NC STATE UNIVERSITY

# Dung Beetles of Central and Eastern North Carolina Cattle Pastures

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## Dung Beetles (Coleoptera: Scarabaeidae and Geotrupidae) in Cattle Pastures

Dung beetles, in the insect families Scarabaeidae and Geotrupidae, are an important group of insects associated with the decomposition of animal manure around the world. They consume large amounts of dung as adults and larvae. Some species prefer woodland habitats while others are common on pastures. Their actions have been credited in reducing pasture fouling, adding nutrients to soil, aerating soil and competing for nesting habitat and food resources with flies (particularly the horn fly, *Haematobia irritans*, and the face fly, *Musca autumnalis*).

Beef cattle production in North Carolina is characteristically a small cow/calf herd, with less than 50 head of cattle on pasture. Many dairy producers use pastures to provide nutritional forage for young and yearling heifers. A growing number of dairy producers use pastures for lactating dairy cows on a rotational basis. Rotational grazing employs the periodic movement of cattle between paddocks to encourage plant growth, and provide nutritious forage for cattle. The practice tends to minimize overgrazing and conserves natural resources. Rotational grazing increases plant diversity, pasture yield, and utilizes animal manures efficiently. In the absence of dung-inhabiting insects animal feces can be slow to decompose and the benefits of good nutrient distribution may be reduced.

Dung beetles fall into three basic nest building categories, tunnelers (paracoprids), dwellers (endocoprids), or rollers (telecoprids) (Figure 1). Tunnelers consume the dung pat and burrow into the soil beneath the pat. The tunneling activity of *Phanaeus vindex* and *Onthophagus* species brings subsurface soil to the ground surface and fill the tunnel with loosened soil to protect the brood ball (Figure 1I). Manure dwelling beetles, e.g. *Aphodius* species, consume the manure pat and deposit eggs in the manure, or in the soil near the surface (Figure 1II). *Canthon* beetles are dung rolling beetles. These beetles tend to break the pat into brood balls that are rolled to a suitable site and buried (Figure 1III). Each dung beetle nest type improves the soil by increasing percolation, introducing organic matter into the soil, and reducing non-point sources of organic pollution.

Adult dung beetles vary significantly in size from small beetles no more than 1/8$^{th}$ of an inch in length (*Aphodius pseudolividus*) to large beetles measuring 1 ¼ inches in length (*Dichotomius carolinus*). Most dung beetles are brown to black in color. Occasionally, a

bright metallic green beetle appears and can be an easily identified as *Phanaeus vindex*. Many of the male dung beetles have distinct horns, for example, *Onthophagus taurus* horns resemble bull horns, while *Onthophagus gazella* has short spike like horns (Figure 3). Horn size is generally a product of larval nutrition. Major males have large horns while minor males have short horns.

