

Monitoring Northern Fowl Mites (Acari: Macronyssidae) in Caged Laying Hens: Feasibility of an Egg-Based Sampling System

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ABSTRACT Northern fowl mites were monitored on a caged-layer operation in southern California for 22 mo. Three experienced observers underestimated actual numbers of mites in the vent region ~80% of the time. Errors were higher for heavy infestations. Observer estimates were highly correlated with each other ($r > 0.89$, $P < 0.01$) and with mite numbers estimated by vent feather removal ($r > 0.82$, $P < 0.01$). Mites on hens varied between houses and over time. Molting consistently reduced mite numbers, but did not eliminate them in a flock. Long-term monitoring of individual sentinel hens demonstrated that some hens would support high numbers of mites for several months or more. Use of a new sequential hen sampling plan required ~1 min per hen, if mite numbers were estimated. At this site, treatment decisions often could be reached in <20 min per house. Mite scores (index of estimated mites per hen) were well correlated with percentage of hens infested in both test houses. In a chronically infested house, prevalence of mites on eggs averaged 8.5%, with a range of 0–55%. Applications of tetrachlorvinphos-dichlorvos by the producer appeared to be based on mites on > about 20% of eggs. The chemical was marginal for controlling mites on hens (25% reduction in percentage of hens infested), but effectively reduced mites on eggs (95% fewer mites on eggs at 1 wk and 90% at 2 wk). When data were grouped by mite index score on hens, there was a strong relationship ($r^2 = 0.83$, $P < 0.01$) between mite prevalence on eggs and the scores of the hens which laid them. Sampling 100 eggs evenly spaced in a house required <7 min, and adult mites were easily seen. Sampling mites on eggs appears to be useful to localize at least high-level infestations, and egg-based sampling for mites merits further investigation.

KEY WORDS *Ornithonyssus sylviarum*, poultry, ectoparasites, northern fowl mite, sampling

THE NORTHERN FOWL mite, *Ornithonyssus sylviarum* (Canestrini & Fanzago), is considered the worst ectoparasite of poultry in the United States (DeVaney 1978, Axtell and Arends 1990). The entire life cycle requires only 5–12 d and occurs on the host, where the protonymph and adult stages feed on blood (Sikes and Chamberlain 1954, Axtell and Arends 1990, Hogsette et al. 1991). Mites are most abundant in the vent region (Lemke et al. 1988), although at high population densities, mites may be found on many regions of the body. Mite impact on poultry egg production has varied among studies, from no effect (Loomis et al. 1970) to significant reduction at moderate to high mite densities (Hall et al. 1983, Arends et al. 1984).

Although the vast majority of mites in a habitat are presumed to be on a host at any point in time, they do move away or are dislodged from the host periodically. Mite survival off-host was only one to a few days at temperatures of 37–38°C used to hatch eggs (DeVaney and Beerwinkle 1980, Kells and Surgeoner 1996). At lower temperatures, however, 50% of mites survived for ~24 d at 21°C and 28 d at 4°C (DeVaney and Beerwinkle 1980). Movement off-host may be important in mite dispersal among hens in a house, and the ability to survive and persist off-host no doubt contributes to mechanical spread of mites on equipment moved within or between flocks (Kells and Surgeoner

1996). Further, mites present on eggs and cages can readily move onto workers, and the resulting irritation is a key reason for control efforts (DeVaney 1986a, Axtell and Arends 1990).

Sampling for mites has primarily been limited to direct visual examination of the vent region of birds, using various indices. Error in estimation of mite numbers increases at high densities, which may exceed 25,000 mites per hen (Arthur and Axtell 1982, Lemke and Collison 1985). Still, such indices are the easiest way of tracking relative population changes over time, for example in experimental evaluation of acaricides for control. Regular examination of hens in commercial flocks (e.g., weekly or bimonthly) has been recommended to detect and treat infestations before they become extremely high (Axtell and Arends 1990). However, examination of even 0.1–0.2% of hens (Rutz 1981) in large modern flocks of >100,000 hens can be a very time-consuming process for routine surveillance. In an effort to improve the efficiency of sampling, a sequential sampling plan recently was developed (Harris et al. 2000). This plan used a presence-absence sampling scheme, which greatly reduced the need for subjective assessments of mite numbers by observers. It also adjusted the number of hens that needed to be examined based on the infestation tolerance level and mite prevalence, allowing treatment

decisions to be made (at least at very high and low infestation levels) by examining as few as 7–10 hens in a house.

In talking with poultry producers, we felt most of them based treatments on worker complaints of mites on eggs. The current study was conducted on a southern California caged-layer facility. Our goals were as follows: (1) to determine the degree of correlation among experienced observers in estimating infestation levels relative to actual infestations on hens; (2) to document trends in mite numbers over time in the flock in general and on individual hens; (3) to test the logistical feasibility of the sequential hen sampling plan of Harris et al. 2000, including time needed to reach a treatment decision; and (4) to observe the number of mites on eggs relative to numbers on hens. If mites on eggs proved to reflect mite numbers on hens reasonably well, this might be exploited to develop an egg-based mite sampling plan.

