# Dung Beetles - Their usefulness in the pasture ecosystem and what affects their populations

On Thursday, March 12, the last technical session, **Dung Beetles - Their usefulness in the pasture ecosystem and what affects their populations**, began at 8:00 AM. Dr. Thomas Griggs, Assistant Professor of Forage and Grassland Agronomy, West Virginia University, Morgantown was session moderator.

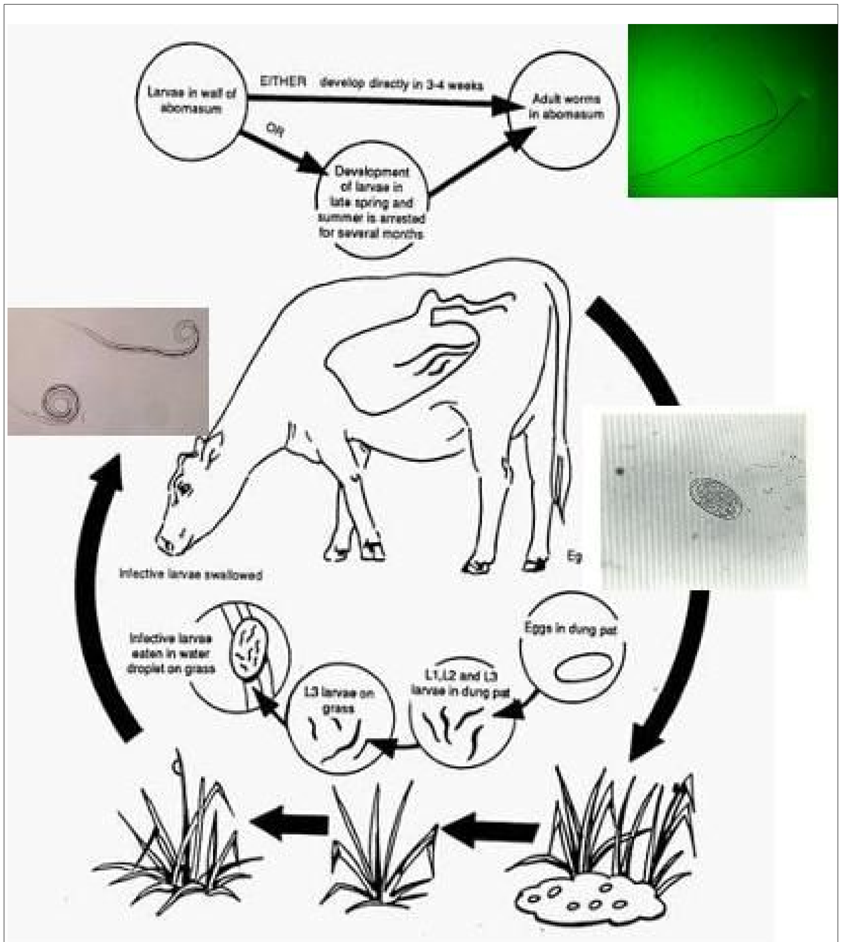
Dr. Griggs introduced the first speaker, Dr. Scott Bowdridge, Assistant Professor of Food Animal Production, Department of Animal & Nutritional Sciences, West Virginia University, Morgantown, WV. Dr. Bowdridge presented *Anthelmintic resistance in cattle, and livestock health management to improve survivability of dung beetles in pastures*. Dr. Bowdridge presented first since he had a class to teach at 10:00 AM back on campus. This had been scheduled to be the last paper of the session. Problem parasites in livestock, such as *Haemonchus contortus*, *Haemonchus placei*, *Ostertagia ostertagi, Cooperia* spp., *Trichostrongylus* spp., and *Oesophagostomum* specie, caused a need for cattle, sheep, and goats to be treated with parasiticides. The life cycle of the parasites includes a time when these parasites live in the grass sward of a pastures on leaf blades. Livestock grazing these pastures drop dung that contains the eggs of the parasites. Once on the pasture surface, they hatch and crawl onto grass leaves. Livestock get reinfected by the larvae when they eat the grass. Fecal egg counts (FEC) can be done from sampling fresh dung pats. If the parasiticides are effective, FEC is reduced 90% or more. A 60 to 90% reduction constitutes a moderate level of resistance. If they are ineffective, less than a 60% reduction occurs, indicating severe resistance to the particular parasiticide.

