Recent Progress in Poultry Pest Research

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Our projects deal with pests of livestock, poultry, and occasionally wildlife. Riverside is in southern California, where many caged layers are located, so we usually have at least one major field project dealing with poultry pests at any given time. Over the years most of the work has addressed fly problems, especially the house fly, *Musca domestica*, and the little house fly, *Fannia canicularis*. Both are serious problems for poultrymen who have manure buildup systems, and who have increasing numbers of suburban neighbors. In the past few years we have begun to work more on northern fowl mites as well. While the flies are mainly a public relations problem, the mites directly impact the poultry operations, either through reduced production and feed conversion efficiency, or through worker nuisance. Both pests are costly to control.

In essentially all our studies, we work through and with UC Cooperative Extension. Nancy Hinkle (Veterinary Entomology Specialist, UC Riverside) and Doug Kuney (UC Coop. Ext. Poultry Farm Advisor) have been particularly valuable and close collaborators. Additionally, I would be remiss if I did not thank the many producers who so generously have allowed us access to their ranches over the years, or, in some cases, even helped us out with the work itself. Without this access and support, we would simply be unable to do field work to benefit the industry. I hope you can see from the following just how our work can benefit you- thanks again!

The talk will be structured according to 1) recently completed fly work, 2) pending and ongoing fly work, 3) recently completed mite work, and 4) pending and ongoing mite and louse work.

Completed Fly Studies (since 1995):

A. Alternate row cleanout patterns and the role of the residual pad.

These studies were published in the Journal of Economic Entomology (Mullens et al. 1996a) and the Journal of Agricultural Entomology (Mullens et al. 1996b). Producers know that fly problems often follow manure cleanout, possibly because fly natural enemies (predators and parasites) take awhile to establish and are mostly removed in a cleanout. We tested the idea that it might be beneficial to clean out only alternate manure rows, and go back in a month later to get the rest. The idea was that the natural enemies might readily move from undisturbed manure rows to the fresh manure accumulations just across the aisle.

While the idea seems to make sense, we saw no significant effect on either the flies or their natural enemy populations (predaceous mites and beetles) in the newly-cleaned rows. The predators stayed in the older manure accumulations and did not disperse across the aisle to the new manure deposits, even though the new manure had much larger numbers of fly prey. In the newly-cleaned rows, predator populations took 1-2 months to rebound from the cleanout (about 90% were removed, even though a pad of dry manure was left).

It must be remembered that these studies took place in open-style houses, and that there may be more benefit to such an alternating removal pattern if either 1) all the manure is removed (no pad is left) or 2) we are dealing with an enclosed (high-rise or deep-pit) house.

We also looked at the role of the dry pad. It turns out that the pad does not actually absorb significant moisture (blotter-style) from the wetter manure. Rather, the dry pad elevates the manure surface, exposing it to better air flow. So, the pad is still good, as we knew- it harbors some natural fly enemies and helps the new manure dry better. Dry manure always has been important to reduce flies and encourage fly natural enemy activity.

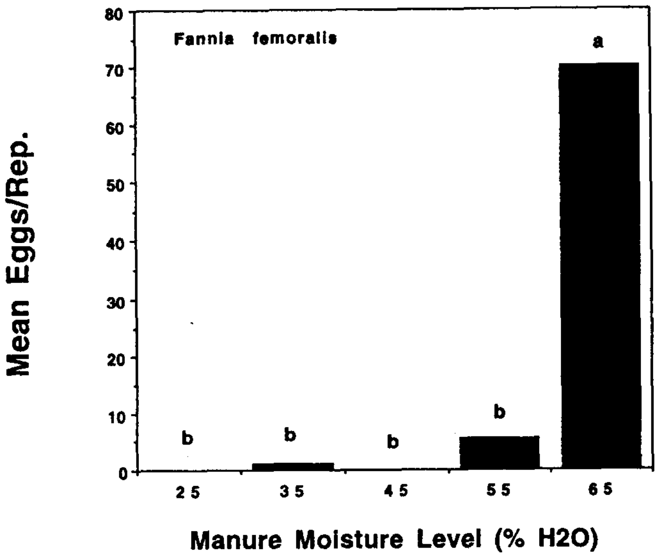
B. *Fannia* and Manure Moisture:
The little house fly, *Fannia canicularis*, tends to be difficult to control in build-up systems. Even producers who are doing a generally good job of manure management can have lots of flies. For this reason we have been studying *Fannia* spp. biology, particularly the response of gravid females to moisture and the effect of moisture level on the ability of larvae to develop. I am working on writing this information up for publication now.

