Master Beekeeping Part III:
Managing Pests and Diseases

Course Project

1. **Design your mite management plan.** Fill in the table below to make a plan appropriate for your operation size, your region, and your goals. *Note: Depending on your location, you may not need to fill in the blanks for every month of the year*.

***Varroa* Mite Management Plan**	
Beekeeper Name: Alan Baxter Colony location(s): 4 apiaries in Hampshire, England	Number of colonies you manage: 20 approx. plus nucs Primary beekeeping goals (honey production, pollination queen rearing, etc.): 1. Honey production, 2. Teaching, 3. Queen rearing 4. Quarantine
Will you consider using any resistant stock? If so, what kind? Yes, colonies displaying Varroa Sensitive Hygiene characteristics. I have inherited one colony which hadn't been treated for more than 4 years on which I am running tests and weekly observations. I will treat it if varroa reaches dangerous levels but hope that it won't be necessary. The colony has gentle temperament, and I will breed from it if the results are positive.	

Month	**Treatment threshold (mites/100 bees)**	**Monitoring method you plan to use**	**Cultural options you will consider**	**Chemical treatments you will consider**
January				
February				
March	2	7-day count of Mite drop through screened floor	Screened floor*	Formic Pro if mite count is more than 2
April	2	Alcohol wash	Insert drone foundation	

May	2	Alcohol wash	Drone brood removal	
June	2	Alcohol wash		Formic Pro if mite count is more than 2
July	2	Alcohol wash		Remove supers
August	2	Alcohol wash		Formic Pro
September	2	Alcohol wash		
October	2	7-day count of Mite drop through screened floor		Formic Pro if mite count is more than 2
November				
December				Oxalic acid by GasVap

***the invaluable and underestimated screened floor can provide a wealth of information about activity in the hive.**

2. Provide your response to this scenario-based question:

You're volunteering at the Dyce Lab and meeting with a commercial beekeeper to help him develop a mite management plan. The commercial beekeeper manages 1,000 colonies and has four employees to help him in the bee yard. He keeps his colonies in New York from May to October and then brings them to Florida from November to April. For the past two years he has lost an average of 35% of his colonies each year, mostly due to *Varroa* mites. Below is his *Varroa* mite testimonial:

"I manage my colonies for honey production, so I purchase Italian queens every year. I have never monitored for mites, but I don't need to because they are everywhere — I usually see them in the drone brood that I cut out with my hive tool from time to time. Every year I treat my colonies, but I don't think any of the treatments we have on the market work anymore. I heard that you shouldn't rely on the same chemical, so I make sure to use two different chemicals every year. Nothing works, but I am doing everything right.

Each year I treat with oxalic acid three times: once in the first week of May, again in the second week of May, and again in the third week of May. I add honey supers immediately after. I remove my honey supers at the end of August and treat them at that time with formic acid. I bring my colonies to Florida in November, where the climate is mild and winters are easier for them. Still, I experience unsustainable losses."

What recommendations would you suggest he try this year to reduce his colony losses from mites? Based on the IPM approach we covered in class, what tools and methods would be most appropriate for his operation and why?

Problem. Beefarmer suffering 35% loss of colonies per year that he ascribes to Varroa resistance to all currently authorised treatments. He believes he is doing all the right things but in vain.
Evidence supplied. Mainly anecdotal and heresay. Limited evidence as to cause in the absence of resistance testing, varroa load monitoring or available hive records. No information as to whether honey harvest, assumed to be the primary business driver, is reduced also by 35% but it is to be assumed that there is some loss of production. No climatic or forage information about locations in Florida nor New York State. No financial information provided as to revenues, or costs of labour, transport, consumables, treatments etc..
Analysis.
The following seeks to consider the various factors that may be contributing to the losses. The "Costs" details cannot be fully completed at this stage but, as the beekeeper is a businessman, costs are likely to influence the likelihood of acceptance and degree of priority given to the mitigation recommendations below. His willingness to recognise the need for and readiness to embrace change will also be a factor.

1. **Varroa resistance to treatments**

Evidence
Whilst he is correct in being cautious about resistance to some chemical treatments, says he hasn't carried out any testing on any of his colonies so there is no data to support his claim. The likelihood of causing loss is high because he avoids using techniques and products that could reduce his losses.
Solutions.
Carry out resistance tests e.g. the Beltsville Test[1] on sample colonies and adapt the treatment regime according to the results.

