DEPARTMENT for ENVIRONMENT, FOOD and RURAL AFFAIRS

Research and Development

Final Project Report

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Project title	Monitoring of red mite habitat preference and distribution in a barn egg production system, and strategies for control
DEFRA project code	**AW0224**
Contractor organisation and location	ADAS Consulting Ltd Gleadthorpe, Meden Vale Mansfield, Notts, NG20 9PF
Total DEFRA project costs	£ 39,541
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Executive summary (maximum 2 sides A4)

Poultry red mite (*Dermanyssus gallinae*), is a serious and widespread welfare problem for the UK egg industry. Heavy infestation of poultry houses can result in loss of egg production because adult female mites feed on chicken blood, and in severe cases the birds can become anaemic. The irritation caused by the mites has also been implicated in outbreaks of aggressive pecking and cannibalism. Little is known about the distribution of mites within houses, although it is presumed that they do not live on the birds, preferring to migrate on to birds during darkness to feed, before retiring into harbourages such as crevices etc. during the daytime. For this reason the extent of infestations is not always easy to determine. Knowledge of habitat preference and population distribution in barn systems would help in formulating strategies for more focused and effective control.

The main objective of this work was to monitor red mite numbers during an egg-laying cycle, and assess their spatial distribution and preference for specific habitats, so that more effective control strategies could be recommended.

The work took place in collaboration with a commercial egg producer in Nottinghamshire. Two barn egg houses and one free range house were monitored. All three houses were populated within a week of each other. Each of the three poultry houses was divided into four sections for monitoring

purposes. A number of red mite traps (artificial harbourages) were installed at various locations in each house section. Traps were collected and replaced once a fortnight and mite numbers counted. Traps were sited on nestboxes, egg belts, drinkers, feeders, stairs and roof vents. Periodic assessment of the proportion of different lifestages of the mites (larvae, protonymph, deutonymph, adult male and adult female) was also determined. Samples of feed and litter were assessed for evidence of red mites, and spot checks were carried out during the dark period to assess mite activity levels. Production data for the houses were obtained from the commercial house records. Data obtained included production, mortality and egg size. The timing of chemical treatment events (and products used) within the houses was noted.

The population in free range house A increased gradually from mid February, whereas the population in the barn houses B and C started to increase from late December to early January. Mite numbers were very variable between trap positions in the house. Most mites were found on the feed trough, nest box or egg belt (more than 50000 mites were present in some traps), with fewer on the drinkers and stairs. No mites were found on the vents in the roof until very late in the laying year.

On four occasions within the life of the flocks used in this study a chemical red mite control treatment was used. Dates were 16 March 01, 18 May 01, 15 June 01 and 12 July 01. The monitoring data show that the chemical acaricides seemingly had little lasting effect on the population of red mites within the houses.

Production peaked at about 90% in all three houses. Egg size generally increased over the period of lay. Mortality was quite high reaching 15.5% in the free range house and 17% in the two barn houses by 70 weeks of age.

The lifestages of the mites present were determined every 2 months, with mites being classified as larvae, protonymph, deutonymph, adult male and adult female. Large numbers of all lifestages were identified in all three houses at each sampling occasion, suggesting the populations were constantly increasing. A more static population would consist of a greater proportion of adult mites.

The study showed that the egg industry would be advised to adopt a new approach to the major welfare issue of controlling poultry red mites. Red mites have been shown to have clear habitat preferences within the barn house system, although when the mite population is very large all areas of the house are used. This implies that the distance travelled by some mites to reach a blood meal can be quite considerable.

The study has also clearly established the need to “design out” of poultry houses the perfect red mite refuges that are found at present in a typical barn system. The feeder and nestbox systems are metal and wooden structures that have many unsealed joins and junctions, which are ideal red mite refuges. These problems should be avoidable in new installations, but existing houses can be modified during clean-out between flocks. The use of a silicon sealant in the folds and joints of house furniture would be a simple, cheap and potentially effective control measure.

The finding that small numbers of mites were present in the roof vents towards the end of the flock is potentially useful for the planning of the clean out strategy between flocks. Less attention may be paid to cleaning the areas of the house that are not actually inhabited by the birds, resulting in small numbers of red mites surviving in less stringently cleaned and treated areas, that can subsequently infect the next flock to be housed.

Recommended control strategies, suggestions for further work and knowledge transfer activities are discussed.

Scientific report (maximum 20 sides A4)

Background

Poultry red mite (*Dermanyssus gallinae*), is a serious and widespread welfare problem for the UK egg industry. Heavy infestation of poultry houses can result in loss of egg production because adult female mites feed on chicken blood, and in severe cases the birds can become anaemic. The irritation caused by the mites has also been implicated in outbreaks of aggressive pecking and cannibalism. Little is known about the distribution of mites within houses, although it is presumed that they do not live on the birds, preferring to migrate on to birds during darkness to feed, before retiring into harbourages such as crevices etc. during the daytime. For this reason the extent of infestations is not always easy to determine. Knowledge of habitat preference and population distribution in barn systems would help in formulating strategies for more focused and effective control.

Objective

The main objective of this work was to monitor red mite numbers during an egg-laying cycle, and assess their spatial distribution and preference for specific habitats, so that more effective control strategies could be recommended.

Methods

The work took place in collaboration with Dean's Foods Ltd at their Walesby, Nottinghamshire site, where two barn egg houses and one free range house containing laying hens at different stocking rates were made available for the study. Birds were housed at 9.07 birds m^{-2} in the barn houses and 11.7 birds m^{-2} in the free range house.

