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# Dustbathing behavior: Do ectoparasites matter?

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ABSTRACT

A presumed function of dustbathing behavior is to remove ectoparasites. Providing dustbathing substrates in furnished cages for laying hens might therefore offer an alternative to pesticide use to reduce ectoparasite populations. We investigated the effectiveness of dustbathing substrates for controlling northern fowl mites in individually caged beak-trimmed White Leghorn hens ($N = 32$). Each cage contained a 32 cm × 32 cm plastic tray that was either: (1) filled with 1200 g of sand (SAND); (2) empty (CONTROL); (3) covered with Astroturf (AT); or (4) covered with AT on to which 150 g of feed was delivered daily (ATF). AT and ATF are used in the dustbathing/foraging area of many newer commercial furnished cages. Hens were infested with approximately 35 mites at 25 weeks of age. Mite numbers were estimated weekly. Time spent dustbathing and dustbathing bout numbers and lengths in the tray and on the wire cage floor were determined from video recordings made for 2 consecutive days from 12:00 to 20:00 h immediately before and after infestation and at weeks 1, 3, 5, and 7 post-infestation. Data were analyzed using a repeated-measures ANOVA in SAS. Treatment did not influence the total time spent dustbathing (average across substrates: 11.3 min). However, there were treatment effects on the time spent dustbathing in the trays ($F_{2,21} = 3.67$, $P = 0.043$) and on wire ($F_{2,21} = 7.68$, $P = 0.031$). SAND and ATF hens spent more time dustbathing in the trays (11.4 and 9.1 min, respectively) than AT (2.3 min), and CONTROL and AT hens spent more time dustbathing on wire (11.6 and 4.7 min, respectively) than ATF (0.4 min). There was a treatment effect on infestation ($F_{3,28} = 3.08$, $P = 0.04$), with ATF having more mites (back-transformed mean = 1500) than AT (330), and with SAND (460) and CONTROL (447) intermediate. This study confirmed that the substrate type affected dustbathing behavior. SAND was a preferred dustbathing substrate but was not effective for controlling mite numbers, nor was the time spent dustbathing in any substrate or in total influenced by infestation levels. Our data also suggest that adding feed to the AT pad in furnished cages might lead to increased mite numbers in infested hens. The reason for this effect is unclear, but could be due to feed particles contributing to a change in feather structure that creates a more favorable mite habitat.



## 1. Introduction

Egg producers in a number of countries are adopting furnished cages (larger versions of which are also called enriched colonies) as an alternative to conventional cages. These cages include a nest, perches and a substrate to encourage foraging, scratching and dustbathing behavior. The most common material used for this substrate is an Astroturf (AT) pad onto which loose material like feed may be distributed (Scholz et al., 2010; Alvino et al., 2013). Finer substrates like sand can be also dispensed onto this pad but create problems if they occlude the overhead dispenser or abrade the mechanical delivery system (Scholz et al., 2010). However, materials with a fine structure like sand are preferred by hens for dustbathing over substrates consisting of large particles (Olsson and Keeling, 2005) and are also preferred to substrates like AT or AT and feed (Alvino et al., 2013).

One function of dustbathing is to maintain the integument in good condition by reducing excess feather lipids (Olsson and Keeling, 2005). It has long been suggested that another function of dustbathing is to help remove ectoparasites (Rothschild and

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Clay, 1952; de Jong et al., 2007; Clayton et al., 2010), however there is only one study evaluating this presumed function. Martin and Mullens (2012) provided hens housed on litter with dustboxes filled with sand and sulphur, sand and kaolin (clay) or sand and diatomaceous earth. Sulphur and inert dusts like kaolin and diatomaceous earth have been demonstrated to increase ectoparasite mortality (Creighton et al., 1943; Furman, 1952; Kilpinen and Steenberg, 2009). Martin and Mullens (2012) found that the hens that used these dustboxes had significantly fewer chicken body lice (*Menacanthus stramineus*) and northern fowl mites (*Ornithonyssus sylviarum*) than hens that did not use them, and also fewer ectoparasites than caged hens without access to dustboxes. Two older studies (Hoffman and Hogan, 1967; Hoffman and Gingrich, 1968) evaluated the effect of a chemical (Zytron) and a microbial (*Bacillus thuringengis*) insecticide mixed with sand in dustboxes on three species of lice in infested hens in a non-cage system. They reported that there was a reduction in the number of lice when the insecticides were included in the boxes but not when sand was the only substrate. However, they did not actually record dustbathing behavior. To our knowledge there are no published studies evaluating the relationship between ectoparasites and the performance of dustbathing behavior. Moreover, there is no information on whether hens that dustbathe in substrates that have not been treated with inert dusts or insecticides have reduced ectoparasite populations.