Three classes of drugs are approved for use in cattle:

1.) Macrolytic lactones
    Include: Cydectin, Eprinex, Dectomax, Ivomec

2.) Benzimidazoles
    Include: Valbazen, Safe-Guard, Panacur, Synanthic

3.) Neonicotinoids
    Include: Levamisole, Tramisole




*Life cycle of cattle intestinal parasites showing how they persist in pastures by being deposited as eggs in cattle feces, hatching, and growing into infective larvae that get ingested by grazing cattle thereby returning to the abomasum to complete the cycle.*

The Ivermectin class of chemicals have lost their effectiveness in controlling parasites. Ivomec only reduced FEC 42 percent in a southern WV bull test study in 2007 while Safe-Guard reduced FEC by 95%. Safe-Guard is Benzimidazole put in a polymer. As the polymer breaks down in the gut of cattle, the parasiticide is slowly released. It works well on cattle, but does not work in sheep. Anthelmintic resistance in WV indicates a lack of efficacy of macrolytic lactones (Ivomec) especially in the pour-on formulation. The injectable formulation of Ivomec gives somewhat better control but only reduced FEC by 63%. Meanwhile macrolytic lactones demonstrated a negative impact on dung beetle larvae, although Moxidectin has less impact on dung beetles. Therefore, the use of these macrolytic lactones is ineffective in controlling stomach worms in livestock, while killing off the dung beetles who are beneficial insects in a pasture. The other two classes of drugs, Neonicotinoids and Benzimidazoles have no effect on dung beetles.

In another study, 300 calves were treated at weaning time with Safe-Guard by 5 producers and 1 producer used Synanthic in the WV North Central Calf Pool. Seventy-five percent of the calves had no worms at weaning time. Forty-five days after weaning FEC goes up as the wormer wears off and calves are reinfected. Less than 20% of the calf herd contributes more than 80% of FEC.

Since benzimidazoles do not kill dung beetles, why don't all producers use benzimidazoles?
There are 3 principal reasons:
1.) Not available in pour-on formulation so ease of application is lacking.
2.) No endectocide effect (active against both endoparasites [e.g. stomach worms] and ectoparasites [e.g. lice])
3.) Not as safe as other parasiticides to treated cows.

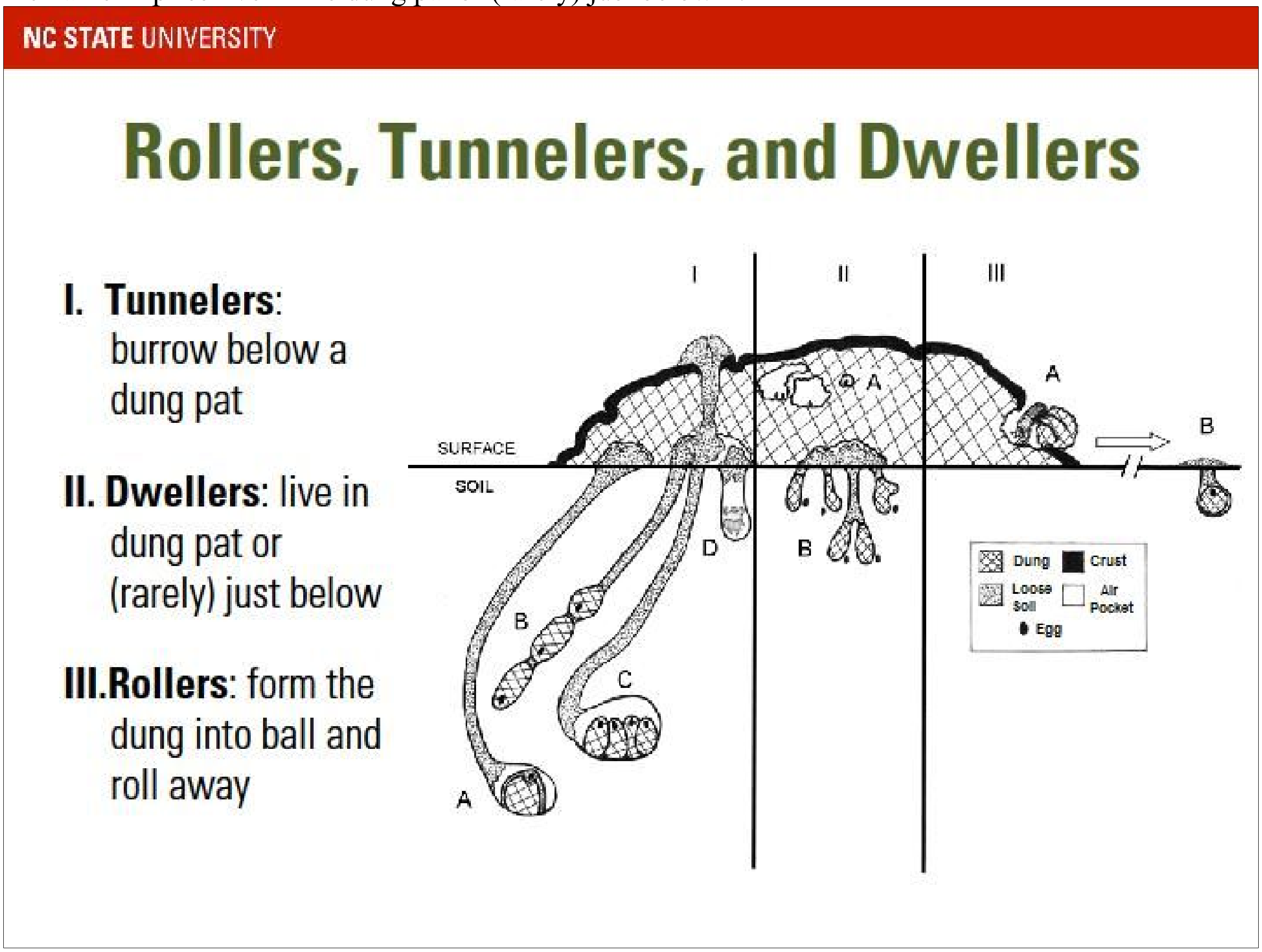
Pyrethrins and their derivatives that are used for lice and fly control on cattle are also bad for dung beetle survival.