Each of the three poultry houses was divided into four sections for monitoring purposes. A number of red mite traps (artificial harbourages) were installed at various locations in each house section. The traps were small pieces (2cm x 8cm) of corrugated plastic that provided shelter for the mites. Traps were collected and replaced once a fortnight. Where small numbers of mites were present a direct count was used, but in heavily infested traps the 'Hawksley slide sub-sample' method, an established technique for quantifying entomological samples, was employed. The contents of the red mite trap were washed into a 25 ml universal tube using 50% industrial methylated spirits (IMS). The tube was then filled to volume with further IMS. The mite and alcohol suspension was mixed with a pipette and exactly 1 ml was pipetted onto the counting grid of the Hawksley slide. Three separate counts were carried out, an average taken, and the average mite number was multiplied by 25 to obtain the total mite count per trap.

The extent of infestation in different parts of the buildings was assessed by siting traps on nestboxes, egg belts, drinkers, feeders, stairs and roof vents. Changes in distribution and abundance of mites was then monitored and plotted throughout the laying year. Periodic assessment of the proportion of different lifestages of the mites (larvae, protonymph, deutonymph, adult male and adult female) was determined in order to monitor the status of the mite population (increasing, static or decreasing).

Samples of litter and feed were collected from each house at intervals in order to assess the extent of mite infestation via a different method than trapping using artificial harbourages.

At intervals throughout the life of the flock "spot check" assessments were made during the dark period to assess mite activity levels. Mites hide in cracks and crevices during the day, moving out during the hours of darkness to find a bird for a blood meal before retreating back to their hideout. Mite activity at the various house locations (nestboxes, egg belts, drinkers, feeders, stairs and roof vents) was monitored using a sticky tape trap. The trap was pressed onto the surface of the house furniture once only close to the site of each harbourage trap. Number of mites adhering to the sticky surface was assessed.

On one occasion, a randomly selected group of birds from each of the houses was assessed for evidence of mite activity. This also occurred during the dark period as this is when the mites move onto the birds for a blood meal. Virtually no mites were found on the birds so this assessment was not repeated.

Production data for the houses were obtained from Deans Foods house records. Data obtained included production, mortality and egg size. The timing of chemical treatment events (and products used) within the houses was noted.

<u>Statistical analysis</u>

This was an observational study in which there were no experimental treatments *per se*. The monitoring data gave rise to highly variable and skewed distributions. Attempts were made to analyse the data using an analysis of variance, e.g. a repeated measures analysis, but the sparse count data at the beginning of the experiment and the number of missing values made some computations impossible. However, the marked non-uniformity of variance of the data, even when logarithmically transformed to base 10, made the results from an analysis of variance questionable. As an approximation a Kruskal-Wallis test (non-parametric) was performed on the data from the last five monitoring periods.

Results

Red mite monitoring

The red mite numbers, distribution and habitat preference for each of the sections of the three houses are presented in figures 1 to 12. The population in free range house A increased gradually from mid February (birds aged around 33 weeks), whereas the population in the barn houses B and C started to increase from late December to early January (birds aged around 26 – 29 weeks). Mite numbers were very variable between trap positions in the house. Most mites were found on the feed trough, nest box or egg belt (more than 50000 mites were present in some traps), with fewer on the drinkers and stairs. No mites were found on the vents in the roof until very late in the laying year.

Chemical control events

On four occasions within the life of the flocks used in this study red mite control treatments were used. Dates of treatment were 16 March 01, 18 May 01, 15 June 01 and 12 July 01. The same product was used on the first two application dates and different products on each of the later dates. The monitoring data show that the treatments used seemingly had little lasting effect on the population of red mites within the houses.

Alternative sampling techniques

Very few, if any mites were found in the feed and litter samples, the spot check samples taken during the dark period, or the ‘on bird’ counts. These tests are therefore not considered any further in this report.

Production data

Trends in the production data for the houses monitored for red mite are presented in figures 13 – 15. Production peaked at about 90% in all three houses. Egg size generally increased over the period of lay. Mortality was quite high reaching 15.5% in the free range house and 17% in the two barn houses by 70 weeks of age. However this is not unusual for barn houses and the red mite is therefore not thought to be a direct cause of this high mortality.