Materials and Methods

Study Site. The study was conducted on a caged layer poultry ranch (95,000 hens) in western Riverside County, CA. The houses were 50 m in length, narrow and open-sided ("California style"), and this location was known to have chronic mite infestations. Rows of single-tiered wire cages (two to three hens per 38 cm by 45 cm cage) were suspended 1–1.5 m above the floor. Eggs rolled into collection racks in front of the cages, where they were collected by hand daily. Manure accumulated on the floor and was cleaned out at 3- to 6-mo intervals. Two houses, one with older hens (≈ 80 wk old at the start of the study), and one with younger hens (≈ 33 wk old), were monitored weekly. The house with older hens (house 9) had 10 rows of back-to-back cages. Cages in the house with younger hens (house 18) were arranged in two long rows (back-to-back cages) in the center of the house and single-cage rows along the edges of the house. Monitoring was conducted weekly for 22 mo. Emphasis in these studies was on the younger hens (house 18).

No attempt was made to influence the producer's use of acaricides or insecticides, but we did monitor the timing of acaricide applications. This producer used tetrachlorvinphos-dichlorvos for mite control, spraying the hens from below. A hygrothermograph was placed in the house with younger hens; air temperatures and humidities were recorded at each visit immediately before examining hens and eggs for mites. Molting periods also were recorded.

Relating Visual Estimates to Actual Mite Numbers. To determine the accuracy of visual scoring, 46 hens (total) were selected over several different days. One of us visually scored a particular hen, immediately passed it to the next observer for scoring, then it was passed to the third observer. Observer order was rotated, and scores were recorded independently. The feathers then were removed from the vent area, placed into marked containers, and taken back to the laboratory. Each sample of feathers was placed in a 10% KOH solution and heated to boiling. As soon as

the feathers had dissolved (≈ 8 min), the mite remains were strained out through a #200 mesh sieve and backwashed with a small amount of fluid into a beaker. After agitation, an aliquot of the total sample was removed to a plastic rectangular counting dish with a grid on the bottom. Mites (nymphs–adults) were counted in 10-grid squares evenly distributed on the bottom of the dish and the number corrected to generate the estimate of the total mites in the sample.

Sampling Mites on Hens. Hens in house 9 (older hens) were examined by moving down a walkway and removing a hen about every 3–5 m from first the right side of cages and then the left side. With the aid of a headlamp, the vent region of each hen (a circular area 6 cm in diameter immediately anterior to the vent) was systematically examined by parting feathers. Hens were scored according to the index of Arthur and Axtell (1982). Index numbers were as follows: 0 = no mites seen, 1 = 1–10 mites, 2 = 11–50 mites, 3 = 51–100 mites, 4 = 101–500 mites, 5 = 501–1,000 mites, 6 = 1,001–10,000 mites, 7 = >10,000 mites. Based on a presence-absence judgment, we used a sequential sampling plan (Harris et al. 2000) with a fairly high 35% safe threshold (infestations below that were categorized as not needing treatment) and a 45% action threshold (infestations above that were categorized as needing treatment). The plan required a minimum of 10 hens to be examined; if all had mites, sampling was stopped, and the house was judged to need treatment. Similarly, if 14 hens were examined and all were negative, sampling stopped and the house was judged not to need treatment. Intermediate levels of infestation required continued sampling, but we curtailed the sampling at 50 hens and categorized this as a treatment decision. The time required to reach a decision was documented at each visit. The treatment decisions were strictly for our own evaluation purposes and were not used at all by the producer in actual treatment decisions. Similar sampling was conducted in house 18 (younger hens). Hens in the general population were examined and scored weekly as above.

Sentinel Hens. In addition to the sampling in the general house 18 population, we deployed sentinel hens there for repeated sampling of the same hens over time. Twenty hens, selected for various levels of initial mite infestation (from no mites to heavy mite infestations), were selected from the regular flock. They were then put into individual cages, which were spaced evenly throughout the house (five per row). Colored leg bands were put on each hen for identification. Cages were numbered and identified as University of California test sites. Mites on the hens were monitored weekly using the scoring index. Mite scores were recorded after they had been in the cage alone for 1 wk. For the first 8 mo, new hens were selected from the general house population on a monthly basis. In the second year of the study, the same 20 hens were kept individually for an entire year. The same observer usually evaluated the sentinel hens.

Estimating Mites on Eggs. Eggs from the general hen population (not sentinels) in house 18 were examined weekly for any presence of mites. The ob-

Table 1. Differences among observers in estimating northern fowl mite numbers visually on 46 caged-laying hens, and relationships to estimated actual numbers of mites recovered from vent feathers

Estimates ^a	Individual 1	Individual 2	Individual 3
% underestimates	85	78	83
% accurate estimates	15	20	15
% overestimates	0	2	2
% false Negatives ^b			
Actual 1-10 mites	75	50	75
Actual 11-50 mites	17	17	17

^a Estimates refer to the index score assigned by the observer after visual examination of the hen versus the score based on actual number of mites estimated on the feathers following feather digestion and laboratory counting. Visual score < actual score is an underestimate; visual score = actual score is accurate; visual score > actual score is overestimate.