Dr. Bowdridge rounded out his talk explaining the concept of refugia and how it might help retain dung beetles in pastures. Every time you treat an animal with an anthelmintic you change the population of parasites. We assume that all dewormers are 100% effective when in reality they may only be 80-90%. The remaining worms in the animal after deworming have survived treatment, and therefore, have been selected to reproduce a more resistant population. Maintaining a population of parasites that are still susceptible to dewormers is creating a refugia. It is accomplished through selective deworming. By not deworming some cattle, you are allowing a "refuge" for susceptible genetics to live so that the dewormer being used still has some effectiveness. The goal of deworming is not parasite-free. Select a percentage of the herd to deworm, 20% of cows and 10-20% of replacement calves. Selective deworming in cattle needs to be addressed as it may be a source of balance between parasite control and dung beetle survivability. Since much fewer cows or calves being treated with dewormers, the untreated livestock's dung is dewormer free. The dung beetles feeding on those dung pats will not be ingesting the parasiticide.

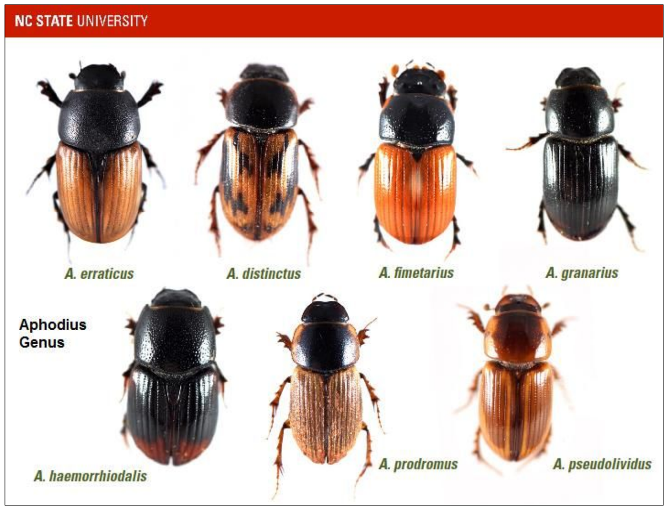
Dr. Matt Bertone, Extension Associate, Entomologist, NCSU Plant Disease and Insect Clinic, North Carolina State University, Raleigh, was the next speaker. His topic was the *Natural history of dung beetles and commonly-encountered pasture species*. Dr. Bertone described beetles as little tanks that rule the world. They are the most diverse group of organisms on Earth. There are over 350,000 named species. They live on land and in water. They are characterized by hardened or leathery outer wings (elytra) that protect the inner wings from harm. They haunt many habits. Dung beetles themselves could be loosely described as any beetle that visits dung. Some are predators, while others feed on dung directly. True dung beetles belong to two families, *Scarabaeidae* – Subfamilies *Aphodiinae* and *Scarabaeinae*, and *Geotrupidae*. They are characterized by lamellate (leaf-like) antennae. They are the most important dung-feeding beetles. Dung beetles are quite diverse. There are approximately 5,000 spp. world-wide, composed of 234 genera with approximately 1,800 species in *Onthophagus*. In the US, there are 150 specie in 17 genera. Dung beetles are most diverse in the Southwest.

