10. Arthropod pests in poultry production

10.1 Litter Beetles

The litter beetles, *Alphitobius diaperinus* (the lesser mealworm), *Typhaea stercorea* (the hairy fungus beetle), *Ahasverus advena* (the foreign grain beetle) and *Carcinops pumilio* are commonly found in Danish poultry houses. These beetles are very difficult to control and often constitute a pest problem. In addition to their role as potential transmitters of human and avian disease, litter beetles can cause structural damage to poultry houses, can cause allergies, and are often a considerable nuisance.

A. Spencer

10.2 The role of litter beetles in the transmission of disease

This year saw the completion of a major three year study with the following specific objectives: (1) to investigate the occurrence, biology and behaviour of the beetles, (2) to develop and implement strategies for the prevention and control of the beetles, and (3) to investigate if persistent infections with *Salmonella* or *Campylobacter* are related to the occurrence of beetle infestations. The project involves collaboration between the Danish Veterinary Laboratory, the Danish Poultry Meat Association, the Danish Pest Infestation Laboratory (project co-ordinator), and many veterinarians and poultry meat farmers. The conclusions of the report are detailed in the final project report.

Most of the major conclusions of this study are detailed in the 1998 DPIL Annual Report.

Work will continue into the role of insects (including litter beetles) in the transmission of disease to livestock animals.

A. Spencer

10.3 Insecticide resistance in litter beetles

Our earlier work indicated that in many poultry facilities, litter beetles were apparently surviving significant insecticide use. This led us to hypothesize that insecticide resistance may be contributing to the control problems common in these facilities. We therefore carried out a resistance survey of Danish broiler houses. *Alphitobius diaperinus*, *Typhaea stercorea* and *Ahasverus advena* adults from up to 14 farms were analysed by residual exposure to three discriminating doses of five insecticides. This study found no evidence of significant resistance in any of the populations tested. From this we have concluded that resistance is unlikely to contribute to the widespread control failure experienced. Furthermore, the lack of resistance, even in populations from heavily treated houses, probably indicates that beetles are not exposed to the insecticides used.

A. Spencer

10.4 The control of litter beetles

Having concluded that current efforts to control litter beetles are largely inadequate. It is our intention to study the control of litter beetles in more detail in the future in an effort to overcome this problem.

A. Spencer

10.5 Behavioural response of the chicken mite to host-related stimuli

Chicken mites (*Dermanyssus gallinae*) are blood-sucking ectoparasites of poultry. The mites spend most of the time hidden in cracks and crevices in the vicinity of the birds, and they come out to feed mostly during the night. However, preliminary observations have shown that after a few days of starvation mites will also come out to search for a host during the day when stimulated with vibrations. The aim of this study was firstly to determine the frequencies of vibrations most effective in activating the mites, and secondly to investigate how carbon dioxide and vibrations affect the behaviour of chicken mites under different light intensities.

Mites taken from our laboratory culture were isolated in small arenas on plexi glass platforms and starved for at least 4 days prior to the experiments. The mites were stimulated with pure sine wave vibration pulses delivered to the platform on which they were standing, and with pulses of carbon dioxide (approximately 40%) blown on the mites. The experiments were carried out under different light intensities (3 to 80 lux) and the responses of the mites were recorded on video tapes for subsequent analysis.

Video analyses have shown that 2 kHz is the frequency of vibrations most effective at activating the mites. Furthermore, the behavioural response of chicken mites to vibrations and in particular carbon dioxide is highly dependent on the light intensity.

At the lowest light intensity (3 lux), the mites are activated by carbon dioxide as well as vibrations and there is a synergistic effect in case of subsequent stimulation with both types of stimuli: the mites start running fast and they continue to run for a long time, giving the impression that they are searching for a host.

At the highest light intensity (80 lux), carbon dioxide alone can have a weak, activating effect on resting mites. Already active mites react to carbon dioxide with a freezing response: they stop and remain motionless for a variable period. Vibration pulses activate the mites mostly during the pulse but also to some extent in between pulses. In the case of subsequent stimulation with both types of stimuli, the mites react to carbon dioxide with the freezing response and are activated by vibrations, but only for the duration of the pulse - as soon as the vibrations stop, the mites stop moving.