^b N = four hens for 1-10 mites, n = six hens for 11-50 mites.

server moved through the house without looking down at the collection racks. At ~50 locations, evenly spaced throughout the entire house, the observer placed their hand on top of a cage and spot checked the 1-3 eggs found in front of that cage. The eggs were not touched unless there was uncertainty as to whether a mite or another type of spot was seen. This was repeated until 100 eggs had been examined. Records were kept on the number of eggs infested, and also on the time required to check the eggs.

The sentinel hen eggs were separated from the other eggs by a single horizontal cage wire affixed to the collection rack. Eggs from each of these sentinel hens were checked for mites to relate mites on the egg to mite infestation level on the hen. The observer first examined each egg for any mites. The number of mites on each egg was recorded. After the last hen's egg had been examined, the observer went back to the first hen, checked again for any mites on eggs, then examined that hen for mites and scored. This continued until all 20 hens were examined and eggs were checked for a second time.

Results

Relating Visual Estimates to Actual Mite Numbers. In general, all three observers had a distinct tendency to underestimate actual mite numbers estimated by feather removal. Of the 46 hens judged, 24 had heavy infestations (score of 6-7), 11 had moderate infestations (scores of 3-5), 10 had light infestations (scores of 1-2), and only one hen had no mites. Observers underestimated mite numbers (assigned them to the wrong score category) 78-85% of the time (Table 1). Two observers overestimated the mite number on a single hen each, and estimates were accurate 15-20% of the time. Of the 46 hens, four actually had 1-10 mites, and six had 11-50 mites. The three observers regularly missed the very low infestation level (two or three of the four hens), but only missed detecting 17% of hens with a moderately low infestation of 11-50 mites. Converting the index scores to their midpoint value (i.e., a score of 2, with the score range of 11-50

mites, was given a numerical value of 30 mites; a score of 7 was 20,000 mites), observers 1, 2, and 3 judged the 46 hens to average 1,337, 1,537, and 1,532 mites, respectively. The estimated mean number of mites based on feather digestion was 4,121.

The actual hen infestations estimated from feather digestion were broadly grouped as heavy (scores of 6-7), moderate (scores of 3-5), and light (scores of 1-2). If an observer failed to categorize those infestations accurately (i.e., categorize them in the broad groupings correctly), they were termed large underestimates. These large underestimates were more likely to occur with heavy infestations (79.2%) and moderate infestations (69.7%) than with light infestations (36.7%).

The three observers' visual scores were very highly correlated with each other, however ($r = 0.895-0.935$, $P < 0.01$). They also were well correlated with actual infestation level based on mite estimates from feather digestion ($r = 0.881, 0.852$, and 0.823 for observers 1, 2, and 3, respectively, $P < 0.01$).

Seasonal Patterns of Mites on Hens. The infestations among the older hens in house 9 are presented in Fig. 1. As the study began, the hens had recently completed a molt. Infestations built through early January declined for several weeks, and built again until spring, requiring six tetrachlorvinphos-dichlorvos treatments. The old hens then were removed and new, clean, young hens were brought in. Although these hens remained uninfested for several weeks, they required tetrachlorvinphos-dichlorvos treatment in September, which reduced the infestations below 20%. Infestations increased again in late fall, but declined substantially following treatments early in 1997.

The pattern in house 18, which initially had younger hens, was quite different. Hen infestation percentages are shown in Fig. 2 and air temperatures in Fig. 3. This house had very chronic mite infestations, and the producer applied nine applications of tetrachlorvinphos-dichlorvos over the study period in an attempt to control them. While the applications did reduce the mite infestations, the reduction in prevalence (percentage of hens infested) averaged only 25% 1 wk after a spray and 28% 2 wk afterward. Average mite scores of infested hens were nearly unchanged, from 2.96 before a spray to 2.81 and 2.71 1 and 2 wk afterward, respectively. It was not until a complete molt in late June that mite infestations finally declined to low levels; by September the mite numbers had rebounded enough to trigger repeated tetrachlorvinphos-dichlorvos applications. Incomplete molts, used by the producer to regain egg shell quality, appeared to reduce mite numbers by 20-30%, but there were too few such molts to evaluate them statistically.