Figure 1. House A (free range), section 1

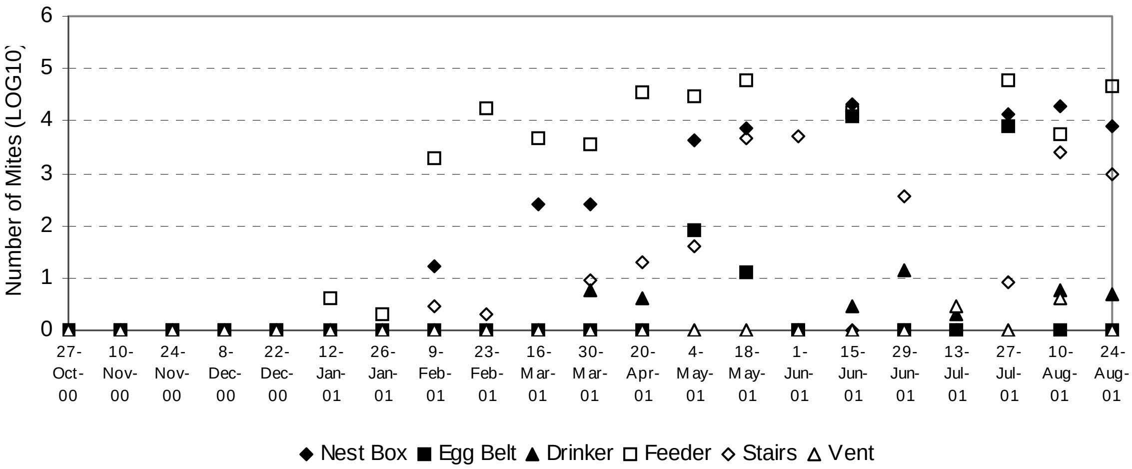


Figure 2. House A (free range), section 2

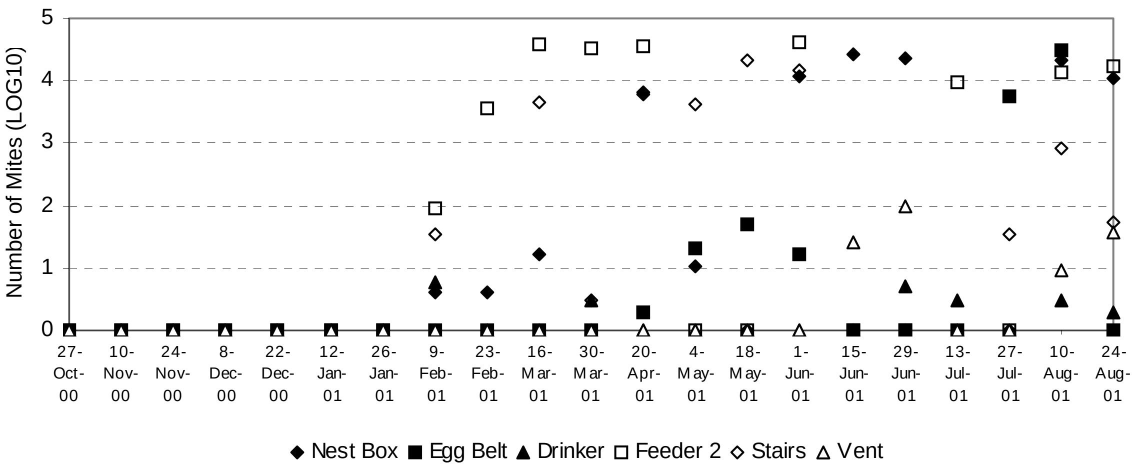


Figure 3. House A (free range), section 3

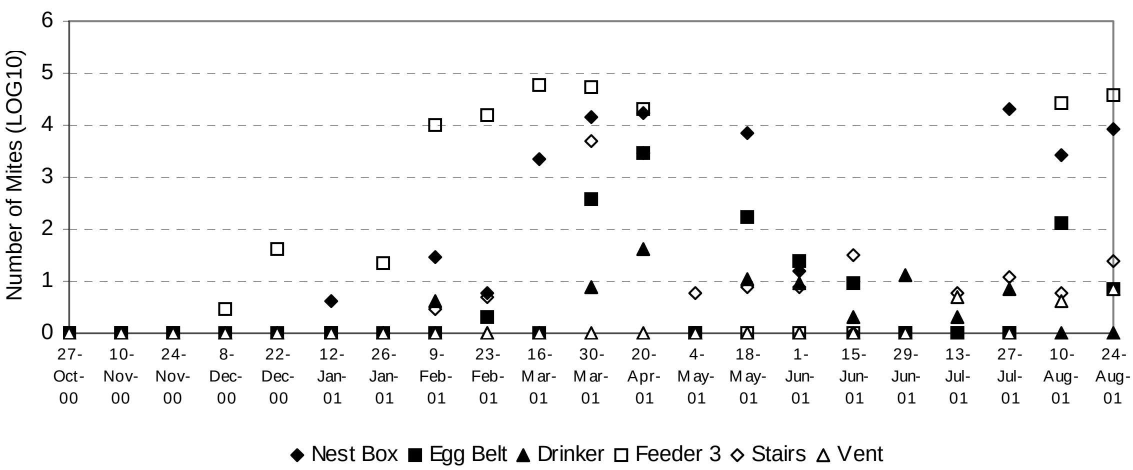


Figure 4. House A (free range), section 4

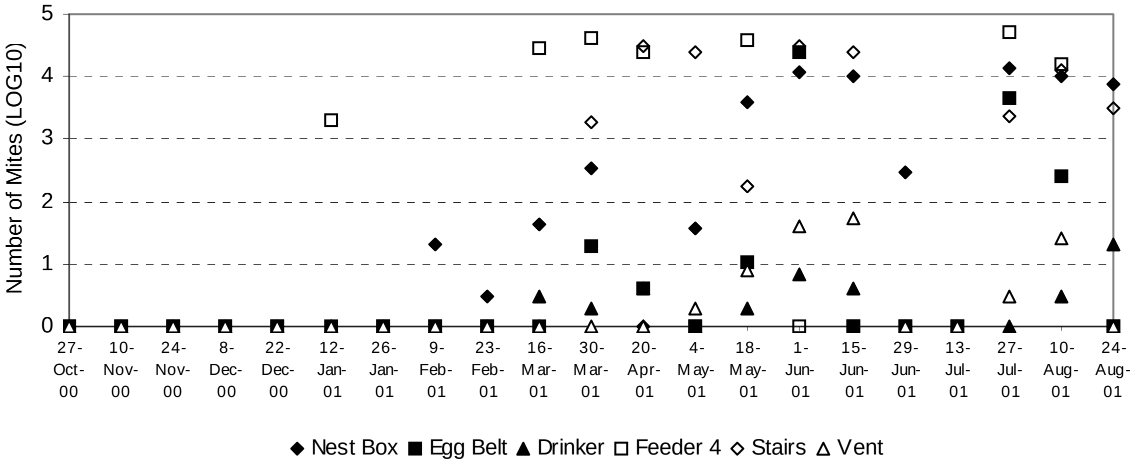


Figure 5. House B (barn), section 1

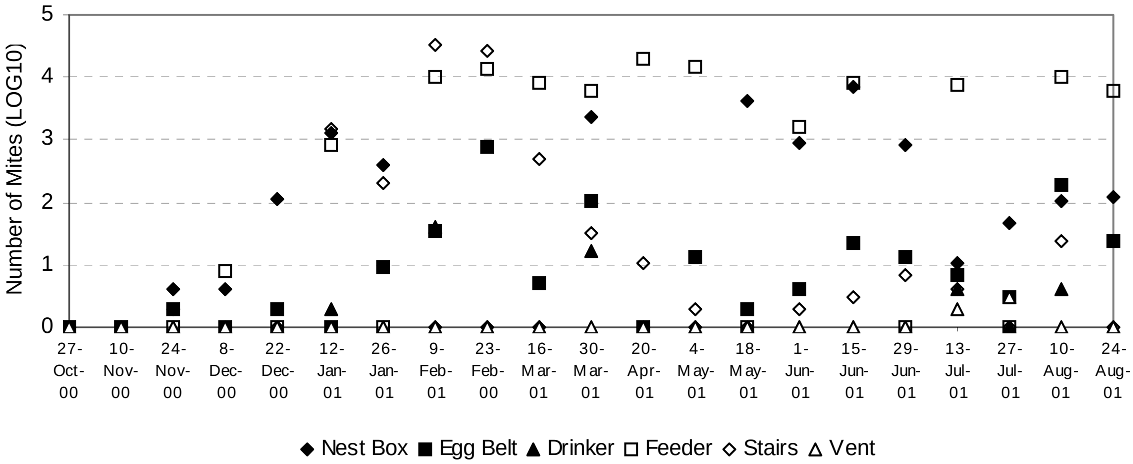


Figure 6. House B (barn), section 2

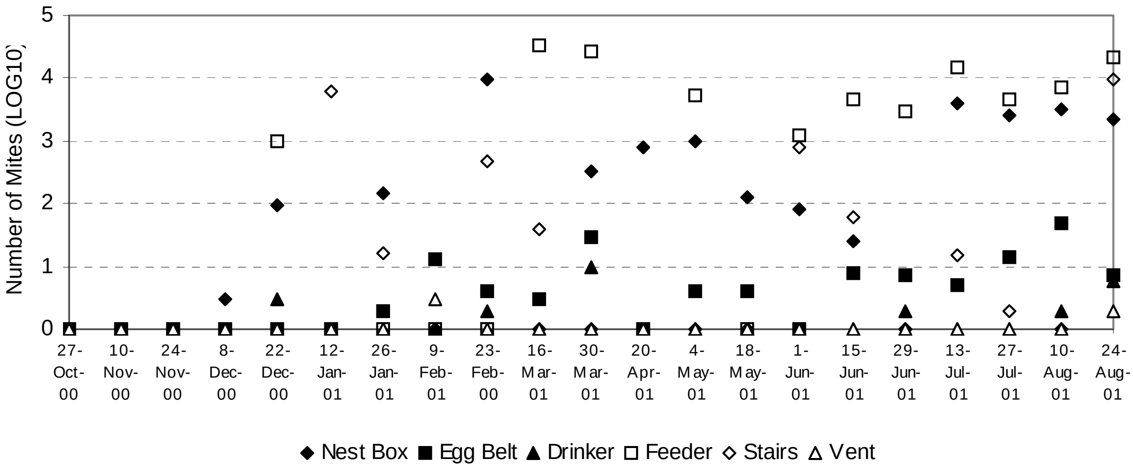


Figure 7. House B (barn), section 3

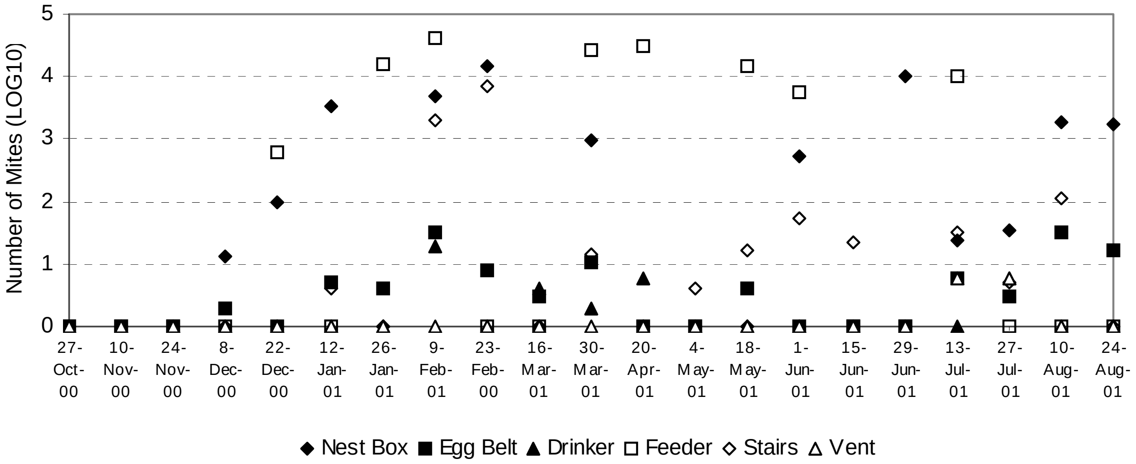


Figure 8. House B (barn), section 4

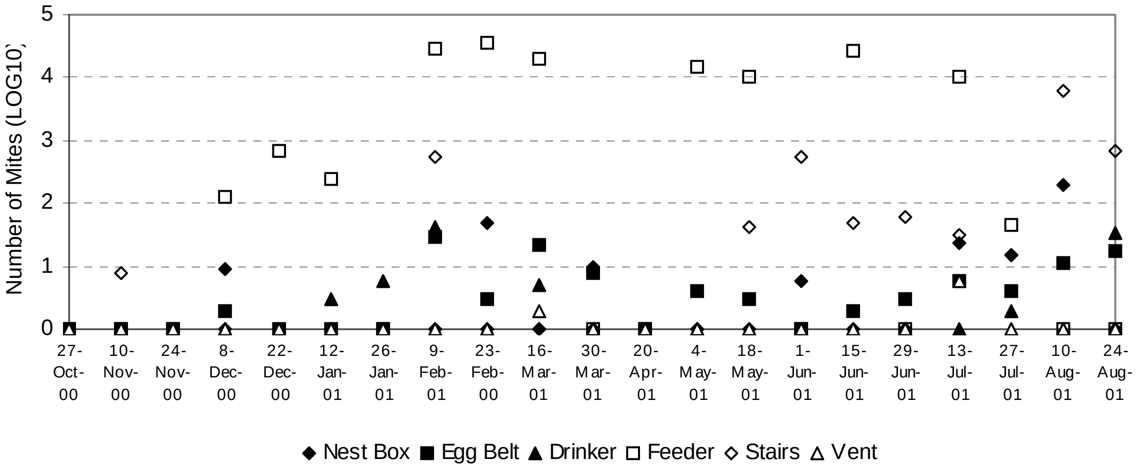


Figure 9. House C (barn), section 1

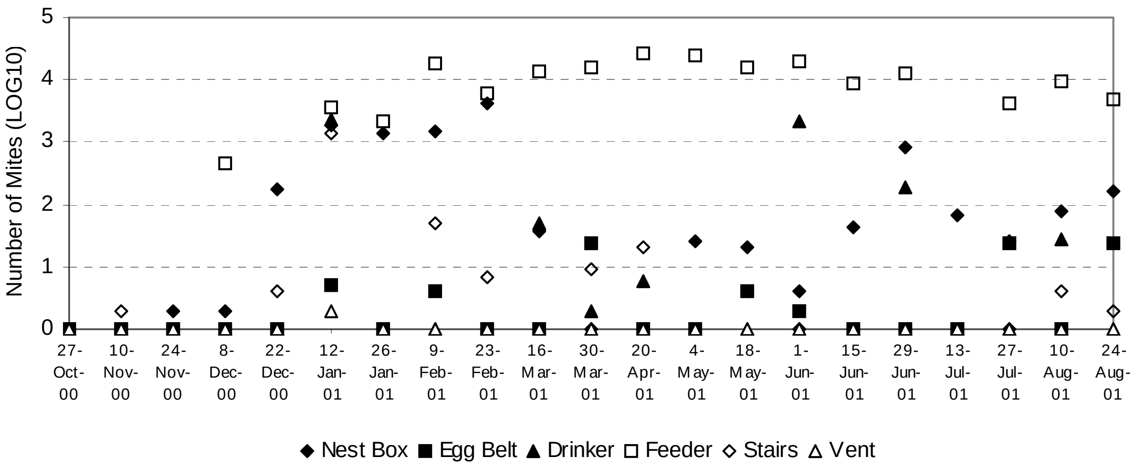


Figure 10. House C (barn), section 2

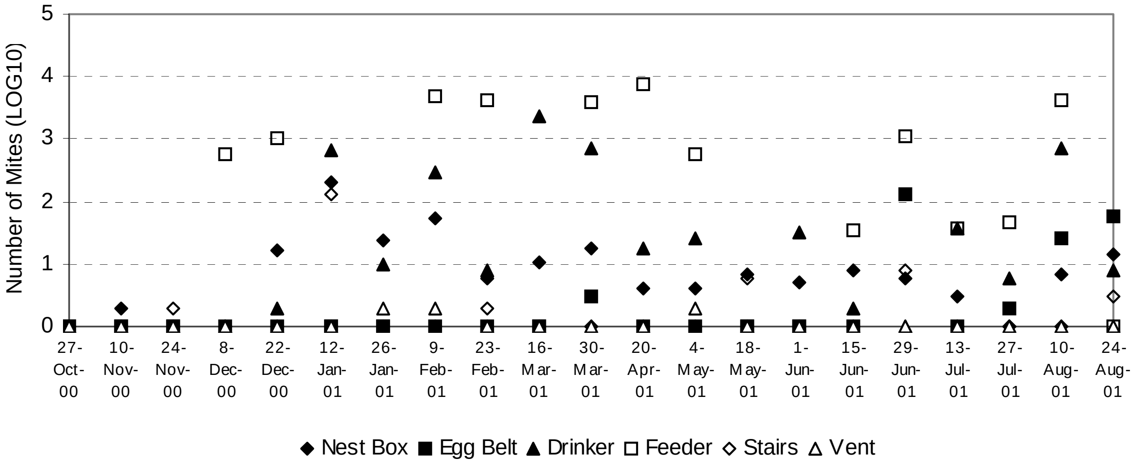