Dung feeding activity was described next. Adults cannot feed on fibers since they have soft filtering mouthparts. They eat microbes and small particles of dung. Larvae have biting mouthparts and do feed on fibers in the dung mass. They are limited to feeding on a dung ball/mass and often eat their own feces a few times. Adults often feed larvae until they are sexually mature. Dung preferences: omnivore, then herbivore, and carnivore last.

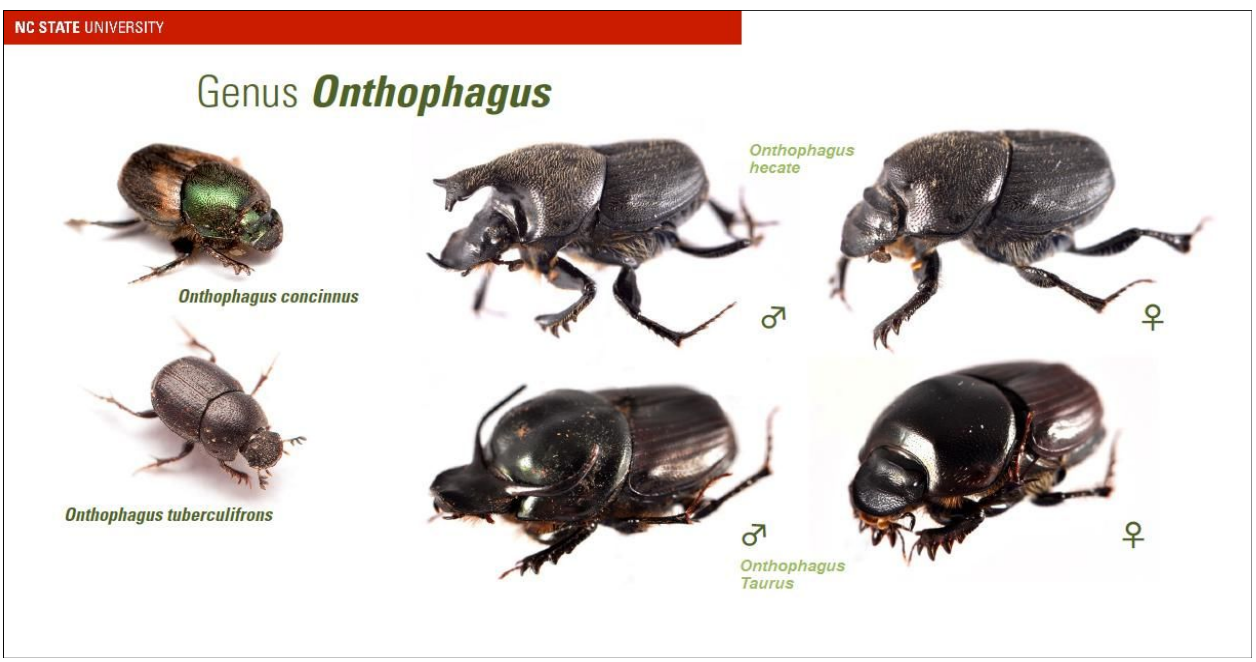
There are three types of dung beetles: rollers, tunnelers, and dwellers. Rollers form dung into a ball and roll it away to bury it in the ground just below the surface after laying an egg in it. Tunnelers burrow several inches below a dung pat to deposit dung balls with eggs embedded in them. Dwellers as the name implies live in the dung pat or (rarely) just below it.