Hens in houses 9 and 18 differed significantly ($t = 6.2$, $df = 169$, $P < 0.001$) in the percentage of hens infested; infestations (mean \pm SE) averaged $36.0 \pm 3.4\%$ for house 9 and $66.5 \pm 3.4\%$ for house 18. Mite scores, reflecting the intensity of mites on infested hens, also were significantly higher in house 18 (2.6 ± 0.1) than in house nine (1.8 ± 0.1) ($t = 5.02$, $df = 169$,

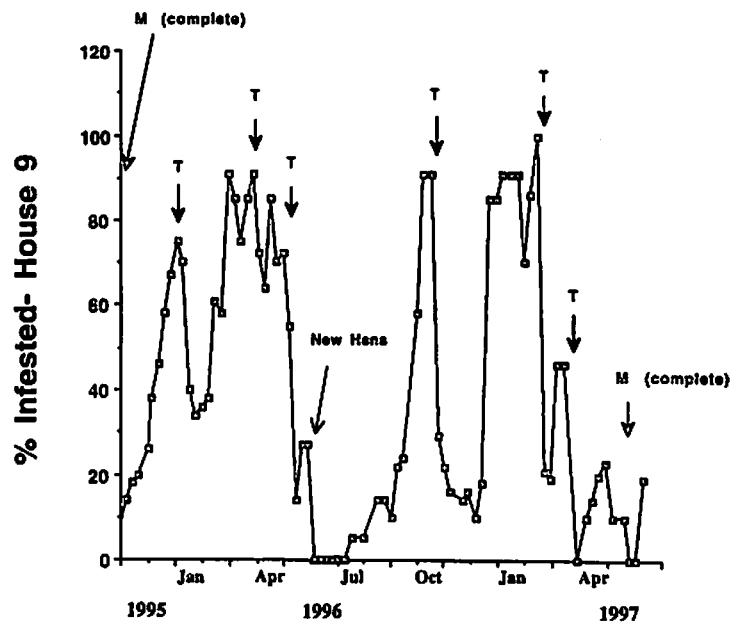


Fig. 1. Seasonal abundance of northern fowl mites on caged-layer hens in house 9 (80 wk old at start of study). tetrachlorvinphos-dichlorvos spray treatments (T) and molt periods (M) shown by arrows.

$P < 0.001$). Mite scores were a function of percentage of hens infested in house 9 and house 18 (Fig. 4).

Although we truncated the sampling at a maximum of 50 hens using the sequential sampling plan (Harris

et al. 2000), infestations, particularly in house 18, were usually either high or low enough to allow a treatment decision by examining fewer than 50 hens. In this study, using the presence-absence sampling plan but

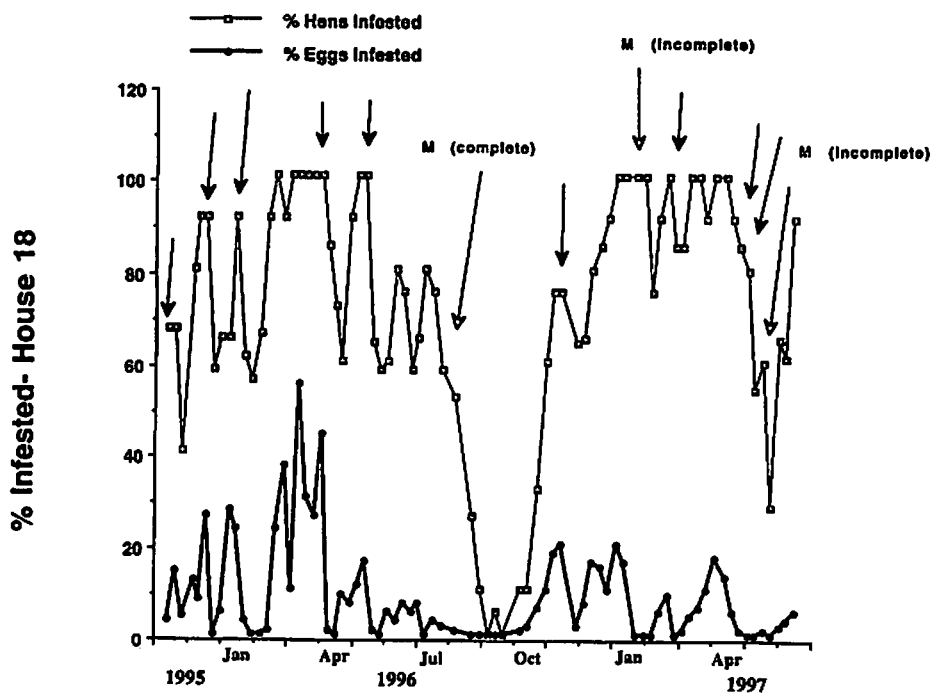


Fig. 2. Seasonal abundance of northern fowl mites on younger caged-layer hens in house 18 (33 wk old at start of study). Tetrachlorvinphos-dichlorvos spray treatments (solid arrows) and molt periods (M, open arrows) noted. Bold line depicts prevalence of mites on eggs.