'Soft' chemical treatments using naturally occurring ingredients are less likely to cause resistance than the 'hard' chemicals authorised for use in the USA[2] so consideration should be given to the use of these products if the resistance testing so indicates.
Likelihood of success High.
Cost implications are minimal apart from some labour during testing.
2. Varroa monitoring.
Evidence
No monitoring is being carried out, so the beekeeper has no information about the need for and efficacy of his treatments. He is blaming his losses on varroa and resistance to treatments whereas they may be multi-factorial in origin. He says he eschews all chemical treatments because he believes they don't work but offers no evidence to support this claim, and then, inconsistent with his stated beliefs, says he uses Oxalic Acid and Formic acid twice a year.
Solutions
Monitoring to be carried out by isopropyl alcohol wash[3] once a month throughout the beekeeping season before and after any chemical treatment. Choose a sample of hives to monitor, say 10% of the total stock in each apiary. Establish a threshold above which treatment is required. 2% or 6 mites per half cup of bees is recommended.[3]
Likelihood of success High.

Cost implications limited to the cost of the test materials and labour costs which are not available. Cost savings may be achieved if the quantity of treatments needed is less.

3. Timing of treatments.

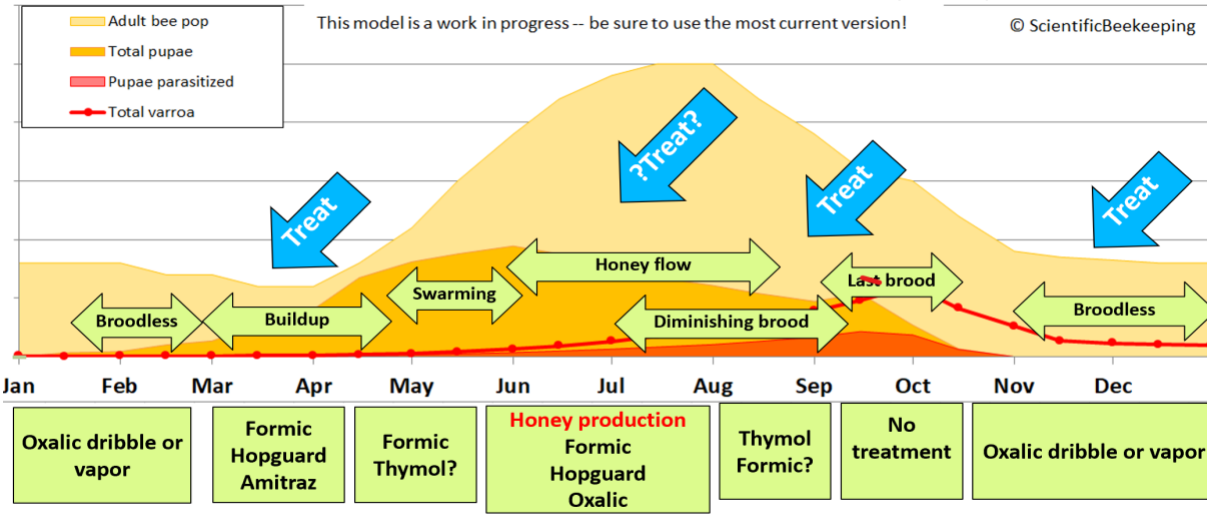
Discussion

Honey bee mortality can be significantly reduced by ensuring that treatments for *Varroa* occur within specific timeframes. Varroa can destroy colonies if not treated at key time points to reduce or remove infestations. Beekeepers who mis-time *Varroa* mite treatments experience exacerbated colony losses, with this effect occurring across a wide range of medications[4].

In the case of this beekeeper, the long delay between treatments, from August to May, is likely to be a factor in his losses, allowing the mites a long period of time to rebuild their population before the next treatment, at a time when the colonies are growing and there is increasingly more brood for the mites to reproduce in. Lack of monitoring exposes the colonies to unacceptable levels of infestation and high risk from infections such as Deformed Wing Virus (DWV) which reduces its victims' lifespan by about two thirds[5]

Solutions.

The following chart is an illustration of how colonies can be given appropriate treatment when the threshold is exceeded, at times when it is most needed for it to be optimally effective[6].



Appropriate treatments for time of season

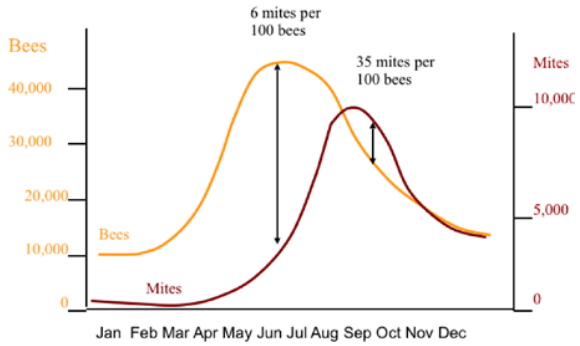
The choice of treatment is at the discretion of the beekeeper but should be dependent on the results of the resistance tests.