This behavioural response pattern is interpreted as a protection mechanism against being eaten by the potential host. A blow of carbon dioxide simulating the breath of a bird indicates that the bird might have seen the mite moving and therefore the best chance of surviving is to stop and remain motionless. A motionless mite, being no more than 1.0 mm long, is very difficult to see, particularly because birds usually see moving objects the best. Subsequent vibrations indicate that the bird is moving with its attention no longer on the mite and therefore it is relatively safe to keep searching for the host.

This is a behaviour that has never been described before, but it could be common among other ectoparasites having to approach a potential host during day time.

O. Kilpinen

10.6 Activation of chicken mites by a temperature gradient

Ten adult female mites were placed on each experimental platform and kept under a reversed day/night rhythm. All experiments were performed during the dark period on mites which had been starved for 5-8 days. The mites were stimulated with heat by a lamp underneath the platform The light bulb was controlled from a computer outside the room through a relay and a rheostat. A synchronous signal was sent to an LED placed next to the experimental platform, visualising stimulation periods on the video recordings. The behavioural reaction was recorded on video tape throughout the experiments.

Before and after each test, the temperature gradient was measured on an identical platform with a temperature probe fixed to the surface. The average temperature gradient (before and after stimulation) was assigned to each test.

By recordings of the fraction of mites being activated by the temperature gradient it was possible to estimate a threshold value of 0.005°C/sec. necessary for the activation of chicken mites. The results showed that temperature changes are an extremely effective activating stimulus which could be employed in the development of future control methods as a way of increasing the exposure to a control agent.

O. Kilpinen

10.7 Influence of parasitic infestations on the behaviour and health of laying hens (*Gallus gallus domestica*)

There has been conflicting reports about the effects of ectoparasitic chicken mites (*Dermanyssus gallinae*) and endoparasitic nematodes (*Ascaridia galli*) on livestock poultry. Therefore, experiments were initiated to investigate this question in collaboration with the Royal Veterinary and Agricultural University in Copenhagen.

Six experimental rooms each with 15 hens were installed at the RVAU. Two groups were infested with *D. gallinae* (D-groups), two groups were infected with *A. galli* (A-groups) and two uninfested groups were kept as control (C-groups). All groups were weighed weekly, and blood samples were taken three times during the experiment. Behavioural observations were made continuously, and video surveillance was carried out during the night. The infestation levels of ecto- and endoparasites were under continuous surveillance.

The chicken mite population showed an exponential increase to a peak level where the nuisance to everybody (man and animal) was so high that barriers were made of insecticides applied to the walls and in adjacent rooms in order to restrict the movement of the mites. However, this also had the effect that the mite population levelled out and partly decreased towards the end of the experiment.

At the peak of the mite infestation, the D-groups showed clear signs of anaemia as the average, packed cell volume was only 0.16 compared with 0.24 in the C-groups and 0.23 in the A-groups. Furthermore, the concentration of haemoglobin in an average blood cell was lower, and the volume of an average blood cell was higher. This indicates that the hens were losing blood (due to the mites) and that they compensated for it by increasing the production of erythrocytes. New erythrocytes are larger and have a lower concentration of haemoglobin than mature erythrocytes. At this time in the experiment, 6 out of 15 birds (40%) died within 6 days in the most heavily infested room. But the experiment was continued as the mite pressure levelled out, and the hens recovered.

Both treatments resulted in a significantly lower body weight. Almost from the initiation of the chicken mite infestation, the hens in the D-groups stopped gaining weight, and at the time when the mite population increased rapidly, the hens actually lost weight.

Behavioural observations showed that mite infested hens spend significantly more time with light feather picking activity - probably due to the mites running on the feathers and on the skin. This was observed both during the day and during the night. In one observation, on the average the hens in one of the mite infested rooms spent half the night with this activity, compared with 5-10% in the other groups.

No significant changes were observed in the immunological blood parameters, but this might be due to a large variation within the groups.

These studies clearly showed the massive impact that large populations of mites can have on the behaviour and physiology of hens. It is obvious that mite infestations must be controlled in order to improve the health and welfare of infested poultry.

O. Kilpinen

10.8 Preliminary screening of fungal isolates for control of chicken mites

As a preliminary screening, adult female chicken mites were exposed to spore suspensions of six different fungal isolates; two isolates of *Paecilomyces fumosoroseus*, two isolates of *Metarhizium anisopliae* and two isolates of *Beauveria bassiana*. The most promising candidate was an isolate of *B. bassiana* that caused 85% control within eight days. Further studies will be carried out to reveal in detail the fungal isolates with the best potential for control of chicken mites.

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