There are two *Fannia* spp. common in manure. Both species do better in somewhat cooler weather (65-75 F), and temperatures above about 85 F are very tough for them. For this reason *Fannia* problems are worse in spring (especially April-June) and sometimes fall. In warmer, lower elevation inland southern CA locations, *F. femoralis* tends to dominate. It is not a pest and stays near the manure. Inspectors should be aware of this fact and know how to differentiate the larvae from those of *F. canicularis*. (see below). The real pest is *F. canicularis*; the males hover at eye level and make themselves extremely obvious to people. It is most dominant in higher elevation locations in southern CA, such as Cherry Valley and Yucaipa.

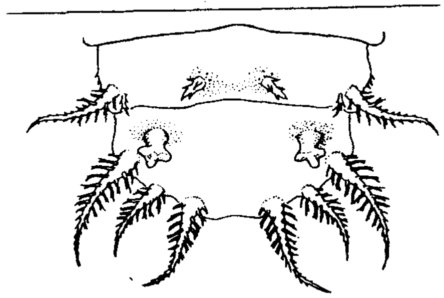
Adult females of both species like moist manure for oviposition, although *F. canicularis* still will lay well on manure of 55% moisture. Especially in spring, it is hard to get manure on top of the surface cone drier than this, although unusually warm, dry spring weather with excellent air flow helps. The real bad news is that larvae of both *Fannia* spp. are remarkably tolerant of low moisture. House flies (*Musca domestica*) cannot develop well, if at all, when manure is less than 55-60% moisture. Even newly-hatched larvae of *Fannia* spp., on the other hand, can develop to maturity at moisture levels of 40-45%. Late stage larvae are even more tolerant of dry conditions. It may take them longer, and the adults are a bit stunted, but they can survive in manure that is as dry as one ever should find in a buildup system.

This is not to say that in-house drying of manure is useless for *Fannia* control. To the contrary, we have shown that drier manure is less attractive for female egg laying. However, most of the effect of the drier manure is probably through the fact that the fly natural enemies, beetles, mites and wasps, probably forage much more efficiently in drier manure. Because *Fannia* are so tolerant of fairly dry manure, however, there is a decent chance that even manure hauled to a drying pad can support larval fly development, and this should be checked. We do have the advantage, though, of the fact that heat is very bad for *Fannia* that may be in manure spread on a pad.

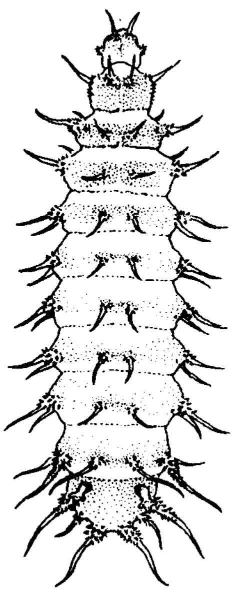
Egg-laying by *Fannia* spp. flies depends on poultry manure moisture



