Darkling beetle impact and control
**Darkling beetles: An overview**

Darkling beetles are the most common poultry house pests. They can be present in extremely high numbers, cause facility damage and reduce productivity. Recent studies have proven darkling beetles to be vectors of poultry diseases, including infectious bursal disease virus (IBDV), astrovirus, RSS orthoreovirus and other unidentified viruses.

**BIOLOGY**
- Eggs are non-mobile; adult females lay eggs in the litter, and eggs hatch in approximately 4-7 days
- Larvae are mobile, burrowing into the ground for insulation as they pupate (3 months)
- Pupae are non-mobile; it takes 2 to 3 weeks for an adult beetle to emerge
- Adults are mobile and can lay up to 800 eggs in a 42-day period
- The darkling beetle life cycle is between two months to a year, depending on downtime between flocks, the season and the temperature

**BEHAVIOR**
- Congregate in large areas
- Burrow down in litter as an escape mechanism
- Migrate from under feed line to side walls within 48 hours after bird removal
- Move deeper into litter in cold weather; move into soil and insulation when birds are absent
- Beetles follow the birds
- Nocturnal, but can be active at all times of the day
- Can fly about ½ mile

**Darkling beetle life cycle**

The lifespan of a darkling beetle, from egg to adulthood, can be anywhere from 2 months to a full year.
### BEETLE CONSUMPTION

Eating beetle larvae has an impact on bird performance.

<table>
<thead>
<tr>
<th>Age (days)</th>
<th>Avg. larvae consumed per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-3</td>
<td>389±18</td>
</tr>
<tr>
<td>4-5</td>
<td>631±14</td>
</tr>
<tr>
<td>6-7</td>
<td>496±20</td>
</tr>
<tr>
<td>8-9</td>
<td>287±33</td>
</tr>
</tbody>
</table>

Eating beetle larvae has an impact on bird performance. Disease can be transmitted to birds via the consumption of darkling beetles.

### DISEASE TRANSMISSION

- Darkling beetles live in litter and are exposed to bird feces
- Chickens commonly feed on beetles, providing transmission opportunities
- *Salmonella* can persist in adults and larval darkling beetles and colonize in broiler flocks:
  - Pathogens were readily transmitted among flock mates mechanically and persisted in the flock for at least 6 weeks
  - Can also persist through pupation; beetles emerging after cleanout and disinfections can re-infect a broiler house
- Intermediate host for cecal and tapeworms
- Implicated as a vector for numerous poultry diseases, including, but not limited to:
  - Fowl Pox
  - *E. coli*
  - Newcastle
  - Laryngotracheitis (LT)

### IMPACT OF BEETLE CONTROL

Beetle control delivers a return on investment (ROI) by improving feed efficiency.

<table>
<thead>
<tr>
<th>Savings/cost</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>4 pts. of improved FC (From 2.13 to 2.09)</td>
<td>$0.036/bird</td>
</tr>
<tr>
<td>X 100,000 birds</td>
<td>$3,600</td>
</tr>
<tr>
<td>Treatment cost (5 houses)</td>
<td>-$600</td>
</tr>
<tr>
<td>Total ROI per 100,000 birds</td>
<td>$3,000</td>
</tr>
</tbody>
</table>

Assumptions: 4 pts. of FC* = $0.13/lbs. of feed at a cost of $330/ton x body weight (5.6 lbs.) $120 per house treatment x 5 houses = $600
*Based on Grogan and Arends study results, 2008.

### FACILITY DESTRUCTION

- Beetles cause damage to nearly every part of a facility, including:
  - Wood structures
  - Insulation (must be replaced every 2-3 years, can cost $2,000 to $4,000*)
  - Sill sealers and vapor barriers
- Tunnel through insulation, carving out vacant channels
- Create spaces between the concrete and flooring

*Per 20,000 sq. ft. house
DARKLING BEETLES AS VECTORS OF POULTRY DISEASE: STUDY RESULTS

Study designed to assess the role of beetles as vectors for economically important bacterial and viral pathogens

STUDY DESIGN
- 2 poultry integrators
- 1 house per farm
- 5 farms composted litter, 5 farms non-composted litter
- Beetle traps at 18 predetermined sites
- 3 collections during grow-out
  - Placement
  - 3-4 weeks
  - Pre-processing
- Trap collection 5 days post-placement

MICROBIAL EVALUATION
- Adult pools and larval pools were prepared for each of the 3 house sections
  - 3 adult pools per house
  - 3 larval pools per house
- At the second collection time (3-4 weeks), each pool was separated into 2 aliquots
  - 1 pool for bacterial evaluation
  - 1 pool for virology