Likelihood of success High.

Cost implications. Estimated to be positive in the form of savings by only giving treatments when necessary, saving the cost of replacing lost colonies and lost honey production.

4. Cultural actions a.k.a. biotechnical measures

Evidence
There is no evidence that the beekeeper is employing cultural measures apart from occasional drone brood removal.
Solutions
Using open mesh (screened) floors allows mites to fall out of the brood box and onto a sticky board where they can be counted and cannot climb back into the brood area, thereby reducing reinfestation.
This arrangement can also be used to assess the degree of varroa resistance in the colony by observing damaged mites, larval remains and removed cappings.
Drone brood removal can reduce the varroa load during the periods when there is drone brood available. *But the real battleground is worker brood* which is infested to a greater degree for much longer periods, particularly in the autumn when the varroa population is at its most dangerously high as shown in this graph[7]:



Adding of a frame of drone foundation to each colony in spring, and removal for destruction before the adults are due to emerge, can temporarily reduce the mite population to the level lower than the trigger point for applying treatment, but the mites continue relentlessly to reproduce in the worker cells rebuilding their numbers quickly if not treated.
Likelihood of success Medium
Cost implications replacement of solid floors with open mesh (screened) The cost of drone brood foundation is neutralised by the saving on worker foundation.
5. Migration of colonies.
Discussion
Migration over the very long distances between the northeast and the south of the country and back again puts the bees under stress, thereby increasing their vulnerability to pests and diseases. Being locked in the hive for several days at a time and subjected to movement, noise, vibration and heat with no opportunity to leave the hive to defecate and forage for nectar, pollen and water must have an impact on the bees' general health and wellbeing.
Compared to their stationary counterparts, migratory colonies experience greater exposure to pesticides and lower quality forage all of which may increase susceptibility to disease [8]
Wintering in the mild southern climate means there is no brood break to interrupt the varroa reproduction cycle. The bees continue to work instead of the colony having a period of low activity in winter, the varroa continue to reproduce and their numbers continue to rise. The reduction in lifespan of the winter bees infected with DWV means that they are dead by the end of the year, leaving a diminished colony unable to thermoregulate or tend the queen and any brood.

Researchers at Cornell examined why Florida beekeepers experienced losses of up to 90% of their colonies, and $4.28 million in revenue, though the damage was limited to a few very large commercial honeybee operations. Early indications are that neonicotinoid pesticides, possibly used to control Asian citrus psyllid pests on oranges, were to blame.[10]

The beekeeper doesn't say which part of Florida he visits. Climate, plant communities, and timing of floral resources differ significantly between the three main regions in Florida: north Florida, central Florida, and south Florida[11]. It would be helpful to have more information on this matter

Another Cornell study found a high level of pesticide use in apple orchards in New York State, leading to significant losses of honey bee colonies.[12]

Nutritional stress is associated with land use intensification and the expansion of monoculture agricultural areas, which deprives bees of the necessary polyfloral pollen needed to fulfil their nutritional requirements.[13] If the bees are kept in areas where these conditions are present this could be a contributory factor in his losses.

It seems that the choice of business model (ie migrating colonies rather than staying in one place) and the locations where the summer and winter operations take place might play a part in the beekeeper's difficulties.

Likelihood of causing losses High

Solutions

It is assumed that ending migration to areas where the bees are exposed to stress, poor nutrition and high levels of pesticides is not negotiable. The solution must lie in mitigating the effects of the migration by changing husbandry practices in the following ways:

- Frequent changes of brood comb to provide a clean living environment free of accumulated larval debris and the chemicals used to treat the colony and those brought into the colony by the foragers or blown in on the wind.
- Leaving each colony with enough of their own stores to survive the journey and the winter period instead of removing all the honey with all its nutritional benefits, and resorting to artificial feeding of 'junk' food in the form of sucrose syrup and pollen substitutes.

Cost implications

In the absence of financial information and details of the business model it is difficult to evaluate but it is hoped that the improvements would be at least cost neutral.
Extra cost of foundation and frames if the frequency of changes is increased plus labour.
Savings include fewer losses and gains can be achieved with increased honey production.