Figure 11. House C (barn), section 3

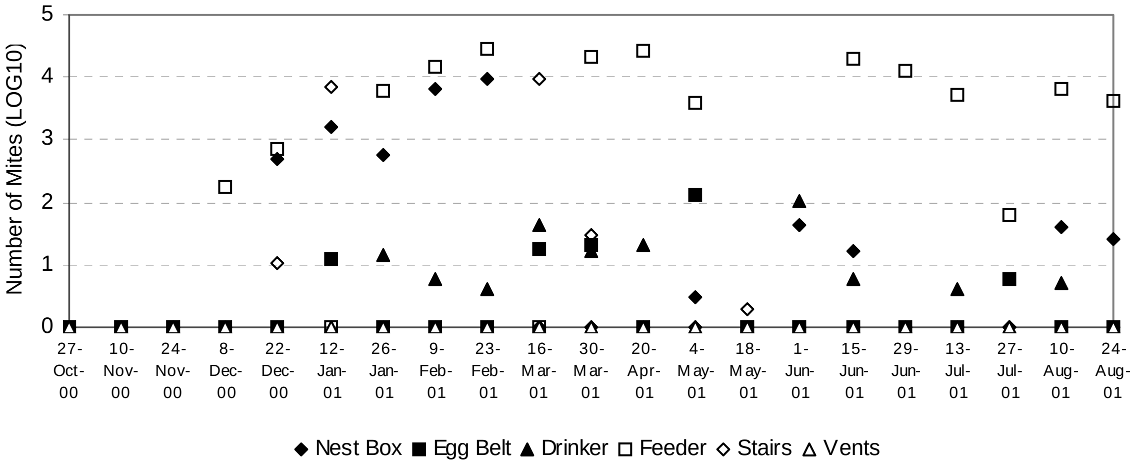
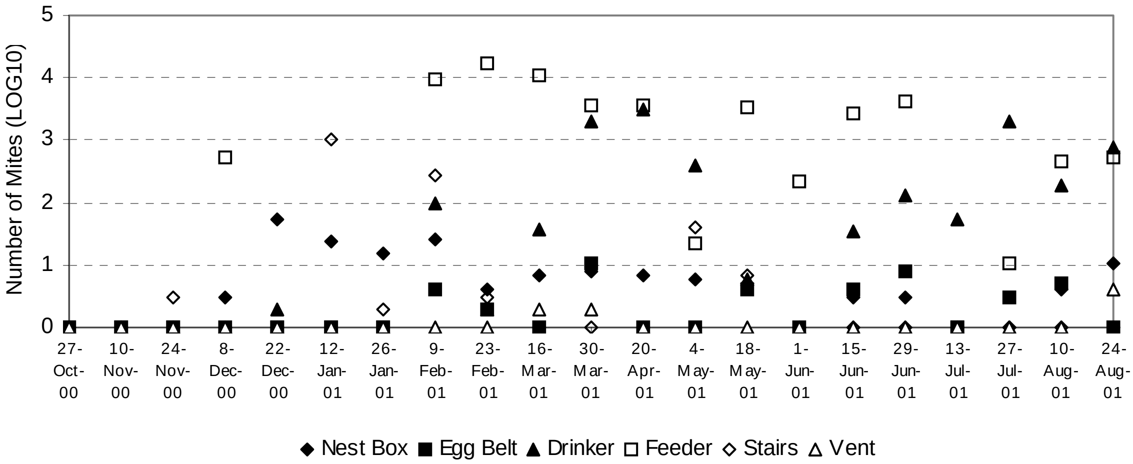


Figure 12. House C (barn), section 4



For the monitoring data there was generally a significant difference between specific sites where traps were placed, with the greatest mite count always found by the feeder (table 1). The nest box and egg belt were also popular locations for red mite refuges. No mites were found in the artificial harbourages in the roof vents until the last few monitoring periods when a few mites were present. This supports previous findings (Nordenfors and Höglund, 2000) that the mites prefer to hide during the day in crevices close to the birds' roost sites.