Dr. Bertone used a series of slides of common eastern US dung beetles so the audience could recognize them in a pasture setting. The first dung beetle shown was the genus *Aphodius*. Most are dwellers, generally small (~4-7 mm), pill-shaped with elytra covering rear. Their legs have spiny ridges. They are black to copper colored and some have black heads and pronotums and copper elytra. Many native and introduced species are present in the eastern US. They have more diverse diets than other dung beetles. These are the common *Aphodius* dung beetles: *A. erraticus* (black head and pronotum - dull copper elytra), *A. distinctus* (black head and pronotum - copper elytra with dark blotches), *A. fimetarius* (black head and pronotum- bright copper elytra), *A. granarius* (all black - shiny), *A. haemorrhiodalis* (mostly black - copper tinged elytra at rear), *A. prodromus* (black head with pronotum black on top with tinged copper at sides - dirty copper elytra), and *A. pseudolividus* (all brownish copper). All have a scutellum (a small triangle between the two elytra directly behind the pronotum). Pronotum is the first segment of the thorax immediately behind the head.




The next genus displayed was *Onthophagus*. They are tunnelers. They are small to medium sized (~3-12mm). Many of the males have horns. Some are brightly colored but most black. They have a round shape and lack a scutellum. *Onthophagus concinnus* has a metallic green head and pronotum and dark copper elytra. *Onthophagus tuberculifrons* is metallic gray. *Onthophagus hecate* is a native dung beetle ~5-8mm in size. It has bumps (granules) on pronotum and is black and hairy. A major male has a spatula-like horn on pronotum and pointed horn on nose. *Onthophagus taurus* is ~6-8mm long. It is shiny with fine punctures on pronotum. The elytra are reddish to dark brown. The major male has bull horns. This species is Eurasian in origin but was introduced to the US in the 1970's.



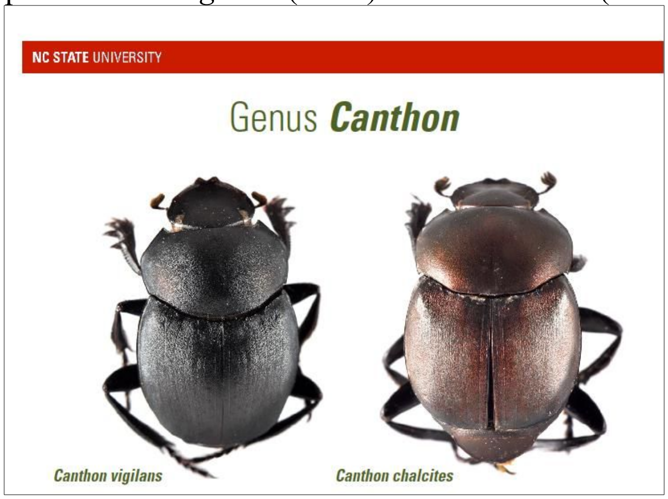

Other native *Onthophagus* are *O. pennsylvanicus* (also similar: *O. oklahomensis*) and *O. tuberculifrons*. These dung beetles are oval in shape and are shiny black. Their front feet look like mole feet. *O. nuchicornis* is a non-native dung beetle that has a brownish gray head and pronotum with copper and black mottled elytra.

The genus *Digitonthophagus* is a non-native that was imported into the US. *Digitonthophagus gazella* is a common species in the southeastern US. Oval in shape without noticeable protrusions, it has a black head with a black pronotum with copper fringed sides. The elytra are copper to brownish copper. It is the most widespread dung beetle in tropical and subtropical pastures north to North Carolina.

*Phanaeus vindex* (rainbow scarab) are tunnelers. They are large (~11-22 mm) and brightly colored (iridescent green & red). Males have a "rhinoceros" horn. Pairs bury dung for offspring. The dung balls are coated in soil.

Other tunnelers are *Copris minutus* and *Dichotomius carolinus*. They are shiny black. *D. carolinus* is twice the size of the *C. minutus* and is copper tinged on the legs, at joints between head and pronotum, and the joint between pronotum and elytra.