6. Choice of queens

Discussion

A.m.ligustica, the Italian honey bee, originates from the Mediterranean region where the summers are hot and dry, with a nectar dearth between May and August. Winters are mild with comparatively little rainfall. Mediterranean forage is commensurate with this climate with

region-specific species, a strong nectar flow in spring and a dearth from May to August. The Italian bee is genetically adapted to these conditions.
Summers in NY State are warm and humid, with nectar flows in spring and summer, whilst in Florida the temperature and level of humidity are high all year round.
The Italian bee is known for its ability to build big strong colonies with queens capable of laying up to 2,000 eggs a day but has the disadvantage of poor navigation skills leading to drifting and potential spread of pests and diseases. They are reported to be profligate with winter stores and require supplementary feeding to avoid winter/spring losses[14]. Their lifespan is shorter than other species and they must produce more brood to offset this.

In a trial in Malta[15] A.m.ligustica was found to have less effective hygienic behaviour than locally adapted bees and a lower colony survival rate when infected with varroa.

Another study comparing Varroa Sensitive Hygiene (VSH) colonies and Italian colonies in U.S. commercial apiaries found VSH colonies required fewer mite treatments during the study period: Only 12% of VSH colonies required mite treatments, while 40% of Italian colonies required mite treatments. Furthermore, both stocks produced similar amounts of honey.[16]

This would suggest that A.m. ligustica is not the sub species of honey bee best adapted for the north-eastern and southern climatic conditions, the rigors of migration, and the type of forage available to them.
Likelihood of causing loss high.
Solutions
Other sub species of honey bee have traits that are more adapted to the conditions under which the beekeeper's stock is kept.

For example, Carniolan bees which originate in Austria, northern Yugoslavia and the Danube Valley are known for their calm and docile behaviour, winter thrift, good orientation, rapid spring buildup, less prone to robbing and spreading diseases, resistance to disease an parasites and exceptional honey production.[17]

VSH Carniolans are available in the market and the price is similar to that of Italians.
There are suppliers that sell pure VSH, Minnesota Hygienic, Ankle Biter, or Russian stock. Each of these has varroa resistant characteristics that might be of benefit to the beekeeper.
Recommendation

- Change supplier of queens to one who breeds Varroa resistant stock.
- Then start a selective breeding program using simple splits into nucs to raise his own queens. These to be raised from selected lines that exhibit desirable traits including Varroa Sensitive Hygienic behaviour and are better adapted to the conditions in the areas where they are deployed.
- Careful observation and record keeping are required for this to succeed.

Cost implications This would require initial investment in more equipment if he hasn't enough already, and time, but would save money thereafter from buying queens every year, loss of honey production and replacing lost stock.

Likelihood of success High.

Summary of recommendations

- Carry out chemical resistance tests to establish which treatments are effective for the current stock.
- Introduce monthly varroa monitoring to establish varroa levels and give treatments when the load exceeds 2%.
- Modify the timing of treatments according to the results of monitoring and avoiding long periods between treatments when the varroa population grows unchecked.
- Make more effective use of cultural methods of control to reduce dependence on chemical treatments.
- Improve stock husbandry during migration to reduce the impact of stress on the colonies.
- Review the choice of queens in favour of sub species that are resistant to varroa and more adapted to the climate and forage in the northeast and south of the country.
- Establish own queen rearing operation from selected stock that evidence varroa resistant behaviour and are adapted to local conditions.

Summary of benefits

- Fewer losses of colonies
- Increased revenue from honey production
- Reduced cost of replacement queens
- Reduced expenditure by more efficient use of chemical treatments

References

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2. https://extension.psu.edu/methods-to-control-varroa-mites-an-integrated-pest-management-approach
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4. https://news.exeter.ac.uk/uk/cornwall/improved-treatment-timing-reduces-honey-bee-losses-to-varroa-mites/
5. Martin & Grindrod Natural Varroa-Resistant Honey Bees BBKA Special Issue Series 2020
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16. https://www.lappesbeesupply.com/beekeepers-blog-about-beekeeping/?p=italian-honey-bees&srsltid=AfmBOoo4z8xAoej_HDVAuHZc6n0UCiaQWLAFZ7hElwGNNAcogEDuKlHd
17. https://apiexpert.eu/carniolan-honey-bee/

3. Provide your response to this scenario-based question:

At your beekeeping club meeting there is a lot of discussion about Randy Oliver's new "oxalic acid and glycerin shop towel" method for treating *Varroa* mites. Everyone thinks this might be the silver bullet for managing mites. Take some time to investigate this method online and answer the following three questions:

a) How do you use this method?