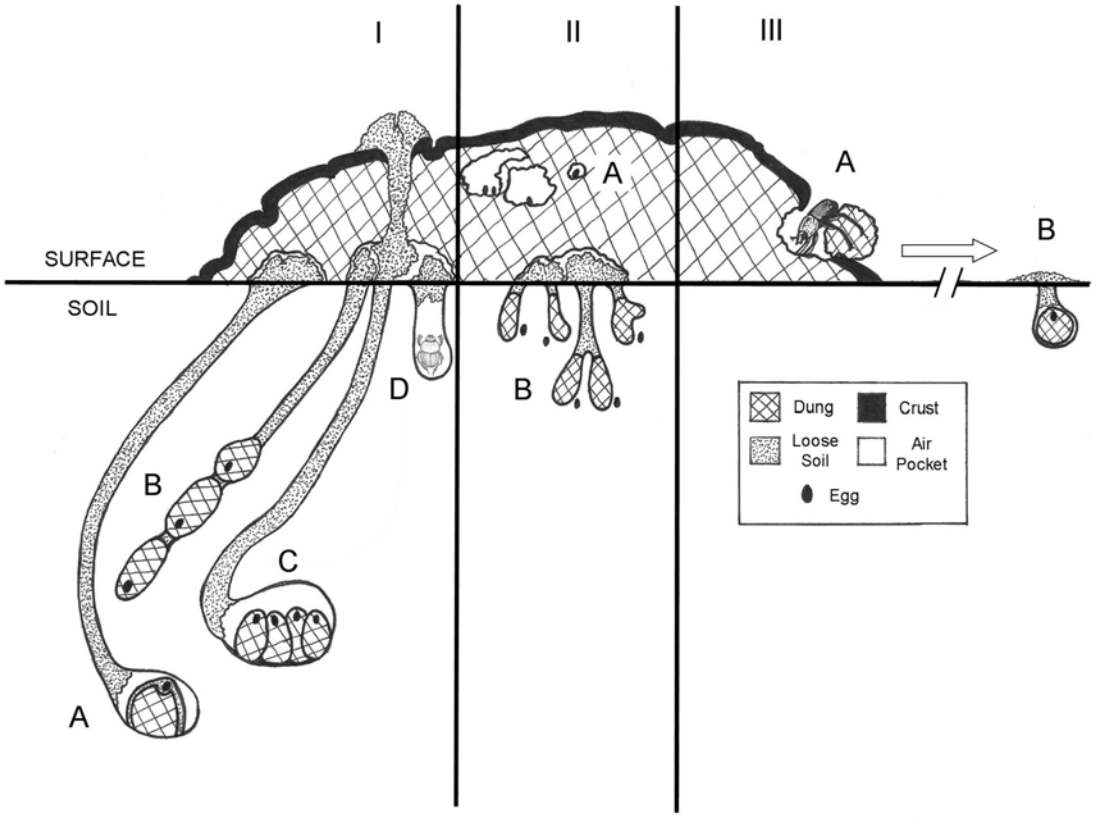


**Figure 1**. Cross section through dung pat depicting three nesting types:

**Tunnelers I**-A. *Phanaeus vindex* tunnel with single, soil-coated brood ball in single chamber; B. *Onthophagus* species tunnel with multiple brood masses; C. *Copris minutus* multiple brood balls; D. beetle excavating new tunnel (note subsurface soil is pushed through the dung pat crust)

**Dwellers II**-A. *Aphodius pseudolividus* eggs are laid singly or in groups inside dung pat; B. *Aphodius erraticus* bury dung under pat with eggs laid beside brood masses.

**Rollers III**-A. *Canthon pilularius* adult carving out dung into a ball; B. ball rolled a distance away from pat and buried shallowly.

## Species Composition and Seasonality in Eastern and Central North Carolina

Twenty-eight species of dung beetles have been identified from beef and dairy pastures located at the Center for Environmental Farming Systems (CEFS), Goldsboro, NC. The CEFS pastures are characteristic of those in the NC coastal plain. Fourteen species of dung beetles were identified from dairy (Piedmont Research Station, Salisbury, NC) and

beef pastures (Nashville, NC) at the interface of the coastal plain and piedmont region of North Carolina. Dung beetles were more abundant at the eastern NC sites than on the Piedmont Research Station. For example beetle collections over an 18-month period from the CEFS dairy pasture were 57,025 while in contrast 4,111 specimens were collected from the Piedmont Research Station dairy. Although fewer beetles were collected in the winter, dung beetles were active year round (Figure 2).

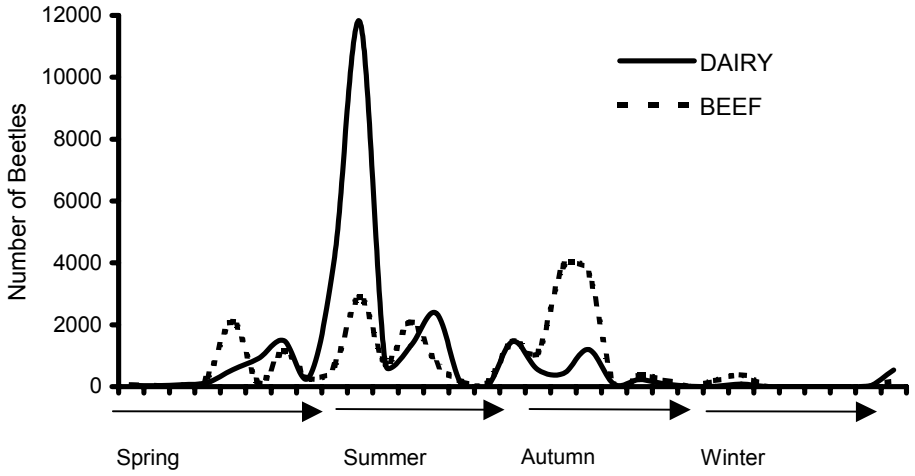


**Figure 2.** Annual dung beetle activity on beef and dairy pastures located in eastern North Carolina.

**Species composition change seasonally**

Some species, such as *Aphodius granarius* and *Aphodius erraticus* were present from late winter through spring, but were not collected in the summer and fall. *Phaneus vindex* is a large metallic green beetle that is found from spring to fall. *Geotrupes backburnii* activity increases in the fall and winter months. *Onthophagus gazella* was not present until the middle of the summer, and were most abundant in August, while others were active most of the year.

