Predatory mites against the poultry red mite

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Introduction

Occurrence of the poultry red mite

• The poultry red mite ‘PRM’ *Dermanyssus gallinae* is the most important ectoparasite of laying hens in Europe (*Chauve 1998*)

• The prohibition of conventional cages was expected to cause higher infestations due to more hiding places for PRM

• In Finland, PRM probably occurs in the majority of the commercial hen houses

• In the EU egg industry, economic costs of PRM (control and losses) have been estimated at €130 million per year (*van Emous 2005*)
Introduction
Occurrence of the poultry red mite
Introduction
Effects of PRM on laying hens

- PRM feeds on blood of hens during night hours
- Feeding of PRM may cause stress to hens and affect restless behavior
- The presence of PRM can cause blood spots on eggs
- Substantial feeding of PRM may reduce egg quality by thinning of shell
- High infestation may cause anaemia and even death of hens
- PRM may serve as a vector of pathogens
- PRM may suck also human blood and cause skin irritation
Introduction
Current control of PRM

• Prevention of initial infestation
  • PRM free pullets
  • Good hygiene to avoid PRM transportation by people, animals and goods

• Disinfection during the production break
  • Chemical disinfectants, acaricides, heat treatment

• Cleaning and vacuuming

• Acaricides, also during the egg production
  • Phoxim (Byemite) registered as a vet medicin against PRM
  • Permethrin, Pyrethrins registered against insects and mites indoors (in general)
Introduction
Problems in pesticide use

• Very few pesticides available (registered against PRM)
  • Organophosphate acaricide phoxim (Byemite)
• Difficulties to use during egg laying period
  • ByeMite is allowed but difficult to avoid contamination of birds
• Doubts of safety and environmental contamination
• Development of resistance to synthetic pesticides in mite populations
  • Permethrin and other pyrethroids
• Insufficient effectiveness
• Difficult to get good coverage during egg laying period
Introduction

Biological or non-chemical alternatives

• Biological pesticides, earlier used for plant protection
  • Bacteria: *Bacillus thuringiensis*, *Sacharopolyspora spinosa* (Spinosad)
  • Fungi: *Beauveria bassiana*, *Metarrhizium anisopliae*

• Inert dust products
  • Silica based products (diatomaceous earths)
  • Sodium bicarbonate, aqueous suspension

• Plant derived products
  • Extracts of neem (Azadirachtin)
  • Essential oils (e.g. Paralice)

• Vaccination?
Introduction
Biological control by predatory mites

- Only few known natural enemies of PRM
  - *Cheyletus eruditus* – Acari: Cheyletidae
  - *Androlaelaps casalis* – Acari: Laelapidae
  - *Stratiolaelaps scimitus* – Acari: Laelapidae

- Model from greenhouses
  - Repeated ample releases of predators
  - Candidate species: soil-dwelling predaceous mites (Laelapidae)

- Laboratory experiments: feeding and reproduction
  - Selected species: *Stratiolaelaps scimitus* (=*Hypoaspis miles*)

- Layer house experiments
  - Cage and free-range systems
Potential biocontrol agents

**Cheyletus eruditus**

- *C. eruditus* is a predatory mite that commonly lives in bulk food stores such as granaries.
- It is also often found in animal feed, poultry litter, and mammal and bird nests.
- Its diet comprises a variety of insects and mites.
- It is present in many countries around the world.
Potential biocontrol agents

Androlaelaps casalis

- *A. casalis* is a soil dwelling predatory mite that preys on other mites and small invertebrates.
- It is present in soils worldwide.
- Recently, it has been introduced as a predatory mite against red poultry mite (e.g. Koppert B.V. NL)
Potential biocontrol agents

*Stratiolaelaps scimitus*

(*Hypoaspis miles*)

- *S. scimitus* is a soil dwelling predatory mite that is currently used in greenhouses against thrips and gnat larvae.
- It is mass produced in Finland
- This species was selected as a candidate predator against poultry red mite in 2009

Photo: Izabela Lesna
Laboratory experiments

- *Stratiolaelaps scimitus (Hypoaspis miles)*
- Tests in petri dishes
- Female and male predatory mites in dish
- Fed daily by surplus of eggs, larvae or nymph stages of PRM
- Registered:
  - Number of consumed PRM eggs, larvae and nymphs per day
  - Number of laid eggs/day/female
Laboratory experiments

Consumption of eggs and larvae of *D. gallinae* by two (female+male) *Hypoaspis miles*
Laboratory experiments

Egg production of *Hypoaspis miles* fed with eggs of *D. gallinae*
Laboratory experiments

Summary

• *Stratiolaelaps scimitus* completed the life cycle when fed on PRM eggs and larvae
• *S. scimitus* consumed 1.5 eggs or larvae of PRM/day
• *S. scimitus* produced 1.5 eggs/day when fed by PRM
• *S. scimitus* produced 40 eggs in 30 days when fed by PRM

✓ Egg laying was comparable to the egg laying when fed by acariid mites (used in massproduction)

✓ PRM lays 2-3 eggs/day – twice that of *S. scimitus*

✓ For any control effect *S. scimitus* mites are needed more than the initial adult PRM population?
Cage battery experiments

- The first effort in a small (960 hens) layer house
- Three batteries with pairwise cages of 8 layers
- Weekly introductions of *S. scimitus* after the first ocular observation of PRM in slow release sachets (1000 mites) placed on the roof of the cages (only the middle battery)
The first experiment: Results
- PRM population followed by corrugated cardboard traps
- Green arrows indicate the introductions of *S. scimitus*