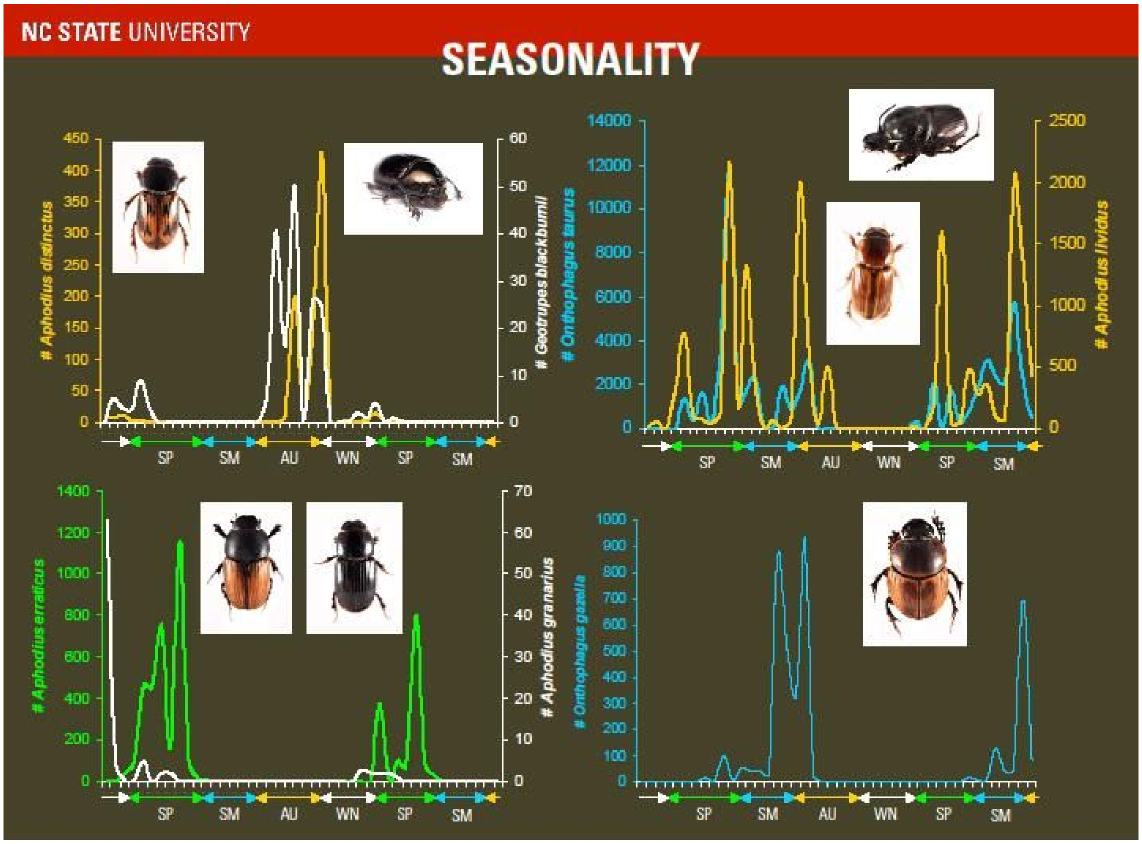
The genus *Canthon* are rollers. They are small to large (~4-25mm). They never have horns – males and females are similar. Their hind legs are thin. Most are black or with a bronze/green sheen. They have a strong odor. Two species are *C. vigilans* (black) and *C. chalcites* (bronze).




The last genus shown was *Geotrupes*. They are tunnelers that go deep into the soil. They are large (~12-25mm) and have exposed mouthparts. Their antennas have 11 segments. They are shiny black with metallic blue, green, or bronze tinge.