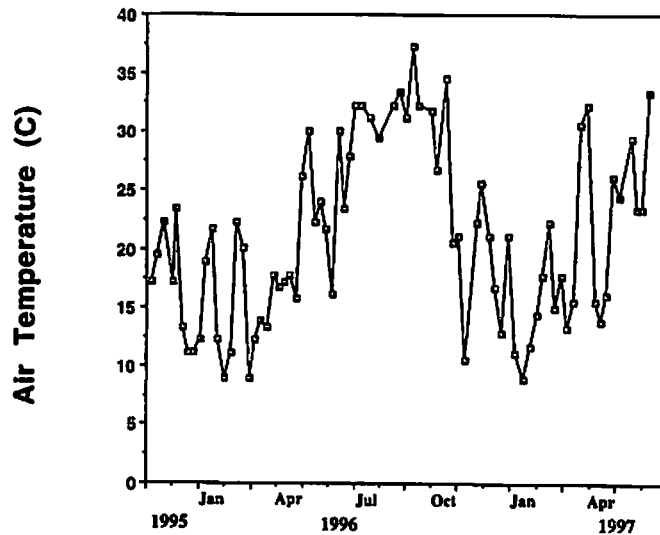


Fig. 3. Air temperatures at time of sampling in house 18.

actually scoring the hens for degree of infestation, the examination required (mean \pm SE) 0.98 ± 0.22 min per hen. Over the range of infestation levels and dates, the range was 0.5–1.7 min per hen. There was a relatively weak but positive relationship between the infestation level and the time required per hen ($r = 0.43$, $P < 0.01$).

Sentinel Hens. Twenty hens per month were selected from the general population for the first 8 mo, held singly in cages, and sampled weekly. Their mite numbers, relative to those in the general population, were regularly higher than those on hens in the general population. Data are shown for two periods when pesticide applications did not interfere with mite population development (Fig. 5). Numbers on the individual hens and group-held hens were similar when hens were first placed into individual cages, but mite scores diverged significantly within 2–3 wk of the sentinel hens being placed into separate cages.

Trends in mite numbers over a year on 20 sentinel hens are shown in Fig. 6. Substantial variability was observed both among hens and on the same hen over time. Certain hens maintained very high mite populations for many months (e.g., 2, 6, 13, and 16). Hen 6 maintained a score of 7 (highest) for essentially 14 continuous weeks. Others remained relatively mite-free for substantial periods. Hens 17–20 were lightly to moderately infested at the beginning of the period, but lost mites during the August molt, and did not show significant mite infestations for at least 4 mo thereafter. The clearest reduction in mite scores among hens occurred after the molt, but certain hens sustained mites fairly well. Hen 16, for example, had very high mite numbers before molting, but mites were absent only for 2 wk (4–5 wk after the molt began). A second, partial molt in early January also reduced mite scores on most hens, but its effects were hardly noticeable on some hens (e.g., hens 2 and 6). As was the case in the general population, the tetrachlorvinphos-dichlorvos

treatments (9 October, 4 February, early April) usually resulted only in short-term, minor suppression of on-host numbers. The April treatment, however, did coincide with the disappearance of mites from several lightly infested hens (hens 1, 5, 9, 10, 12, 14, 15).

Mites on Eggs. The prevalence of mites on eggs in house 18 is shown in Fig. 2. As many as 55% of eggs had mites in a given week, and the overall prevalence of mites on eggs in this house was 8.5%. Occasionally an egg would have >15 mites, but it was unusual for a given egg to have >2–4 mites on it. Adult mites showed up very well against the white background. Although immature mites occasionally were found on eggs, washing of infested eggs into a fine-mesh screen for subsequent microscopic examination confirmed that most mites on eggs were adults. On several occasions we observed an egg being laid; no mites were on the eggs immediately after deposition. Within 10–30 min, however, mites sometimes could be found on those eggs we had observed being laid. Short-term persistence (10–15 min) of mites on eggs was determined by re-examination of sentinel hen eggs, using for analysis eggs from five dates (69 eggs) when infestations were high (>25% of sentinel eggs had one or more mites) and acaricide treatments did not interfere. Rarely mite numbers on an egg would change substantially even over the 10- to 15-min period. Overall, the correlation between the number of mites at the initial observation and the same egg 10–15 min later was very high ($r = 0.856$, $P < 0.01$).

The producer did not examine hens for mites, but generally was aware of mites on eggs because of worker complaints, and tended to spray when egg infestation levels exceeded $\approx 20\%$ (Fig. 2). This usually corresponded with a hen infestation of >90%. Numbers of mites on eggs were reduced by an average of 95% 1 wk after a spray, and by 90% 2 wk after an application. By 3 wk after a spray, mite numbers on eggs tended to rebound. Examination of 100 eggs