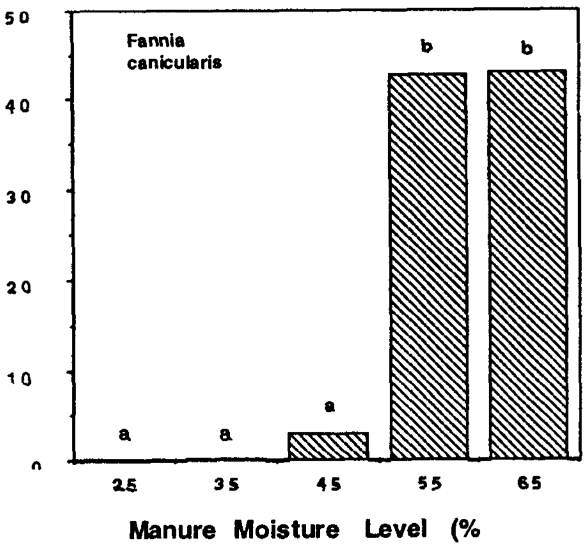
F. femoralis - Top view



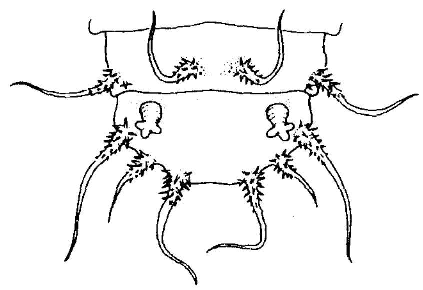
End of larval abdomen



F. canicularis Larva



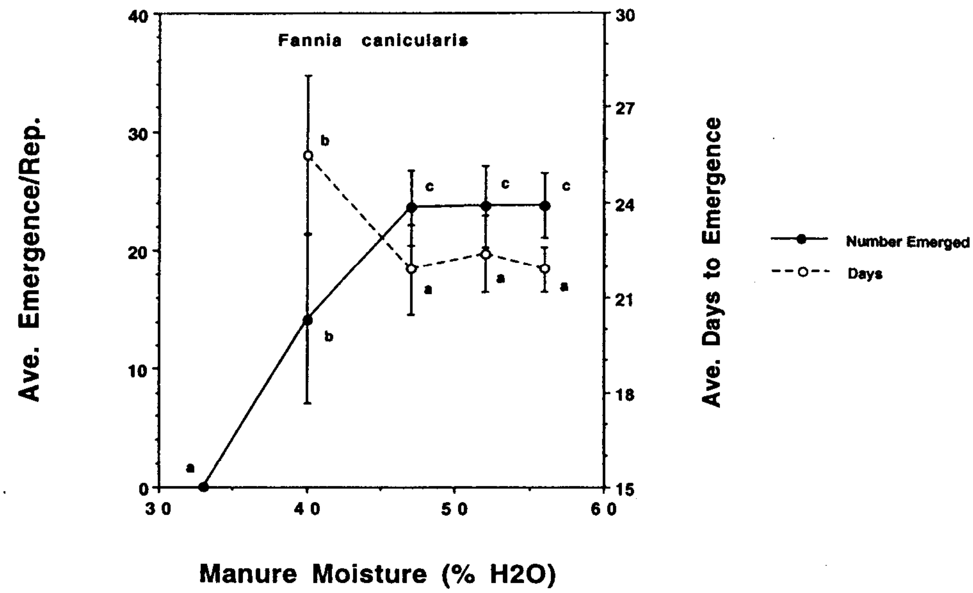
F. canicularis - Top view



End of larval abdomen

Fannia larval drawings from Axtell, R.C. 1986. Fly control in Livestock + Poultry Production. Tech. Monograph by CIBA-GEIGY Corp.

Development of larval *Fannia* can occur at manure moisture levels as low as 40%



C. House Fly Resistance to Baits:

This work is just beginning, through the work of one of my graduate students, Jon Darbro. So far we have begun to sample adult flies from different ranches, bring them back to the laboratory, collect eggs from them, and then test the first to third generation progeny. We are testing in three ways. First, a range of concentrations of the toxicant in the baits (methomyl) is placed directly on the flies individually. The number of flies that die after a given dose can be compared with a susceptible fly strain. This is strictly a physiological resistance test, although we know that the method of application (topical) is not necessarily equivalent to methomyl the flies might consume. So far field flies are only slightly resistant to methomyl applied in this way. A second method, used by most researchers looking at bait resistance, is to take hungry flies and put them with a sugar/methomyl mixture of varying concentration. In this case the flies can either eat the bait or starve. Field flies given this choice are much less likely to die relative to susceptible flies. The third method is to give adult flies a choice between untreated sugar and bait. This is the most realistic test. Some field flies are taking far longer to die compared with susceptible flies. We are looking at the nature of the resistance mechanisms now, to see if we might be able to counteract it.

D. Sampling for Northern Fowl Mites:

Northern fowl mites are the worst, and hardest to control, ectoparasite of poultry in the U.S. Most producers believe they reduce egg production, and several experimental studies support this idea. We are in the middle now of a 3-year survey of mites in caged-layers, and 17/19 ranches had mites. They probably come into a clean flock via wild birds and/or contaminated equipment and personnel. Once the mites become abundant, eradicating them is difficult at best, and may be impossible pending depopulation and complete site sanitation.

Several UC Entomology researchers who have since left UC Riverside (Mary Harris, Jeff Meyer and Mike Brewer) developed a hen sampling plan for mites. This is a presence-absence plan, and was just published (Harris et al. 2000). Basically, a person moves through a house and removes hens, looking in the vent feathers for mites. Depending on the proportion of hens infested and the level of tolerance for them, the plan allows the producer to judge whether the mites are worth treating at that time.