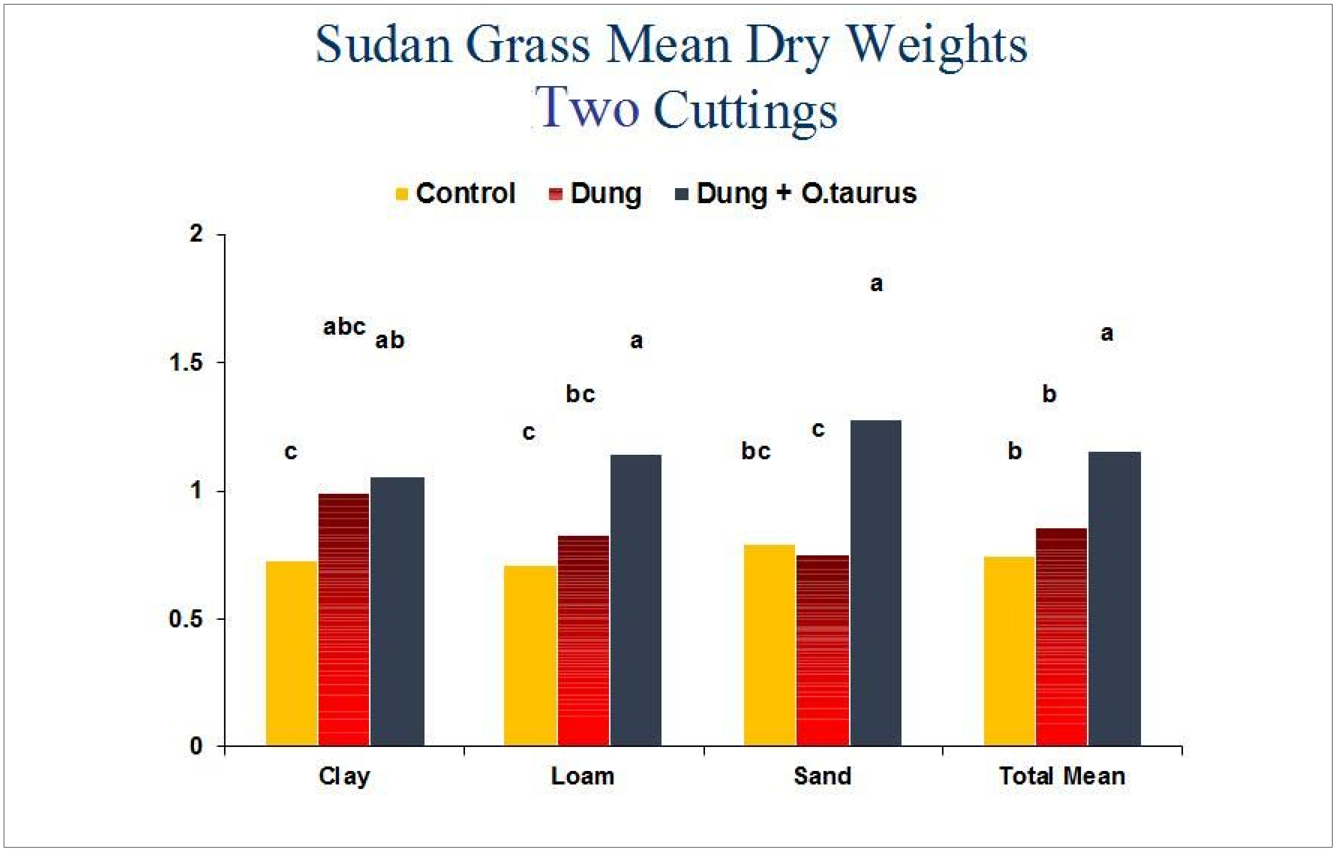
Dung beetles are seasonal with different species appearing at different times during the year. *Aphodius erraticus* are active in the springtime. *Aphodius distinctus* and *Geotrupes blackburnii* are most active in the fall. *Aphodius lividus* is active from early spring to late summer. *Onthophagus gazella* is most active from midsummer to mid-fall. See seasonality chart below.

Adult dung beetles are preyed upon by birds and small mammals.