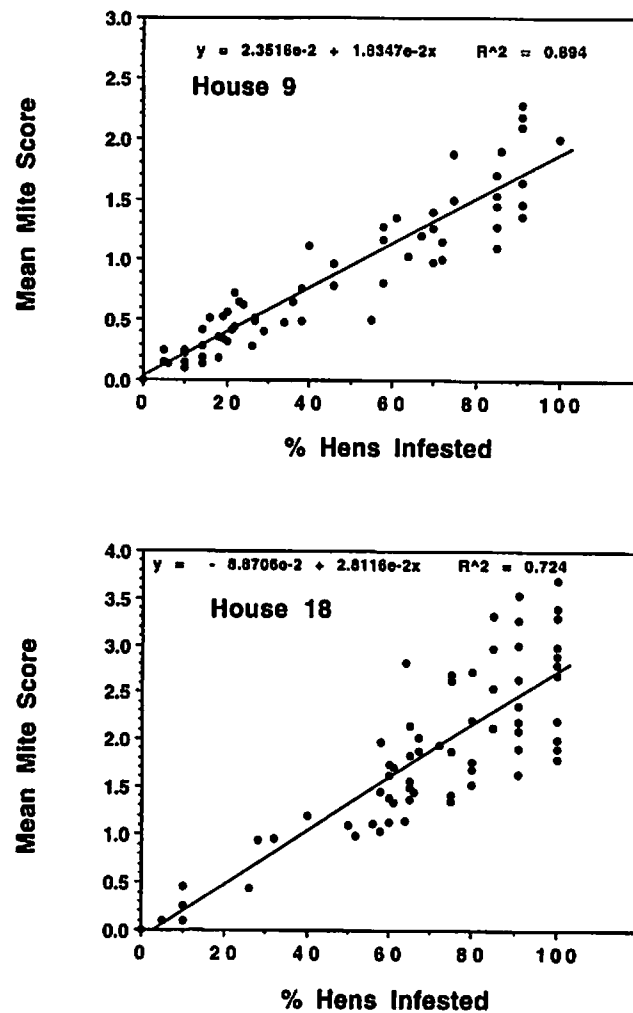


Fig. 4. Relationship between percentage infestation and mean northern fowl mite score index (visual estimate based on vent examination) on caged-laying hens in house 9 and house 18. Index is 0, no mites; 1, 1-10 mites; 2, 11-50 mites; 3, 51-100 mites; 4, 101-500 mites; 5, 500-1,000 mites; 6, 1,001-10,000 mites; 7, >10,000 mites.

(evenly spaced in the house) for mites required an average of 6.8 ± 1.9 min.

The frequency of mites on eggs collected from the sentinel hens over the first 8 mo (different monthly groups) was plotted against the infestation score for the hens that laid the eggs (Fig. 7). When regressed against infestation level, the relationship was highly significant ($r^2 = 0.83$, $P < 0.001$). We did not evaluate mites on hens in adjacent cages.

The number of mites on eggs was significantly positively correlated with the percentage of hens infested ($r = 0.455$, $P < 0.01$) and mean mite score (all hens) ($r = 0.304$, $P < 0.01$) and negatively correlated with temperature ($r = -0.264$, $P < 0.05$). It was not correlated with the mean mite score only of infested hens ($r = 0.087$, $P > 0.05$) as determined by the sequential sampling plan.

Discussion

The underestimation of actual mite numbers when assessing mites visually agrees with Arthur and Axtell (1982) and Lemke and Collison (1985). Unlike Lemke and Collison (1985), our visual estimates were well correlated with actual estimated numbers in the vent area examined. Time limitations confine visual searches to the vent region favored by the mites, but mites at a range of densities may be found on other body regions (Lemke et al. 1988), and those would have been missed. Although accuracy was not good, underestimation among observers and across time was consistent and allowed detection of relative changes in mite numbers on the hens. Not surprisingly, estimation errors were greater when mite numbers were highest; the dense aggregations of mites and their

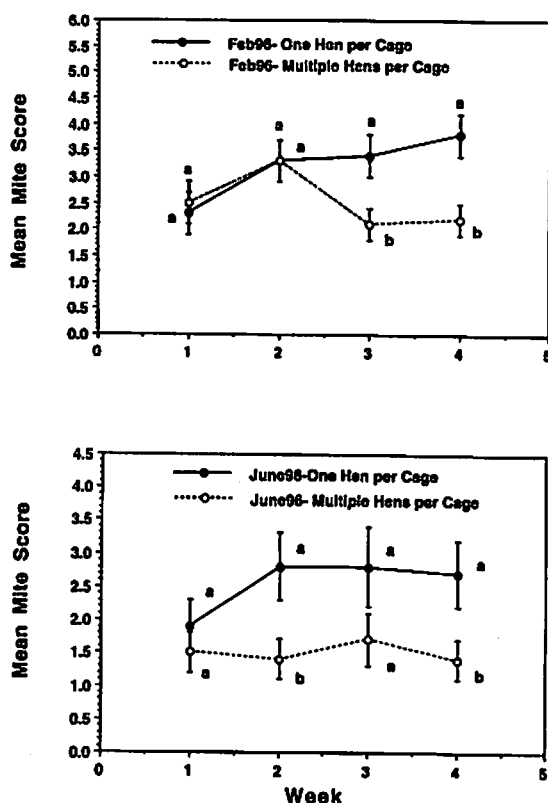


Fig. 5. Mean northern fowl mite scores (see Fig. 4) on hens held individually (beginning on week 0) versus hens held in groups of 2–3 hens per cage. Within a date, score means followed by the same letter are not significantly different by *t*-test ($P > 0.05$).

feces on matted feathers make accurate enumeration impossible. Direct observations were very accurate in detecting moderate or high infestations. For detection purposes, however, it was significant that we failed to spot two to three of four very lightly infested hens (1–10 mites), and one of six hens with 11–50 mites. Mites run away as feathers are parted, and dense feathers in young hens are especially difficult to search thoroughly. It is likely that many very light infestations are missed by visual examinations.

