ish bees (1/2 cup)
  - Perform test, count mites, compute mites per 100 bees
    - E.g. 6 mites per 300 = 2 mites per 100 = 2%
  - Double this number (maybe triple when brood rearing is at peak)
    - Why?
      - Your counting mites on adult bees (phoretic mites) not the mites in brood. 50% or more of the mites could be in with brood (at peak brood rearing it is 33% adult - 67% brood)

Why powdered sugar works for testing mite loads

- Powdered sugar clogs the mite’s ambulacrum with dust. The ambulacrum of adult female Varroa is a claw-like form (sclerites) used for grasping the hairs of bees. The claw-like sclerites of the ambulacrum enable mites to move rapidly on adult bees and other substrata.

- Stimulates the bees’ grooming behavior.

- Dust on the mite’s body may stimulate it to release from its host to groom itself.
  - An aside - One of the first products used to control Varroa was Sineacar, a mixture of powdered sugar (98.2%) and chloropropylate and bromopropylate (1.8%)
  - The idea of using a powder to dislodge is also how oxalic acid powder was discovered as a potential mite treatment (1989)
Treatment thresholds based on sugar rolls or alcohol wash

- Varies by information source and has reduced over the years
  - 8% to 12% - thought to be the economic threshold when treatment is absolutely necessary (this was back in mid 1990s)
  - 6% or less (2000 to 2008)
  - Some argue the threshold changes by the season with a lower tolerance in the spring such as 2% and then higher in summer

Variable thresholds for sugar roll

<table>
<thead>
<tr>
<th>Colony Phase</th>
<th>Acceptable (further control not needed)</th>
<th>Caution (Control may be warranted)</th>
<th>Danger (Control promptly)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Dormant&quot; with brood</td>
<td>&lt;1%</td>
<td>1-2%</td>
<td>&gt;2%</td>
</tr>
<tr>
<td>&quot;Dormant&quot; without brood</td>
<td>&lt;1%</td>
<td>&lt;2-3%</td>
<td>&gt;3%</td>
</tr>
<tr>
<td>Population increase</td>
<td>&lt;1%</td>
<td>&lt;2-3%</td>
<td>&gt;3%</td>
</tr>
<tr>
<td>Peak Population</td>
<td>&lt;2%</td>
<td>&lt;3-5%</td>
<td>&gt;5%</td>
</tr>
<tr>
<td>Population Decrease</td>
<td>&lt;2%</td>
<td>&lt;2-3%</td>
<td>&gt;3%</td>
</tr>
</tbody>
</table>
Using drone brood monitoring to decide appropriate level of control to apply – less reliable

<table>
<thead>
<tr>
<th>Proportion of infested drone pupae</th>
<th>April, May, June</th>
<th>June, July</th>
<th>August</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 2% (&lt;1 mite in 50) No action</td>
<td>2% – 4% (Between 1 mite in 25 and 1 in 50) Plan controls for season</td>
<td>More than 4% (&gt;1 mite in 25) Consider control</td>
<td>9% – 10% (Between 1 mite in 10 and 1 in 20) Light control</td>
</tr>
<tr>
<td>Less than 3% (&lt;1 mite in 30) No action</td>
<td>3% – 7% (Between 1 mite in 15 and 1 in 30) Light control</td>
<td>More than 7% (&gt;1 mite in 15) Effective control Severe risk</td>
<td></td>
</tr>
</tbody>
</table>

Treatment Options

- Varies by beekeeper’s philosophy and management requirements
  - Integrated Pest Management
    - Screened bottom boards (maybe 2-3% reduction)
    - Drone brood removal (requires constant management)
    - VSH, etc. genetic lines
    - Nectar flow or syrup to stimulate hygienic behavior
    - Small cell (lots of debate over how well this works)
  - “Soft” Chemicals
    - Organic acids – formic, oxalic
    - Essential Oils – thymol, eucalyptol, menthol
  - Synthetic Chemicals
    - amitraz, fluvalinate, cuomaphos

Number of registered treatments

- US – 11 unique products (EPA registered)
  - A couple no longer manufactured
  - 8 registered products in WI
- Europe – 13 unique products collectively
  - Apistan, Apiguard, Apilife-VAR, Checkmite+, MAQs, are common between US and Europe
    - Oxalic acid is only authorized for use in Austria, Italy, Hungary and Spain but is generally tolerated in the remaining 25 EU countries
- Canada – 8 unique products

How the treatments work

- The most commonly used synthetic Varroa treatments are based on amidines, organophosphates, pyrethroids or carbamates and all affect the nervous system of the mite (and bees too) in one way or another
  - The “trick” – need concentrations high enough to damage or kill mites but not so high as to significantly damage bees
**Nervous system structure**

- a) Electrical impulse emitted, strikes synaptic termination
- b) Liberation of neurotransmitters
- c) Neurotransmitters connect with receptors and impulse is transmitted
- d) Hydrolysis of neurotransmitters in the synaptic gap

**THE SYNTHETIC CHEMICALS**

**Apivar (Amitraz)**
- Chemical class: amidine
- Mode of action: antagonistic effect on *octopamine* receptors of the nerve cells

**Apistan (Fluvalinate)**
- Chemical class: pyrethroid
  - Penetrates cuticle of the insect
  - Mode of action: prevents the closure of the sodium channels
Checkmite+ (Coumaphos)
- Chemical class: organophosphate
- Mode of action: inhibits Ach channel

MAQs (Formic Acid)
- Chemical class: organic acid
- Mode of action: fumigant – vapors from the product kill mites through respiratory inhibition
  - (messes up the citric acid/glycolysis cycles in cells which is necessary for cell "respiration")

HopGuard (Potassium salt of Hop beta acid)
- Chemical class: potassium salt
- Mode of action: contact – mode is not completely understood
**Oxalic Acid**

- Chemical class: organic acid
- Mode of action: contact or fumigant – mode is not completely understood
  - It is thought that vapors may enter through the soft pads of the mite’s “feet” and travels to their circulatory system. It is also thought that it could damage the mite’s mouth

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**Apiguard (Thymol)**  
**ApiLife Var (Thymol, eucalyptol, menthol)**

- Chemical class: essential oil
- Mode of action: fumigant; kills the mites by disrupting their cell membranes and general cellular processes rather than being highly specific to nerve channels.
IPM Examples

- Screened bottom boards for Varroa trapping and monitoring (2-3% reduction)
- Powdered sugar dusting to control Varroa
  - (very mixed results on effectiveness)
- Drone trapping method of Varroa control
- Chickens in apiary to control small hive beetle
- Proper location and orientation of hives
- Provide clean and consistently available water source
- Hive entrance reduction when appropriate
- Frame/Comb replacement schedule (5 year schedule)

IPM Examples

- Clean/sterilized tools and equipment
- Proper storage of frames and combs
- Use of physical barriers, traps and deterrents
- Maximize distance between hives when possible or practical
- Genetic resistance and selection
- Locating hives out of sight from road traffic
- Hives raised off ground
- Vented cover for increased hive ventilation
- Feed sugar water and pollen patties when appropriate to reduce stress
- Use enclosed feeders to reduce robbing

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