If dustbathing does function to remove ectoparasites, providing the types of dustbathing substrates that are typically used in furnished cages might offer an alternative to pesticide use. Therefore, there is an opportunity to evaluate the effectiveness of dustbathing behavior for controlling ectoparasite populations using a preferred dustbathing substrate like sand (Shields et al., 2004; van Liere et al., 1990; Olsson and Keeling, 2005), or even a non-preferred substrate like Astroturf (AT). Sand might abrade the ectoparasite cuticle, leading to desiccation, while the AT could mechanically dislodge parasites, an effect that could be potentiated when feed is added to make the AT more desirable for dustbathing. It is also possible that dustbathing in feed could directly affect ectoparasite survival. Scholz et al. (2014) found that the feathers of hens that dustbathed in feed compared to lignocellulose had a higher lipid content. Moyer et al. (2003) found that preen oil from the uropygial gland negatively affected the survival of rock dove lice *in vitro*, although experimental removal of the uropygial gland did not impact louse populations *in vivo*. There have been no studies of the effects of feather lipids on mite infestation. Finally, it is not known whether the presence of ectoparasites affects dustbathing behavior and whether infested hens increase the time they spend dustbathing in non-preferred substrates like feed or AT in an attempt to reduce their infestation.

The northern fowl mite (NFM) is the most common and serious poultry ectoparasite in North America (Axtell and Arends, 1990). It spends its entire life cycle on the host, feeding on blood and laying its eggs at the base of the feathers, particularly in the vent area. The aims of our experiment were to evaluate: (1) the role of dustbathing behavior in controlling NFM populations; (2) the effectiveness of commercially used dustbathing substrates in reducing NFM levels on infested hens; (3) the effect of NFM on dustbathing behavior. We hypothesized that dustbathing behavior plays a role in controlling ectoparasite populations and that different dustbathing substrates would have different effects on NFM populations. We predicted that NFM populations would be lower in hens that dustbathed, and that the provision of a highly preferred substrate would reduce NFM populations more than the provision of non-preferred substrates. We also hypothesized that infestation with NFM would increase the total time spent dustbathing by increasing both the length and the number of dustbathing bouts.

## 2. Materials and methods

### 2.1. Animals and Husbandry

This experiment was conducted at the Avian Science Facility at the University of California, Davis. Thirty-two hens were randomly selected from a flock of 168 CV20/W36 beak-trimmed pullets that had been previously used in a study of early rearing effects on dustbathing substrate preference (Alvino, 2013). The day-old chicks had been obtained from a commercial hatchery (JS West and Companies, Modesto CA) and kept in a Petersime brooder, where they were raised either completely on wire or exposed to either AT plus feed (ATF) or sand as dustbathing substrates. At 11 weeks of age, the pullets were moved in pairs to grower cages, and the previous treatments were maintained until they were 18 weeks of age. The pullets were then singly housed in 90 cm × 46 cm × 46 cm cages in two experimental rooms for the current study. From 14 to 18 weeks of age the light was increased 1 h per week to reach a 16L:8D photoperiod, which was maintained for the duration of the experiment.

Each experimental room contained 4 racks of cages and each rack held 4 cages. Each cage had a 32 cm × 32 cm plastic tray (Akro Mils SRO12500A34) that was either: (1) empty (CONTROL); (2) filled with 1200 g of sand (SAND) (Sakrete Natural Play Sand, Dixon, California); (3) lined with Astroturf (AT) (GrassWorx XPSP, 14 mm pile height); or (4) lined with AT on to which 150 g of feed was delivered daily (ATF). This amount of feed covered the entire surface of the pad. Pullets were assigned to the treatments most similar to their rearing substrate exposure (i.e., chicks reared with ATF were assigned either to AT or ATF, wire to CONTROL, and sand to SAND); the four treatments were balanced in the two rooms. All the trays and the AT pads were removed from the cages and washed and dried daily between 9:30 and 11:30 h. The trays were then lined with the clean pads or fresh sand and reintroduced into the cages. Feed was dispensed on to the ATF pads immediately after they were cleaned and dried. Although there was abundant sand and feed in the trays and on the pads at the end of a 24 h period, they were cleaned daily to remove feces and ensure that feed and sand availability and cleanliness were comparable each day. Cleaning was carried out in the morning so as not to disturb the hens during the video recording sessions.

There was a 45 cm long feeder on the front of each cage which was filled every morning with a pelleted diet formulated for high-producing laying hens (Purina Layena, Turlock California 16% CP, high calcium ration, 2.5% fat). Running water was provided *ad libitum* via a trough placed along the back of the cages. The pullets/hens were housed and managed according to the Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching (FASS, 2010). All experimental procedures were approved by the University of California, Davis, Institutional Animal Care and Use Committee.

### 2.2. Ectoparasite infestation

Because we were interested in determining how providing dustbathing opportunities affected the course of infestation, it was necessary to experimentally infest the hens. Approximately 35 northern fowl mites were placed on the abdominal feathers of each hen when the hens were 25 weeks of age. The mites came from naturally infested source hens housed in a building separate from the experimental room at the UC Davis Avian Science Facility. Mite-infested feathers were cut from the source hens and put in a plastic bag. A glass Pasteur pipette was then used to aspirate (Owen et al., 2008) and transfer the mites from the plastic bag to the vent feathers of each experimental hen. Prior to infestation (week −1) each hen was removed from her cage and the feathers and skin of her vent area were checked to verify that they did not harbor any mites;