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Biology and Management of the Lesser Mealworm in Poultry Operations

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Introduction

The lesser mealworm, *Alphitobius diapernis* (Panzer) (Family Tenebrionidae, Tribe Alphitobiini), is one of the most important and widespread pests in Arkansas commercial poultry production. This beetle is also known by many in the poultry industry as the darkling beetle, litter beetle or black bug. Of particular importance in poultry production is its association as a vector and competent reservoir of several poultry pathogens and parasites. Also, under severe infestations, this beetle may cause significant damage to poultry housing (especially insulation) when larvae tunnel through insulation boards in search of a pupation site. Beetle-damaged broiler houses have been reported to use up to 67 percent more energy than non-damaged houses. Finally, because of the beetle's attraction to artificial lighting, adults may fly en masse to artificial light sources such as private residences. This flight is more likely to occur following the spreading of beetle-infested poultry litter onto pastures near private residences.

This insect is a cosmopolitan pest of stored products and is considered a tropical exotic species in North America, likely originating from sub-Saharan Africa. The warm and humid conditions found in poultry houses simulate the tropical conditions of its origin and provide an environment for optimal development and reproduction. In addition to being a formidable poultry pest, the lesser mealworm is a pest of stored flour, meal and other grain products, especially in poorly maintained grain processing plants.

Description

Adult (Figure 1) – Lesser mealworm adults are shiny-black, somewhat flattened, oval beetles approximately 1/4 inch (6 mm) long. Newly emerged (eclosed) adults are reddish-brown and slowly turn shiny black. The head, thorax and hardened outer wings (elytra) are densely covered in tiny depressions with those of the wing occurring in parallel rows.

Eggs – Lesser mealworm eggs are slender with rounded ends and are about 0.06 inch (1.5 mm) in length.

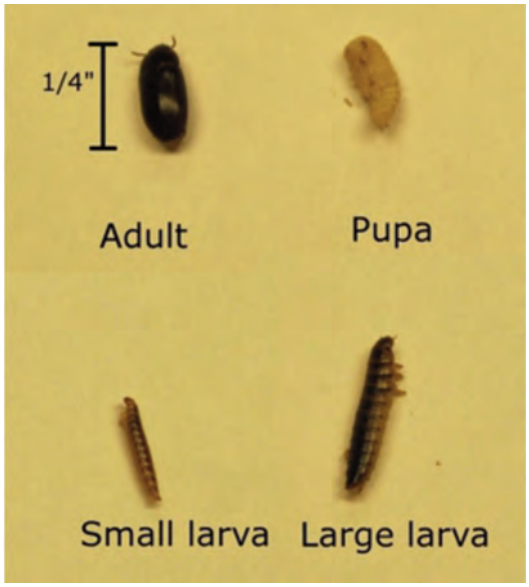

Figure 1. Lesser mealworms (adult, larvae and pupa).

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Freshly laid eggs are creamy white but darken with age. Because the eggs are very small and deposited in small spaces, they are rarely seen.

Larvae (Figure 1) – Lesser mealworm larvae (like other mealworm larvae) are slender, segmented worm-like creatures with three pairs of tiny legs on the thorax (front portion) and one abdominal proleg at the rear. Newly hatched larvae are tiny but will grow to a size of about 1/3 inch (7.5 mm) to 2/5 inch (11 mm).

Pupae (Figure 1) – Lesser mealworm pupae are worm-like and superficially resemble shorter and stubbier larvae. After molting from the last larval instar, the pupa is creamy white but becomes tannish-brown before molting to an adult.

Biology

The lesser mealworm feeds on spilled feed, manure, bird cadavers and cracked eggs associated with poultry litter and/or production. In addition, they are highly cannibalistic. The lesser mealworm also infests a wide variety of stored products – wheat, barley, rice, oatmeal, soybeans, cowpeas, peanuts, linseed, cottonseed, oilseed, tobacco and drugs.

Adults are fairly long-lived, usually from about three months to more than a year. Adult females mate soon after emergence and begin laying eggs. An adult lesser mealworm female will usually lay about 400 eggs (in extreme cases 2,000) during her lifetime. She lays eggs every one to five days throughout most of her life. Eggs are laid in cracks and crevices, litter, manure, grain hulls and under feed or water lines. Larvae hatch in about four to seven days and undergo from six to eleven molts (instars). Lesser mealworm larvae complete development in about seven weeks or less and can reach lengths of about 1/3 (8 mm) to nearly 1/2 (13 mm) inch. Optimal larval development is achieved at temperatures of 86 to 91 degrees F (30 to 33 degrees C) with 90 percent relative humidity. Mature larvae disperse and, when conditions are crowded, burrow into insulation to construct pupal cells to transform into pupae. Pupae are creamy-white immediately after pupation but slowly turn to tannish-brown. The pupal stage lasts from about one week to eleven days. Depending upon temperature, humidity and food quality, lesser mealworm eggs will develop into adults in 40 to 100 days.

Importance and Impact

Structural Damage (Figure 2) – Structural damage to poultry houses is not uncommon. Mature lesser mealworm larvae (especially when overcrowded) chew holes in fiberglass, polystyrene and foam insulation panels used in poultry house walls. This long-term structural damage can increase heating cost by up to 67 percent and result in expensive building repair costs to replace insulation panels.

Figure 2. Insulation damage caused by lesser mealworm. *(Univ. of Ga., Coop. Poultry Ext.)*

Poultry Pathogens – Lesser mealworms are potential vectors of poultry parasites and pathogens. Lesser mealworm adults or larvae can pick up disease-causing organisms by either crawling through an infected environment or eating an infected meal such as a carcass or feces-contaminated food. These organisms can be carried by the beetle for a couple of weeks or longer. Disease organisms potentially associated with lesser mealworms include viral diseases (Marek's disease, infectious bursal (Gumboro) disease, turkey coronavirus, avian influenza, avian or lymphoid leukosis and Newcastle disease), bacterial pathogens (*Salmonella typhimurium, Escherichia coli and Staphylococcus* spp.) and protozoan parasites (*Eimeria* spp., causal agent of coccidiosis).