![Beetle trap placement](image-url)
VIROLOGY METHODS AND RESULTS

- Samples were collected from placement, 3-4 weeks and prior to processing
- Insects only (no litter)
- Methodology favors pathogens in feces
- Rinse adults or larvae in phosphate buffer solution
- Homogenize in diluent with antibiotics
- ~20% weight:volume suspension
- Centrifuge and filter
- Inoculate 11-day-old embryos by CAM (chorioallantoic membrane) route
- Inoculate cell cultures
- Inoculate SPF (specific pathogen free) and broiler chickens

- Among these agents were:
  - **Infectious bursal disease virus (IBDV):**
    An immunosuppressive virus that affects B lymphocytes, causing a decrease in performance and livability of the flock
  - **Astrovirus:** Recognized as an etiology for cystic enteritis, nephritis, plus can interact with coccidiosis and affect bird performance
  - **RSS orthoreovirus:** Also known to cause cystic enteritis and lymphoid cell depletion, can affect performance and interacts with coccidiosis
  - **Unidentified virus(es)/virus classification:**
    Thought to be associated with “flushing” (watery droppings) in 3-to-5 week old broilers; further studies need to be conducted

INOCULATION OF BROILER CHICKS WITH ASTROVIRUS ISOLATED FROM DARKLING BEETLE HOMOGENATE

4 days post-inoculation

- Control
- Astrovirus isolate

INOCULATION OF BROILER CHICKS WITH ORTHOREOVIRUS ISOLATED FROM DARKLING BEETLE HOMOGENATE

6 days post-inoculation

- Orthoreovirus

8 days post-inoculation

- Normal embryo
- Affected embryos
BACTERIOLOGY METHODS AND RESULTS*

- 3-4 week samples only
- Adults and larvae
- Litter
- Bacterial counts per gram
- *Clostridium sp.* (anaerobic)
- Gram-negative aerobes (lactose and non-lactose)
- Total aerobes
- Several infectious agents that affect chicken health and performance were isolated from adult and larvae beetles

BACTERIOLOGY RESULTS

Bacterial counts* (LOG_{10})** for litter and darkling beetle adults and larvae collected from a single farm at 3-4 weeks.

### Company A (composted)

<table>
<thead>
<tr>
<th>House chamber</th>
<th>Darkling beetles</th>
<th>CFU/GM</th>
<th>CFU/GM gram-negative</th>
<th>CFU/GM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Litter</td>
<td>Clostridia sp.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brood chamber</td>
<td>Litter</td>
<td>3.98</td>
<td>4.90</td>
<td>3.45</td>
</tr>
<tr>
<td></td>
<td>Larvae</td>
<td>3.36</td>
<td>5.48</td>
<td>2.70</td>
</tr>
<tr>
<td></td>
<td>Adult</td>
<td>5.11</td>
<td>5.88</td>
<td>4.90</td>
</tr>
<tr>
<td>Non-brood chamber</td>
<td>Litter</td>
<td>4.03</td>
<td>4.95</td>
<td>3.36</td>
</tr>
<tr>
<td></td>
<td>Larvae</td>
<td>2.60</td>
<td>5.76</td>
<td>5.32</td>
</tr>
<tr>
<td></td>
<td>Adult</td>
<td>5.64</td>
<td>5.88</td>
<td>5.94</td>
</tr>
</tbody>
</table>

### Company B (non-composted litter)

<table>
<thead>
<tr>
<th>House chamber</th>
<th>Darkling beetles</th>
<th>CFU/GM</th>
<th>CFU/GM gram-negative</th>
<th>CFU/GM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Litter</td>
<td>Clostridia sp.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brood chamber</td>
<td>Litter</td>
<td>3.92</td>
<td>4.13</td>
<td>2.60</td>
</tr>
<tr>
<td></td>
<td>Larvae</td>
<td>3.32</td>
<td>5.73</td>
<td>&lt;1.00</td>
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<tr>
<td></td>
<td>Adult</td>
<td>5.41</td>
<td>7.15</td>
<td>4.00</td>
</tr>
<tr>
<td>Non-brood chamber</td>
<td>Litter</td>
<td>3.92</td>
<td>3.78</td>
<td>&lt;1.00</td>
</tr>
<tr>
<td></td>
<td>Larvae</td>
<td>2.60</td>
<td>5.45</td>
<td>&lt;1.00</td>
</tr>
<tr>
<td></td>
<td>Adult</td>
<td>5.69</td>
<td>7.34</td>
<td>5.30</td>
</tr>
</tbody>
</table>

*Bacteriology performed by the University of Delaware Lasher Laboratory.
**Bacterial counts were transformed using a common logarithm (example LOG_{10} = 10 cfu; LOG_{3.9} = 9,549 cfu).
†CFU = colony-forming unit.
Note: Statistical analyses were not conducted.