Table 1. Statistical significance (Kruskal-Wallis test) and specific trap location site in decreasing order of mite counts with count median derived from logarithm to base 10 data in parentheses. Key for trap site: 1=nest box, 2=egg belt, 3=drinker, 4=feeder, 5=stairs and 6=vent (vent never in top three ranking).

House	House	29th June	13th July	27th July	10th August	24th August
A	p-value	NS	NS	0.003	0.010	0.005
	Rank 1st	-	-	4(4.75)	4(4.17)	4(4.57)
	2nd	-	-	1(4.13)	1(4.14)	1(3.91)
	3rd	-	-	2(3.75)	2(2.40)	5(2.36)
B	p-value	0.05	0.008	0.017	0.005	0.70(NS)
	Rank 1st	4(3.49)	4(4.02)	4(2.65)	4(3.94)	4(4.06)
	2nd	1(3.47)	1(1.38)	1(1.61)	1(2.80)	1(3.22)
	3rd	5(1.32)	5(1.33)	2(0.54)	5(2.05)	5(1.42)
C	p-value	0.023	0.03	0.013	0.010	0.021
	Rank 1st	4(3.87)	4(2.64)	4(1.72)	4(3.72)	4(3.62)
	2nd	2(1.51)	3(1.56)	2(0.63)	3(1.86)	2(1.58)
	3rd	1(0.78)	1(0.24)	3(0.78)	1(1.22)	1(1.28)

Example of interpretation of table: On 27th July in house A there was a significant difference in the number of mites found at different trap sites (P = 0.003). Most mites were found at position 4 (feeder), followed by position 1 (nest box) and 2 (egg belt). The number of mites in the feeder trap was 56,234 (expressed as $\log_{10}$), in the nest box trap there were 13,490 mites and 5,623 mites in the egg belt trap.

Lifestages

The lifestages of the mites present were determined every 2 months, with mites being classified as larvae, protonymph, deutonymph, adult male and adult female. Large numbers of all lifestages were identified in all three houses at each sampling occasion, suggesting the populations were dynamic. A more static population would consist of a greater proportion of adult mites.