The seasonal pattern of mite infestations lends some support to the observation that mites are worse in cooler weather (e.g., Hall 1979), but this pattern was influenced by the molting pattern, and mites also could be dense in hotter weather. This was seen in house 9, when new, young hens required treatment in September, when the weather was still very hot. Similarly, although molting dramatically reduced mite numbers (probably because of lack of substrate or microhabitat alteration as seen by DeVaney [1986b]), mites persisted on some hens in numbers which were likely sufficient to reinitiate infestations after feathers returned. The distinct tendency of hens housed individually to harbor higher mite numbers (Arthur and Axtell 1982, Hall et al. 1978) was confirmed through

our repeated observations of the same sentinel hens. Although hens housed singly (experimentally infested) by Arthur and Axtell (1983) required 5 wk to exhibit statistically higher mite populations, our studies showed this effect after only 2–3 wk. However, starting mite population levels were higher in our studies. Certainly, our long-term studies indicate some hens can harbor high mite numbers for long periods, at least if housed individually, which also was shown by Arthur and Axtell (1983). Differences in mite numbers among hens with presumably similar exposure have been noted before (Cameron 1938, Lemke and Kissam 1986), and some of this may be caused by a partial acquired immunity (DeVaney 1986a, Lemke and Kissam 1986, Matthyse et al. 1974).

The sequential sampling plan of Harris et al. 2000 worked very well at this site. Examinations required ≈ 1 min per hen, including index scoring used for other parts of the study. Decisions relative to the selected 35–45% infestation threshold could be made fairly quickly (usually <20 min). As in the prior study (Harris et al. 2000), mean mite scores were a function of percentage of hens infested, although this relationship was stronger for house 9 than for house 18. House 18 had repeated acaricide applications and chronically higher infestations, which probably contributed to variability.

We truncated the sampling at 50 hens for logistical reasons. Although the plan is a great improvement on haphazard sampling (or no sampling at all), it does have some limitations. The houses used by Harris et al. had automatic egg collection via belts, which presumably led to the relatively even mite distributions within a row. In houses with hand egg collection (still more common in southern California), mites can be focal even within a row. Provided time is available to examine more hens, it might be possible to subdivide the house (e.g., by row) and apply the sampling plan at that level. In practice, the sequential sampling plan, based on presence-absence, removes much of the observer skill (and bias) involved in rating infestation level, an important advantage. In this study, there was a weak but significant relationship between infestation level and time to score the hen, suggesting that we did spend more time with heavier infestations.

This is the first detailed examination of mites on eggs, although mites have been observed on eggs periodically (see Cameron 1938). Only a few incidental comments are made in the literature. DeVaney et al. (1980) mentioned that mites were evident on eggs once mite numbers on the hens reached >1,000 per hen, and J. F. Butler (in Hogsette et al. 1991) briefly noted that mites on eggs did not necessarily relate to the severity of an infestation. In this chronically infested house, mites were very common on eggs, although not necessarily in numbers high enough to attract the attention of a casual observer. Mite presence on eggs did, on average, reflect the infestation status of the hen nearby (sentinel hen). Mites are not on the eggs as they are laid, but instead apparently climb onto them soon afterward, likely moving along cage wires. The producer's treatments coincided with