Four dung beetle species (Figure 3), *Onthophagus hecate, Onthophagus pennsylvanicus*, *Onthophagus taurus,* and *Aphodius pseudolividus,* were most abundant from March until October when fly breeding was highest and the forage production was greatest. The dwelling beetle, *A. pseudolividus*, does not incorporate manure into the soil but directly competes with horn flies for manure resources. The benefits of the *Onthophagus* species are twofold; dung buried in tunnels beneath the dung pat limit fly resources while providing nutrients for the plant growth.

Factors influencing the natural distribution of dung beetles are not well understood. Native dung beetles, *O. pennsylvanicus*, *O. hecate*, are widely distributed along the Mid Atlantic states. *Onthophagus gazella* was introduced from the Africa and released in

Texas and Georgia to facilitate pasture improvement, whereas *O. taurus* was an accidental introduction from the Middle East and Europe. *Onthophagus taurus* has been collected from New York to Florida. In North Carolina, *O. taurus* was the dominant species collected (Table 1). In contrast, no *O. gazella* were collected from the Piedmont Research Station and 8 specimens were found on the beef pastures in Nash County. Differences in beetle populations may be attributed several factors including, soil type (clay or sandy loam), climate, beetle dispersion or pesticide use.

**Table 1.** Percent species composition of dung beetle populations collected from North Carolina dairy and beef pastures located at the Center for Environmental Farming Systems (CEFS), the Piedmont Research Station, and Nash County.

| | CEFS | CEFS | Piedmont | Nash Co. |
|---|---|---|---|---|
| | Dairy | Beef | Dairy | Beef |
| *Aphodius pseudolividus* | 3.29 | 34.34 | 20.32 | 1.33 |
| *Aphodius erraticus* | 8.50 | 3.84 | 5.20 | <1.00 |
| *Onthophagus taurus* | 78.78 | 43.01 | 67.71 | 84.76 |
| *Onthophagus pennsylvanicus* | 2.50 | 4.88 | 2.60 | 10.91 |
| *Onthophagus gazella* | 3.69 | 8.33 | 0.00 | <1.00 |
| *Onthophagus hecate* | 1.41 | 0.47 | 0.92 | 1.48 |
| Other species | 1.80 | 10.00 | 3.20 | 0.60 |
| Number Beetles Collected | 28,095 | 22,846 | 3,695 | 20,584 |

## The Role of Dung Beetles in Pasture Nutrient Cycling

Dung beetles have the potential to improve pastures through the incorporation of manure into pasture soils. Two dung beetles, *O. gazella* and *O. taurus*, were evaluated in the laboratory for improved soil quality. The test soil was a coastal plain sandy-loam, common to eastern North Carolina. Treatments included bovine dung alone, dung plus *O. gazella*, dung plus *O. taurus*, and a no-dung control. The presence of beetles improved levels of P, K, Mg, and the sum of the cations in soil beneath the dung pat (Table 2).

**Table 2.** Analysis of soil treatments, using Mehlich[3] Extraction (North Carolina Department of Agriculture and Consumer Services).

| Treatment | P ($mg/dm^3$) | K ($meq/100cm^3$) | Mg ($meq/100cm^3$) | Sum Cations ($meq/100cm^3$) |
|---|---|---|---|---|
| Sandy-loam Pre-treatment | 99.40 | 0.08 | 0.53 | 1.66 |
| Sandy-loam + Dung | 174.73 | 0.18 | 0.87 | 2.64 |
| Sandy-loam + Dung + *O. gazella* | 204.57 | 0.25 | 1.06 | 3.35 |
| Sandy-loam + Dung + *O. taurus* | 196.01 | 0.23 | 0.98 | 3.04 |