Figure 13. House A (free range) production data

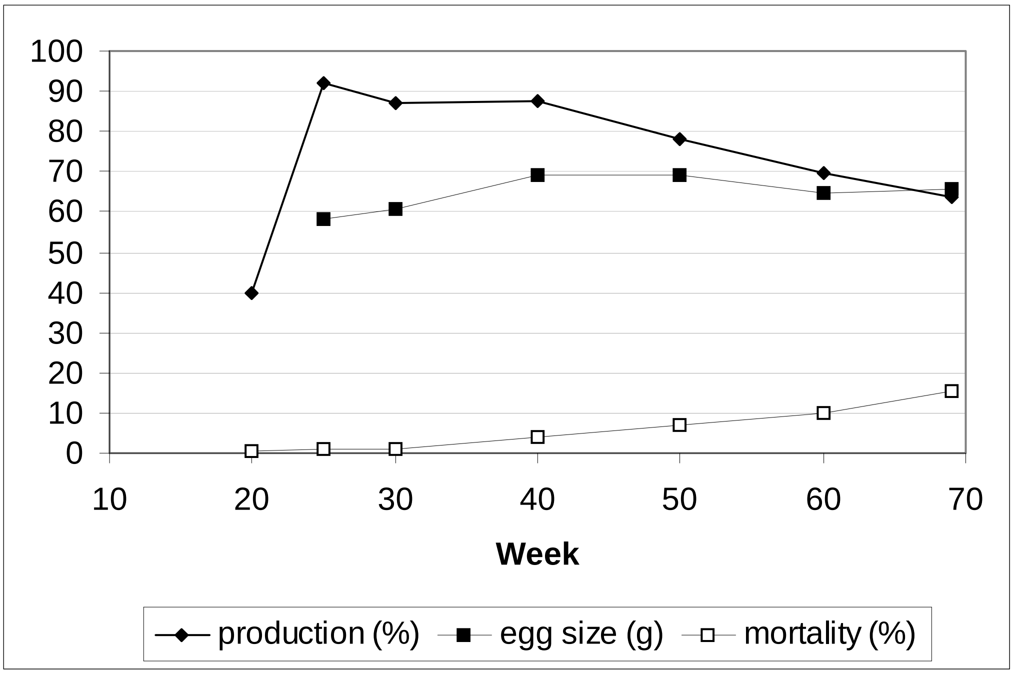


Figure 14. House B (barn) production data

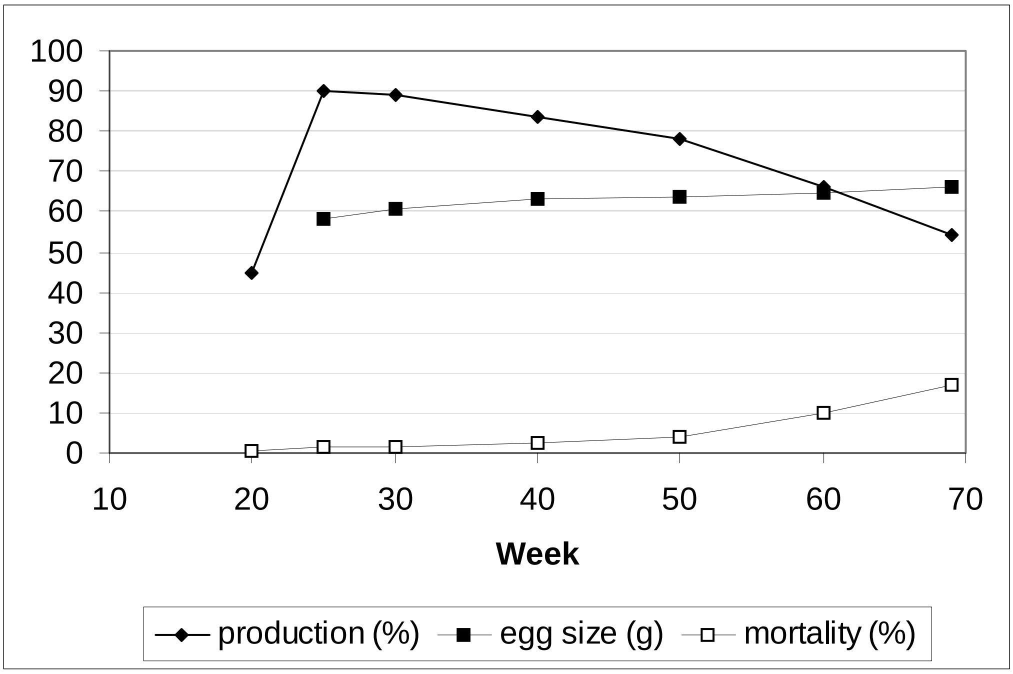
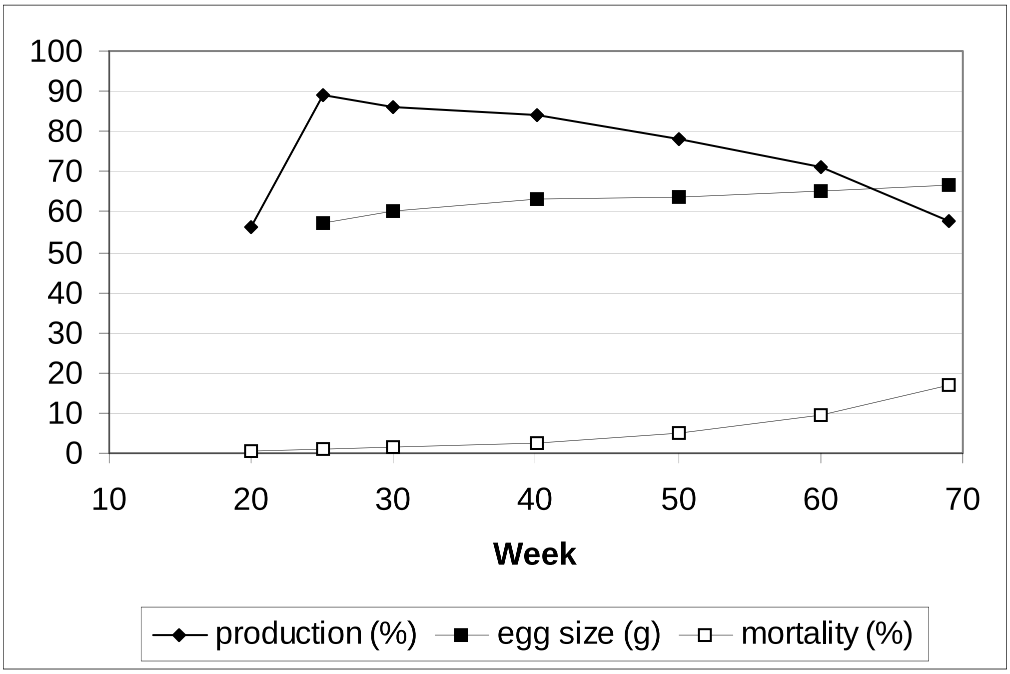


Figure 15. House C (barn) production data



Conclusions

This study has shown that the egg industry would be advised to adopt a new approach to the major welfare issue of controlling poultry red mites. Red mites have been shown to have clear habitat preferences within the barn house system, although when the mite population is very large all areas of the house are used. This implies that the distance travelled by some mites to reach a blood meal can be quite considerable.