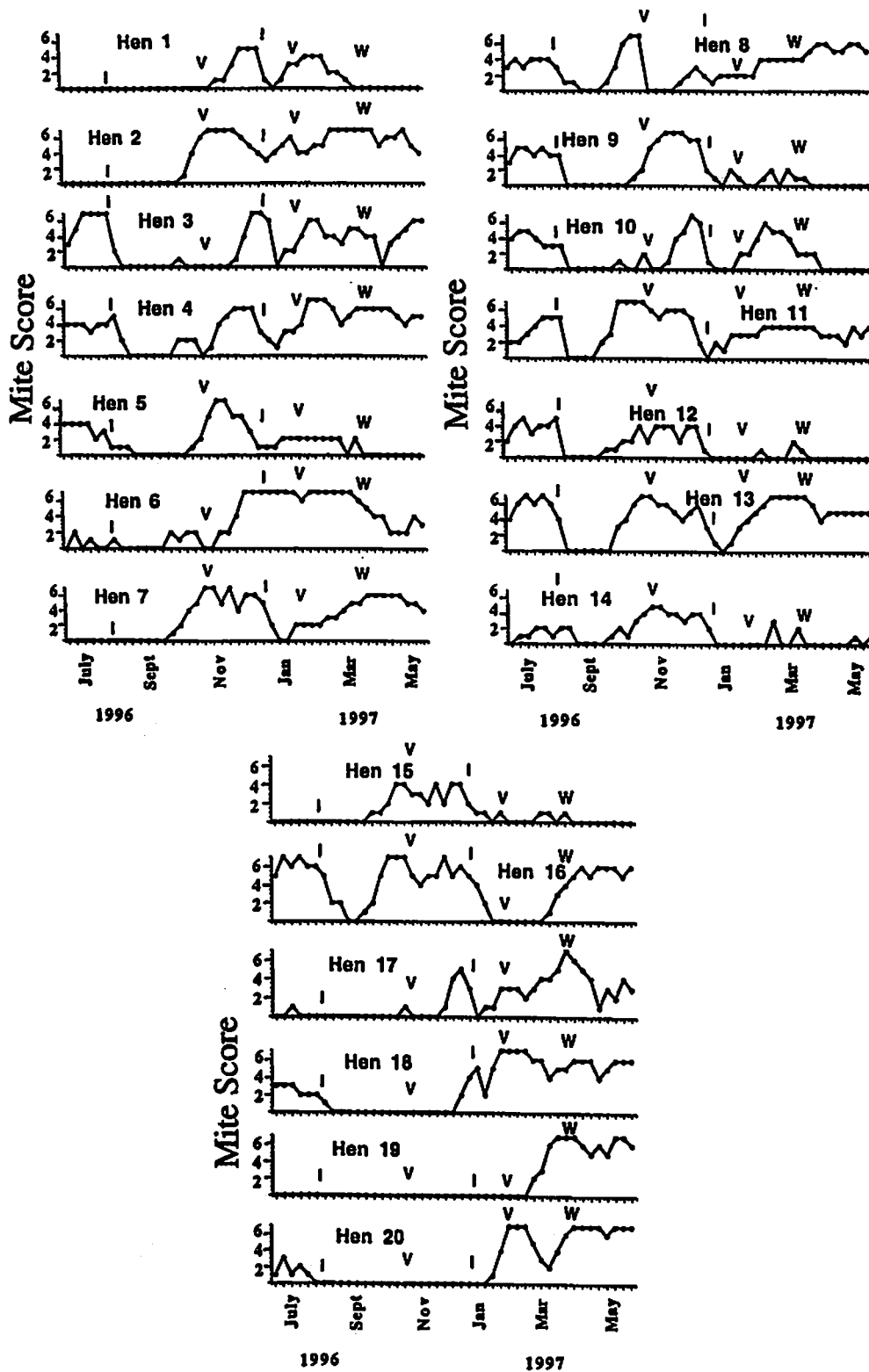


Fig. 6. Northern fowl mite scores (see Fig. 4) on 20 individual hens sampled repeatedly over time. Key management actions marked as follows: molts, "I"; tetrachlorvinphos-dichlorvos treatment, "v"; tetrachlorvinphos-dichlorvos treatment two consecutive weeks, "w."

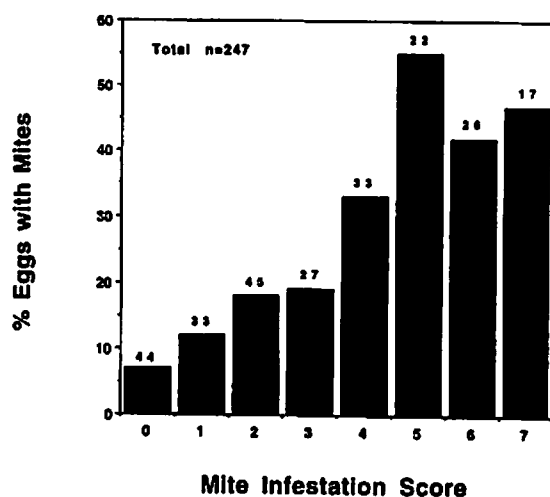


Fig. 7. Relationship between northern fowl mite score (see Fig. 4) on individual sentinel hens and frequency of mites on their eggs. Number of hens evaluated per score category shown above histogram bars.

mites on eggs, usually at a prevalence of >20%. Treatments substantially reduced mite numbers on eggs (prevalence reduced by 95%), but had minimal impact on densities of mites on hens (prevalence reduced by only 25%). This differential effect of the frequent acaricide treatments probably reduced substantially the correlation between mites on hens and mites on eggs. Further, mite movement from adjacent hens probably influenced the number of mites on eggs from our sentinel hens. Hens with scores of 0 still had a fairly high frequency (7%) of mites on their eggs.

Sampling mites on eggs has both advantages and disadvantages. One disadvantage is that it remains to be seen how sensitive mites on eggs are, particularly in detecting low but economic infestation levels. It is unlikely egg sampling is as sensitive as sampling hens. However, egg sampling also has a number of advantages. First, it already is how many producers base their treatment decisions, and it may be easier to modify this than to convince them to implement hen sampling. Second, seeing mites on eggs is fast and easy. In our test house, the average was 4 s per egg, including travel time. An adult mite on a clean, white surface is easy to see because they usually are moving and are unlikely to be mistaken even by an untrained observer. Hens do not need to be captured and removed from cages, with the subsequent bird stress and distasteful need to sort through vent feathers by hand. Third, it is relatively easy to sample more of a house, and this makes it less likely one will miss high-level but focal infestations.

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