**Biological control against Poultry red mite**
MTT layer house (2008)

- **DG, all stages / sample**
- **Hypoaspis miles releases**
- **Untreated**

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The first experiment: conclusions

• In the beginning the treatment cages were significantly more infested than untreated
• The ocular observation of PRM was too late for monitoring
• During the first weeks some control effect noticed both in treated and untreated cages – the predatory mites moved also vertically in the battery (a few found in traps)
• Majority of *S. scimitus* left the sachets in two weeks
• After four weeks PRM population started to grow again
• Too low humidity is a critical factor for predatory mites
• Byemite treatments were effective and only a few mites were trapped in late December
### The second experiment: methods

- Monitoring of PRM by cardboard traps
- First mites in the traps triggered the introductions
- Fortnightly releases of *S. scimitus* and *Hypoaspis aculeifer* in slow release sachets (1000 mites) placed on the roof of the cages (only the middle battery)

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Green: *H. aculeifer* Yellow: *H. miles* Pink: untreated cages

-------------------- Manure

Door
The second experiment: results

- Arrows indicate the release dates (4.2.-28.5.)
- Vertical blue line indicates the possible effective period of earlier Byemite treatments
- Four weeks after the last release of predatory mite PRM population exploded
Second experiment: conclusions

- First PRM were noticed seven weeks after the last Byemite treatment
  - In the laboratory tests the effect of Byemite treatment lasted at most 100-120 days
- Cardboard traps revealed the infestation in time
- No real untreated control was possible to arrange in the same layer house
- PRM population growth was slow when compared to the previous experience of PRM population
- The results encouraged to start experiments in commercial layer houses
Farm experiments: how to manage?

How to release the predatory mites
- Cage batteries and free range aviaries – different methods?
- Slow release sachets are possible only in cage batteries as hens will peck them immediately to pieces
- In aviaries PRM spend the daytime in various places depending on the structures – how to get predators into the right places?

Several methods studied in free range aviaries
- Short pieces of drain pipes, filled with predatory mite production materials fixed in perches
- Same units put on roofs of nests
- The idea was to provide predatory mites the possibility to reproduce in aviaries
Methods of introductions

Paper bags

Pieces of drain pipes
Farm experiments: monitoring trap

Velcro trap (MTT model)
Farm experiments: results (example)

- **Case: modern free-range aviary (2011-2012)**
  - Two floors, in all 21000 layers
  - One quarter of the upper floor treated by *S. scimitus*, other parts (7/8) of the aviary left untreated
  - Releases of *S. scimitus* in pieces of pipes, 180 predators/layer (on the roof of nests in the treated part) at 3-4 weeks intervals
  - PRM follow-up by velcro-trap (MTT) fixed around perches in different parts of the aviary

- **Results**
  - PRM numbers stayed low for two months, but exploded after four months
  - PRM numbers in the treated area did not differ from untreated
  - Indications of better effect in the perch next to the nests
Farm experiments: results

Blue arrows: releases of *S. scimitus* (in pieces of drain pipes)
Farm experiments: results (example)

• Case: conventional free-range hen house (2012)
  • Old cowhouse furnished for 7000 layers
  • Loose materials of *S. scimitus* spread on the roofs of nests and into the floor, each time 10-35 predators/layer, at 4-5 weeks intervals, with a summer break, in all 110 predators/layer/year
  • PRM follow-up by velcro-traps fixed round perches in different parts of the aviary

• Results
  • PRM numbers stayed tolerable in Jan-May, in June-Sept PRM was not monitored but no problems were reported, and again in Oct-Dec PRM numbers stayed low
  • Considerable numbers of *S. scimitus* were present in the traps
Farm experiments: results

Blue arrows: releases of *S. scimitus*
(in pieces of drain pipes)

Biocontrol experiment
Old conventional free range hen house, 2012
Farm experiments: results

- **Case: organic free-range hen house (2013)**
  - 9000 layers, in three separated units
  - High initial PRM infestation, high mortality of layers in the start of the test
  - Loose materials of *S. scimitus* spread on the roofs of nests and on the wooden perches, each time 75 predators/layer, at 2-3 weeks intervals, in all 375 predators/layer in June-August
  - PRM follow-up by velcro-traps fixed round perches

- **Results (preliminary)**
  - PRM numbers stayed high, releases of *S. scimitus* affected the growth of PRM population but did not reduce it significantly
  - Layers’ mortality figures returned almost the normal level
Farm experiments: conclusions

- Introductions of *Stratiolaelaps scimitus* can limit the growth of PRM population in various environments.
- However, in most conditions *S. scimitus* was not able to reproduce or colonise in the henhouse.
- Repeated introductions are needed in most cases.
- Early detection of PRM is essential for proper timing of introductions.
- Better release methods of predatory mites are needed.
- Construction and structures of henhouse devices may influence PRM population growth and success of biological control.
Challenges for biological control by predatory mites

- Prevention of initial infestation: the basis of PRM control
- Integration of different preventive and direct control methods
- Reliable monitoring method in different layer systems
- Improvement of structures for better coincidence of predator and prey
- Improvement of release methods for biological control agents
- Repeated introductions according to monitoring results: how much, how often?
- Search for better biocontrol agents for PRM still going on
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