## Dung Beetles and Insecticides

Managing pasture flies and promoting dung beetles is a delicate balancing act. Pesticides formulated in an ear tag have minimal impact on dung beetles. Pour-on formulations have a greater effect on beetles if the insecticide is excreted in the manure. Parasiticides in the macrocyclic lactone class (abamectin, ivermectin, eprinomectin, doramectin**)** kill flies and dung beetles in the manure (Fincher 1992, Holter et al. 1994, Floate 1998, Lumaret and Errouissi 2002). Similarly, manure excreted by cattle treated with a pour-on pyrethroid was toxic to dung beetles for 1 week following treatment (Kruger et al. 1999). Persistent use of these compounds will have a long- term negative impact on the dung beetle population. In contrast, moxidectin is less toxic to dung beetles and did not reduce dung beetle survival (Fincher and Wang 1992 Lumaret and Errouissi 2002). Occasionally, horn fly and/or face fly pressure on the cattle will require treatment to provide relief to the cattle, so some impact on dung beetle populations may be unavoidable. Fly control strategies that minimize negative impacts on dung beetles are the subject of current research at NCSU and at other universities.

## Do You Have Dung Beetles in Your Pastures?

Unless there is a long history of pesticide use, (especially those listed above), you probably have dung beetles in your pasture. Walk your pastures and examine the dung pats. If you find holes in the surface of the pat, or pats appear to be shredded, you probably have dung beetles. To confirm their presence, open the pats with a spade, trowel or your boot and look for adult beetles or simply walk behind your cattle and observe any insect activity immediately following the deposition of a dung pat. Dung beetles usually arrive within minutes of the deposition of dung when temperatures are above 70$^{o}$F. The photo guide (Figure 3) will help identify common dung beetles present in your pastures.

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**Figure 3. Picture Guide to Dung Beetles Associated with NC Pastures**
Males are indicated by the symbol ♂ and females ♀
Photographs by Matt Bertone

*Aphodius distinctus*
Size: 1/8-3/16”

*Aphodius erraticus*
Size: 1/4-3/8”

*Aphodius fimetarius*
Size: 1/4-3/8”

*Aphodius pseudolividus*
Size: 1/8-3/16”

*Geotrupes blackburnii*
Size: 3/8-3/4”

*Onthophagus gazella* (♀)
Size: 3/8-1/2”

*Onthophagus gazella* (♀)
Size: 3/8-1/2”

*Onthophagus gazella* (♂)
Size: 3/8-1/2”

*Onthophagus gazella* (♂)
Size: 3/8-1/2”

*Onthophagus hecate* (♀)
Size: 1/4-3/8”

*Onthophagus hecate* (♂)
Size: 1/4-3/8”

*Onthophagus hecate* (♂)
Size: 1/4-3/8”

*Onthopagus pennsylvanicus*
Size: 1/8-1/4”

*Onthophagus taurus* (♀)
Size: 1/4-3/8”

*Onthophagus taurus* (♂)
Size: 1/4-3/8”

*Onthophagus taurus* (♂)
Size: 1/4-3/8”

*Phanaeus vindex* (♀)
Size: 3/8-7/8”

*Phanaeus vindex* (♂)
Size: 3/8-7/8”

*Phanaeus vindex* (♂)
Size: 3/8-7/8”

*Canthon pilularius*
Size: 1/2-5/8”

*Dichotomius carolinus*
Size: 3/4 – 1¼”

**Pronunciation guide:** There are no common names of these beetles. To make their names easier to understand, a pronunciation guide is provided.

*Aphodius distinctus*: A-fo-di-us dis-tink-tuss
*Aphodius erraticus*: A-fo-di-us e-rat-i-kus
*Aphodius fimetarius*: A-fo-di-us fim-a-tary-us
*Aphodius granarius*: A-fo-di-us gran-air-e-us
*Aphodius pseudolividus*: A-fo-di-us sue-doe-liv-i-dus
*Canthon pilularius*: Kan-thon pie-loo-lary-us
*Copris minutus*: Koe-pris mi-nu-tus
*Dichotomius carolinus*: Dik-o-tomee-us carolin-us
*Geotrupes blackburnii*: Geo-troop-eze black-burny-eye
*Onthophagus gazella*: On-tho-fa-gus ga-zell-a
*Onthophagus hecate*: On-tho-fa-gus heck-ate
*Onthophagus pennsylvanicus*: On-tho-fa-gus pen-sill-van-i-kus
*Onthophagus taurus*: On-tho-fa-gus tore-us
*Phanaeus vindex*: Fan-ny-us vin-dex (Rainbow beetle)