The product consists of Oxalic acid diluted in glycerin solvent embedded into strong paper towel material. Strips of the material are laid on top of the brood frames; in the case of double brood box configuration, it is placed between the brood boxes. Mites in the reproductive phase inside sealed brood are unaffected but the slow extended release of the active ingredient over several brood cycles delivers the miticide and kills the adult mites in the phoretic (dispersal) stage of the varroa life cycle.

Randy Oliver's experiments demonstrate encouraging results but have to be viewed in the context of his geographical location (California). Other trials indicate different outcomes in other climates. For example one study showed no effectiveness in reducing varroa parasitism in colonies exposed to the towels, others arrived at different conclusions (see below).

This is a summary of the alleged advantages and disadvantages of the technique**:**
Pros and cons[1]
Pros

- Works well even when brood is present
- Has little or no adverse effects on the colony
- Can be applied while honey supers are on
- Can be used in hot weather
- Very easy and safe to apply
- Doesn't contaminate the beeswax
- Very inexpensive
- Considered "organic".

Cons

- It takes at least 6 weeks for the treatment to be fully effective.
- The low dose, slow release is ineffective in cases of heavy infestation
- Some colonies fail to remove the residue after treatment
- Homemade mixture with no meaningful controls on safe dosage limits.

The tested efficacy of the method has produced conflicting results in a number of independent trials. For example a study published in the Journal of Insect Science found *"No evidence to support the use of glycerol–oxalic acid mixtures delivered via paper towel for controlling* Varroa destructor *(Mesostigmata: Varroidae) mites in the Southeast United States"* [2].

Whereas a four-year assay published in the Journal of Apicultural Research found *that the application of strips with 21% (w/v) OA diluted in glycerin and water seems to be more practical, leading to a successful Varroa control even in seasons with brood presence*[4].

Another trial by a team at Auburn University of a slow-release oxalic acid formulation showed its potential as a summer treatment under U.S. beekeeping conditions. While it was not a curative treatment, it limited the growth of Varroa infestations, so may be beneficial as a supplemental treatment in U.S. conditions[5].

b) Are we at the stage where we can recommend this as an effective treatment in the Northeastern U.S.? Why or why not?

All the above is of academic interest because, as far as I can discover, the legal position is far from clear.

In New York State in 2022 it was announced that beekeepers could legally use homemade slow release Oxalic treatments in their hives. Then, in 2023 the authorization was rescinded.

No information could be found about other northeastern states including Maine, Vermont, New Hampshire, Massachusetts, Rhode Island and Connecticut.

In 2024 the US Environmental Protection Agency (EPA) announced that they were no longer going to restrict the use by beekeepers of generic homemade products such as Oxalic acid towels, but subsequently announced that they were passing the problem to the Food and Drugs Administration (FDA) for the registration, sale and use of chemical products for varroa control. A Search on the FDA Website produced no results[3] and a search of the EPA website was equally fruitless.

A cynic might speculate that powerful vested interests are at play.

Therefore, as a Master Beekeeper advising my club, my inclination is to say that it is better not to use it until the definitive legal position is known. Insurances could be invalidated, and the club's officers and individual members could be liable. Seeking professional legal and insurance advice would be a sensible way forward.

Also it would be prudent to wait until the scientific community produces peer reviewed research on the use of this technique and arrives at a consensus.

Alternatively, it might be possible if the club took part in a research program licensed by the appropriate authorities sponsored by or in collaboration with a research institute. A citizen science project might also be envisaged but it would require a structure that satisfied the license requirements.

Finally, and most importantly, there is no silver bullet for the treatment of varroa. A program of Integrated Pest Management employing a combination of chemical and cultural methods is required in function of the results of regular varroa load monitoring and the seasonal life cycle of the honey bee colony and the varroa mite.

c) Are there any potential risks to recommending this method? If so, what are they?

- Risk of overdosing or underdosing, or of residue escaping into the environment because there are no official guidelines on composition and strength of the treatment.
- Breaking the law, with Officers of the Club and individual members suffering penalties if caught.
- Severe financial consequences for the Officers and members of the Club in any successful insurance claim for which the cover was invalidated because you were in default of the law.

Include any references you used in the space below (websites, books, magazines, etc.):

1.https://scientificbeekeeping.com/extended-release-oxalic-acid-progress-report-4/
2. https://academic.oup.com/jinsectscience/article/23/6/18/74589572.
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5. https://etd.auburn.edu/handle/10415/9251

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