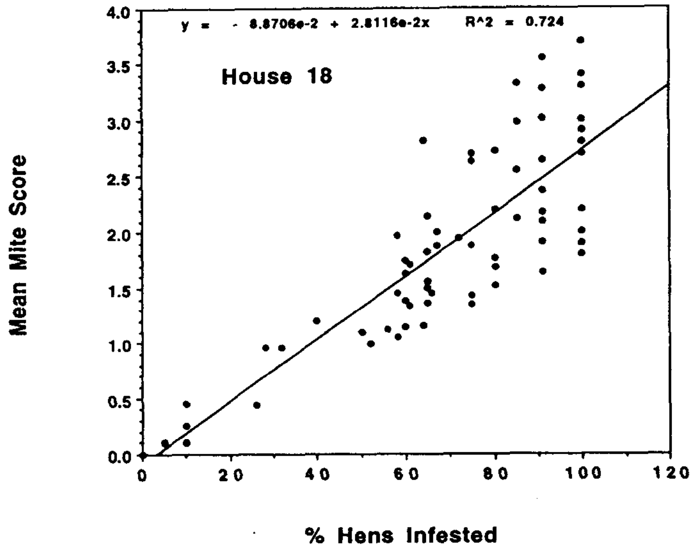
The plan requires about a minute per hen and works pretty well, and one may decide whether or not to treat a house after examining as few as 10-14 birds (if all are either infested or uninfested). At present the plan does not tell you how bad the infestation is, but depends on a relationship between the proportion of hens infested and the average severity of infestation. We have observed this relationship to hold at some ranches, but it is also possible for most hens to be infested but to have only a few mites each. This is a trickier situation in which to decide whether or not to treat.

In talking with producers, most treat when workers complain. They feel the mites probably merit treatment by this time for their direct impact on egg production as well. We are looking into whether mites on eggs might be used for monitoring.

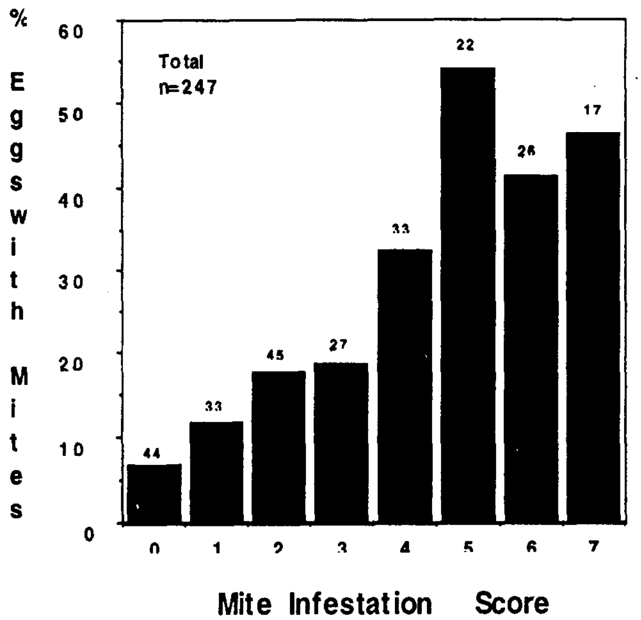
In a 2-year study at a chronically-infested ranch, the producer treated when about 20% of the eggs had mites. By this time over 90% of the hens were infested, some very heavily. There was a good general relationship between % hens infested and the average severity of infestation. Further, in the test houses, the more heavily infested a hen was, the more likely mites were to be found on eggs in the rack right in front of that bird. Thus it looked good for trying to use eggs for sampling. Mites on eggs are very obvious. Checking an egg requires about 4 seconds per egg and does not require removing the hens from the cages. However, looking at hens is more sensitive. If a producer is really concerned about detecting ANY mites, direct hen examination is far superior to checking eggs. We have seen ranches where most hens were infested, but with only a low number of mites each, and no mites were on the eggs. Mites on eggs probably indicate one or more heavily infested hens in the immediate vicinity. A person can check about 15 eggs in the time it takes to check one hen. Thus you can cover more of the house faster by checking eggs, but will almost certainly miss light infestations.