Reduced Feed Efficiency – Research has demonstrated reduced feed efficiency in poultry houses with heavy lesser mealworm infestations. Chickens will readily consume beetles instead of feed, which can have a negative impact if chickens fill up with beetles rather than the more nutritious feed ration. In addition, consumption of larval and adult lesser mealworm can result in intestinal impaction because chickens lack the enzyme (chitinase) necessary to digest the chitin found in these insects.

Human Health Concerns – Tenebrionid beetles can produce quinones as defense against predation. These quinones may produce asthma, headache, erythema and conjunctivitis when humans are exposed to these insects for extended periods. In addition, quinones are suspected carcinogens.

Individuals who routinely work inside poultry houses for extended periods for production or research purposes should wear protective gloves, safety glasses and a respirator with cartridges that remove ammonia to minimize exposure to ammonia and dust. Persons with known allergies should avoid lesser mealworm exposure as much as possible.

Management

Although some poultry producers primarily rely on insecticides to control lesser mealworm, greater control success is achieved when an integrated approach is used. The use of a variety of IPM methods such as routine surveillance, sanitation, cultural methods and insecticides often limit the negative impact of the lesser mealworm.

Routine Surveillance – Monitoring lesser mealworm infestations in poultry facilities is an asset to the overall management program by alerting producers of a rapid rise in numbers or to determine if control measures were effective following a treatment. One method routinely used in studies to evaluate the efficacy of insecticides is the tube trap (Figures 3a and 3b). This trap is simply a 10-inch (254 mm) piece of 1 1/2 I.D. (38 mm) schedule 40 PVC pipe with a hole drilled on each end (to stake the pipe to the floor to prevent movement by birds). Corrugated cardboard is rolled up and placed inside the pipe. A few traps will be staked to the litter floor for about one week then removed. The corrugated cardboard is removed from the PVC, and adults, larvae and pupae are counted. Keep track of the number of adults, larvae and pupae (usually very few pupae are collected). By monitoring weekly or twice monthly with this trap, producers can detect a rapid increase in numbers or a change in the stage structure of the population. Other monitoring methods include use of "sentinel" insulation boards placed on walls or posts for routine monitoring of larval entry holes. Simple counting of lesser mealworm during the evening can also provide an indication of the population (Figure 4).

Figure 3a. Tube trap used to monitor lesser mealworms.

Figure 3b. End view of tube trap used to monitor lesser mealworms.

Figure 4. Lesser mealworm adults in a poultry facility. *(Photo by Magno Borges)*

Cultural Methods – Non-chemical cultural methods may involve taking advantage of environmental conditions or ramping up sanitation procedures. For example, one of the best strategies for controlling the lesser mealworm is frequent cleanout. However, this strategy is not always feasible because it is costly, time consuming and crop or pastureland upon which to apply the litter may not be readily available. Another non-chemical control method is cleaning out houses during winter months or opening curtains between flocks to allow the temperatures in the house to drop below freezing to kill lesser mealworms. Remember, sub-freezing temperatures can kill birds and damage water pipes. Another cultural method is to prevent wet spots under waterers by fixing leaks, using spare waterers while litter dries or changing the position of waterers to prevent leaking. Management strategies such as picking up mortalities and cleaning up spilled feed on a daily basis will reduce available food for lesser mealworms.

Biological Control – Several lesser mealworm natural enemies have been identified. Of those, the fungal pathogen *Beauveria bassiana* has shown the greatest biological control potential. Strains that are highly pathogenic to the lesser mealworm have been identified and are currently under study. In fact, at least one *Beauveria bassiana* product is available commercially. Steinernematid nematodes have also been studied as a potential biological control but to

date have not been shown to provide long-term control. Other organisms such as the entomophilic protozoa have been discovered in lesser mealworm larvae and adults. Mites that are parasitic on lesser mealworm eggs may provide some level of control as well.

Insecticidal Control – Reliance on insecticides to control lesser mealworms is common practice but is more effective if accompanied by other non-chemical methods. Some producers have also witnessed insecticide failures resulting from reliance upon a single insecticide or insecticide class over a long time period. In recent years, insecticide options have become more limited; however, a few new insecticides have become available resulting in a net gain in the number of insecticide classes available to manage lesser mealworms. Producers should use this to their advantage by rotating use of insecticide classes to lessen potential insecticide resistance/tolerance issues. Insecticide classes available for lesser mealworm control in poultry houses include pyrethroids, organophosphates, spinosyns, neonicotinoids and insect growth regulators. Consult the Poultry section of the current year's *Insecticide Recommendations for Arkansas* (MP144) for information on insecticide options for lesser mealworm control (www.uaex.uada.edu/Other_Areas/publications/PDF/MP144/B_Animals_Poultry.pdf).

Application Methods – In general, most insecticides labeled for use in poultry facilities must be used when birds are absent from the facility. Application methods vary with the insecticide label but are generally whole house application or banded applications applied to lower portions of walls, posts and floor litter (under feeders, under waterers and next to walls). In broiler situations, treatments are normally applied after cleanout on top of fresh shavings or between flocks after decaking but before houses are populated with birds. In heavily infested houses, insecticide applications between every flock along with cultural methods might be necessary to get the population under control. When temperatures are cold, make applications after the house has warmed because surviving beetles can be driven into the litter to avoid the cold. As with any insecticide application, always read and follow the insecticide label.

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