SUMMARY OF RESULTS

- Viruses and bacteria isolated from beetles are those frequently found in feces
- Virus isolation procedures “favored” isolation of enteric viruses and infectious bursal disease viruses
- Isolation of viruses from beetles at chick placement suggests “carry-over” from previous flock
- On a per-gram basis, beetles appeared to concentrate *Clostridia sp.* and some of the gram-negative aerobes
- *Clostridia* concentrate in the adult beetles more than the litter
TREATMENT OPTIONS

There are two primary types of treatment: **pre-flock** and **mid-flock**. For both options, the key to successful treatment is application. Poor application will lead to poor results. To ensure correct application, always follow the label directions.

**PRE-FLOCK TREATMENT**

- Provides control of beetles from bird introduction into the house until mid-flock
- Duration of products during the flock depends on the chemical and the degree of insecticide resistance

**MID-FLOCK TREATMENT**

- Controls beetles when chemicals are no longer active from the pre-flock treatment
- Controls beetles where they’re located during the flock: under the feeders and along the wall
- Used to extend the duration of the pre-flock treatment

**Treatment example: pre-flock**

There are two primary types of treatment: **pre-flock** and **mid-flock**. For both options, the key to successful treatment is application. Poor application will lead to poor results. To ensure correct application, always follow the label directions.

The sample treatment above shows the banded application technique. It’s important in this type of application to use enough water to cover the entire treatment area, especially the litter, along feed and water lines, walls and support beams. Low to moderate volumes of spray work best.

**Control rotations**

<table>
<thead>
<tr>
<th>Chemical class and rotation</th>
<th>Neonicotinoids (2-3 flocks)</th>
<th>Pyrethroids (2-3 flocks)</th>
<th>Organophosphates (2-3 flocks)</th>
<th>Spinosyns (2-3 flocks)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Active ingredients</strong></td>
<td>Imidacloprid</td>
<td>Gamma-cyhalothrin</td>
<td>Chiorpyrifos</td>
<td>Spinosad</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cyfluthrin</td>
<td>Tetrachlorvinphos</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bifenthrin</td>
<td>Dichlorvos</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Permethrin</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Brand names</strong></td>
<td>Credo®</td>
<td>StandGuard®</td>
<td>Durashield CS®</td>
<td>Elector® PSP</td>
</tr>
<tr>
<td></td>
<td>Exile DB®</td>
<td>PermaCap®</td>
<td>Pyrofos™ CS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dominion®</td>
<td>Tempo®</td>
<td>Rabon®</td>
<td></td>
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<tr>
<td></td>
<td>MIDASH Forte®</td>
<td>Permethrin SFR®</td>
<td>Ravap®</td>
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<td></td>
<td></td>
<td>Tengard®</td>
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<td></td>
<td></td>
<td>Optimate®</td>
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<td></td>
<td></td>
<td>Optashield CS®</td>
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<tr>
<td></td>
<td></td>
<td>Bifen®</td>
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</table>
Elector PSP directions for use

For control of darkling beetles (*Alphitobius diaperinus*) infesting poultry:

- Low volume spray: Up to 15 gallons of diluted spray applied to 20,000 ft².
- Moderate volume spray: Up to 40 gallons of diluted spray applied to 20,000 ft².
- 2 fl. oz. (60mL) of product treats 5,000 ft² (8 fl. oz. of product treats 20,000 ft²).
- For severe infestations, 4 fl. oz. of product may be used to treat 5,000 ft² (16 fl. oz. treats 20,000 ft²).
- Apply to floor area, especially to litter, around feed and water lines and to walls and support beams, but do not allow run-off to occur. Application should also be made into cracks and crevices around insulation, and where pests have been seen or can find harborage. Reapply after each grow-out or sanitation procedure. Indoor control can be enhanced by making perimeter treatments to the outside of building foundations to prevent migrating adult beetles.

StandGuard directions for use

For control of darkling beetles (*Alphitobius diaperinus*) infesting poultry:

- Dilute 2 fl. oz. of product to 3 gal. of water.
- Apply to walls and floors with a coarse spray at each grow-out or sanitation procedure, before reintroduction of poultry or other animals. Use a sprayer of appropriate design that is equipped to efficiently apply the spray. Pay attention to areas where beetles frequently occur, such as walls, supports, cages, stalls and around the feeders. Allow treated surfaces to dry completely before restocking the facility. Re-application may occur every 21 days as needed.

The labels contain complete use information, including cautions and warnings. Always read, understand and follow the labels and use directions.

It is a violation of federal law to use this product in any manner inconsistent with its labeling. Labeling must be in possession of the user at the time of pesticide application.

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