The trapping method used in this trial has been very successful in determining the changing population of red mites within a barn system over the laying cycle. Trapping for monitoring was carried out on a fortnightly basis. However, the lifecycle of the red mite can be completed in as little as seven days in favourable conditions (warmth and moisture), so it is suggested that in future monitoring studies traps are replaced on a weekly basis.

The study has also clearly established the need to “design out” of poultry houses the perfect red mite refuges that are found at present in a typical barn system. The feeder and nestbox systems are metal and wooden structures that have many unsealed joins and junctions, which are ideal red mite refuges. Simple changes in the design of house furniture could help to control the problem by removing some of the accidental harbourages where mites can hide and multiply. These problems should be avoidable in new installations, but existing houses can be modified during clean-out between flocks. The use of a silicon sealant in the folds and joints of house furniture would be a simple, cheap and potentially effective control measure.

More precise knowledge of red mite habitat preference should enable a more integrated approach to control strategy. Current practice tends to result in “blanket coverage” rather than a targeted approach. The preferred habitats of the mites are the areas where traditional chemical control measures should be targeted. “Baited” disposable artificial harbourages may provide a means of reducing total chemical use, or such harbourages may be used in the future as a means of introduction of biological control agents into the barn in a controlled manner.

The finding that small numbers of mites were present in the roof vents towards the end of the flock is potentially useful for the planning of the clean out strategy between flocks. Less attention may be paid to cleaning the areas of the house that are not actually inhabited by the birds. This could result in small numbers of red mites surviving in less stringently cleaned and treated areas, that can subsequently infect the next flock to be housed.

Mites can migrate in search of food when necessary, they also affect wild birds and game birds (Chauve, 1998). It could be hypothesised therefore that the mites may leave the house as the temperature drops following depopulation in search of a new food source. Cleaning and treating the outside of the poultry barns as a routine part of the cleaning between flocks may therefore be an appropriate control strategy.

A monitoring programme which carried on through depopulation and clean-out, with traps positioned both inside the building and on the outside walls on possible mite migration routes would provide useful information on the persistence of red mites in poultry sheds. Kirkwood (1963) showed that red mites can survive in a poultry house environment for up to 33 weeks without a blood meal. Keeping poultry sheds empty for this length of time is obviously not economically viable. It is suggested therefore, that continuing monitoring through into subsequent repopulation of the houses will detect the first sign of red mite return (or incomplete knockdown at cleanout). Timely treatment can then be carried out, rather than waiting until the infestation has got ‘out of hand’.

Red mites are known to retreat deep into crevices within the house furniture as the house temperature cools, therefore a common sense approach is to treat with a residual acaricide as soon as the birds are removed while the mites are still active and before the house temperature drops. An alternative method is to warm the house and treat with a residual acaricide prior to repopulation. It is suggested that warming the house ‘fools’ the mites into thinking that birds are present again so they will emerge from the deep cracks and crevices in search of a blood meal and will be killed by the chemical treatment. Some of the chemical acaricide manufacturers do indeed recommend this technique as part of the product usage guide.

Recommended Control Strategies

- Design new poultry buildings and equipment to minimise built in red mite harbourages.
- Sealing folds in metal and joints in wooden house furniture with silicon sealant may reduce red mite harbourages in existing buildings.
- Use targeted, rather than blanket application of control products.
- Include a *thorough* clean of out of the way areas (eg vents) during cleanout.
- Clean and chemically treat the outside of the house (especially the eaves and the side vent outlets) as well as the inside.

- Treat the house with a residual chemical acaricide immediately the birds are removed – the mites will still be active while the house is warm.
- Warm the house up and spray with a residual acaride before repopulation.

Possible Further Work

- This trapping and monitoring project has provided invaluable information about the habitat preference of the poultry red mite. However, when conditions are favourable (warm and moist) the mites lifecycle can be as short as seven days. A study where artificial red mite traps are collected and counted on a weekly rather than a fortnightly basis would provide additional information on the spread of mites. Weekly monitoring may be able to differentiate between infestation caused by incomplete knockdown during cleanout, and the introduction of mites from an off-site source (eg on the pullet crates).
- Monitoring programmes which continue through depopulation and clean-out, with traps positioned both inside and outside the poultry house, would provide useful information on red mite persistence within the house and possible mite migration in search of food. Monitoring should then continue into the subsequent flock placed within the house, in order to detect the first signs of red mite infestation, that timely treatment can be applied.
- Many new ‘natural’ red mite control products are appearing on the market. These are either silicon diatomaceous earth products or herbal extracts such as garlic and almond. Research into the effectiveness of these products used alone or in combination with traditional chemical controls is needed.
- Biological control methods such as the use of parasitic insects or fungi may have potential as control agents of red mites, although sustainability in the poultry house is an issue that needs further research.
- The use of disposable artificial harbourages for the control method for red mite should be investigated. A daytime refuge for red mite made of a cheap replaceable material (for example corrugated cardboard) could be installed in poultry houses, and removed and destroyed (incinerated) on a regular basis. Used in combination with the active designing out of red mite harbourages within the fabric of the building, and ‘baiting’ of the harbourages with a control agent (chemical, physical or biological) this may be the control method of the future.
- Targeted industry seminars: the extent of red mite infestation in the UK poultry industry is now so serious that there is an urgent need for egg producers to be given advice on best control practice and red mite risk management. This could be achieved through a series of DEFRA – funded seminars aimed at cage, barn and free range producers, using new information derived from this project.

Knowledge Transfer and Publications

- A poster on the project was displayed at PIC in Blackpool in 2001.
- Numerous producer groups have visited Gleadthorpe and the posters have been on display and discussed.
- An abstract and poster were presented at the WPSA spring meeting in York, 2002.
- An article on red mite was published in the May 2002 edition of Poultry World.
- A scientific paper is being drafted for submission to British Poultry Science Journal.

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