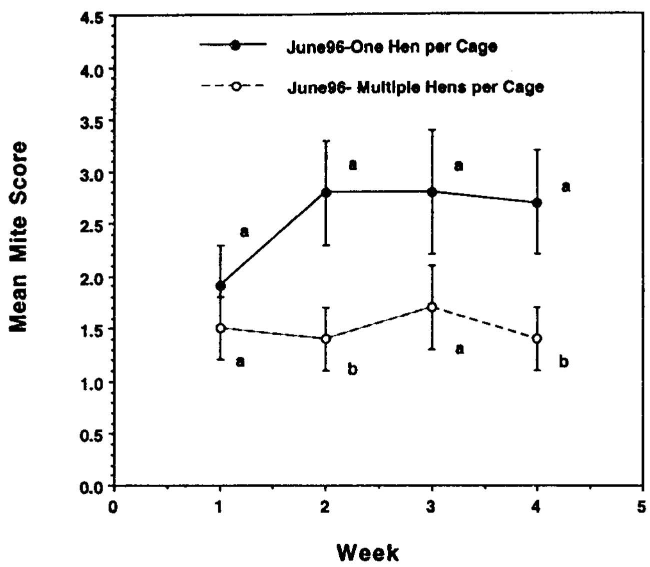
We now are working on checking 36 southern California egg ranches (3 houses on each of 3 dates/ranch). There is a lot of variability in the relationship between mites on hens and mites on eggs, but the trend is quite clear- the relationship is there. For the time being we are checking 400 eggs/house in a regular pattern. We hope and expect we can develop this statistically into a good plan for treating before the mites get completely out of hand.

There usually is a relationship between % hens infested and severity of northern fowl mite infestation. We do sometimes see houses where most hens are very lightly infested.



Heavily infested hens had more mites on their eggs in a chronically infested house, We currently are testing this in a much larger number of ranches.





Hens held singly in cages have more mites than do hens held together. The mechanism is not exactly known, but may be due to crowding stress hormones or simple disturbance by cagemates.

E. Mite Dispersal:

We were able to conduct a small study to determine how well mites dispersed among hens in a small, test layer house. In this case single hens were held, separated by open cages. In each of 4 rows, mites were introduced to a single hen in the middle of the row.

From this initial focus, mites reproduced on each hen in sequence, moving out from the initially infested bird within a row. They generally did not spread to an adjacent hen until they had reproduced to a moderate level. They also generally did not "skip" birds. Notably, the mites had to spread from hen-to-hen across open cages. The study shows 2 things. First, they can disperse across open cages to infest a new hen, and they do not do so until they first multiply for 10-21 days on a hen. Second, the pattern of spread suggests they do this by walking. Mites may "hitch" rides occasionally and temporarily on rodents etc. However, they either leave or get knocked off a hen regularly. At this point they need means of getting back on the required host. Another of my graduate students, Jeb Owen, is doing some very interesting work on how mites respond to host cues such as heat, vibration, and odors. Residual egg heat may be a factor in mite presence on eggs. Eventually we may be able to use knowledge of host cues to check a house for residual mites before we bring in new hens, or possibly to interrupt host-seeking in some way.

F. Mite Resistance to Pesticides:

Once mites are bad, a producer presently has essentially one choice for control- treat with chemicals or not. To date we do not know of any good biological control agents etc. that might be useful. As part of the survey, we are noting what chemicals the producers use for control. We also are bringing mites back from heavily infested ranches for resistance testing. Mites are placed into glass tubes with residues of different concentrations of registered pesticides. The number that die compared with a susceptible strain allows us to determine resistance levels.

Registered materials are malathion, sevin, permethrin, and RaVap. We are seeing low resistance (< 5x) to malathion, low to moderate (up to 20-30x) for sevin, and low to moderately high for Ravap. Resistance varies among sites and is usually related to past history of use. High RaVap resistance (about 160-fold) has been seen only where the producer sprayed very frequently. The most severe and interesting resistance is showing for permethrin. About 25% of sites have severe mite resistance to permethrin- in the range of 1000-fold and higher. These assays are for residues on glass, and thus are useful only in comparing field mites to a susceptible standard strain. They do not necessarily predict how well the materials will perform on hens in the field. However, it is almost certain that the extreme levels of permethrin resistance encountered will result in a lack of control in the field. Interestingly, some of these producers do not use permethrin for mite control. Rather, they spray it for flies. We believe drift is resulting in unintended, and unanticipated, exposure and subsequent resistance in mites. We have at least another year of study on this question before we can be more certain.

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