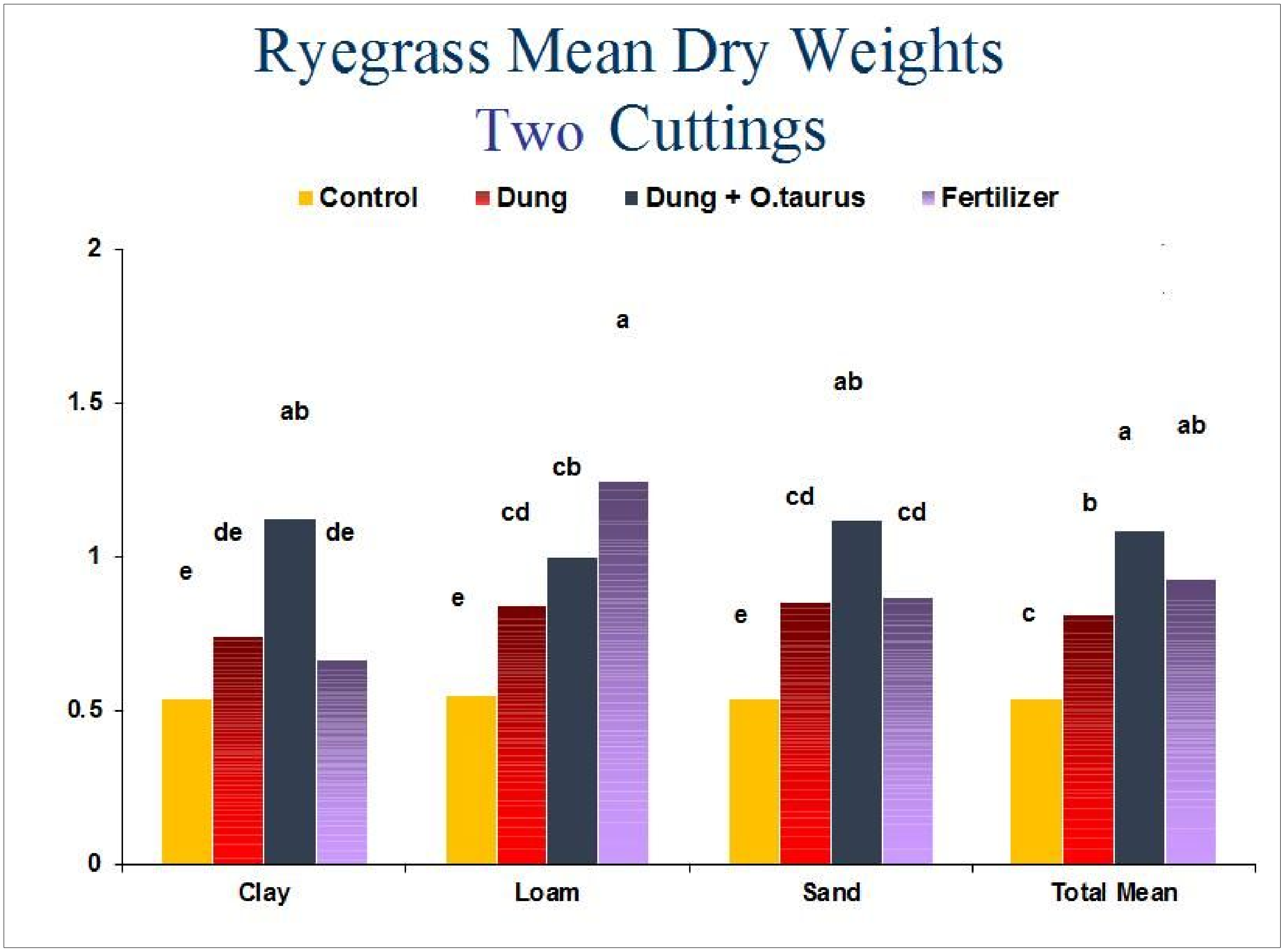



The final presenter at the dung beetle session was Dr. Wes Watson, Interim Department Head - Entomology & Professor and Extension Specialist, Livestock & Poultry, North Carolina State University, Raleigh. His presentation was *Dung beetle contributions to pasture nutrient cycling*. Dr. Watson started his presentation by saying dung is key. Dung quantity (cows defecate 6 times a day) and distribution are important for nutrient cycling. A research study, *Spatial and time distribution of dairy cattle excreta in an intensive pasture system*, by S. L. White et al., J. Environ. Qual. 30: 2180-2187 was cited. He showed how the dung and urine was distributed over a one year period in 2 paddocks that were grazed over 2 days served by one water trough near the gate of the first paddock at a far corner. Paddock 1 was grazed day 1 and day 2 paddock 2 was grazed but cows had to go back into paddock 1 for water and exited from the gate in paddock 1 to be milked twice daily. Distribution uniformity was reasonably good although the dung and urine spots were more concentrated near the water trough and gate in the first paddock since they had to go to water in paddock 1 for both days that they were on these 2 paddocks and also stood at the gate for some time to wait to go back to the farmstead to be milked on 4 separate occasions. A sequence of dung and urine spot patterns were shown after the first grazing event in July, 1997, after the second grazing event in August, 1997, and then after 6 grazing events had occurred from July, 1997 to April, 1998. It shows that short duration rotational grazing tends to make dung and urine distribution rather even. However, it also shows that a short duration rotational stocking of cattle can also be better if each paddock is grazed separately having its own water trough and gate opening. After 6 grazing events in a year, there is a lot of fouling of the pasture by dung so dung beetles are necessary to clean up the mess and help recycle nutrients for use by grass regrowth after a grazing event.

Dr. Watson showed us what the effects *Onthophagus taurus* and *Onthophagus gazella* have on nutrient recycling. They are tunnelers. Tunnelers produce a lot of holes beneath the dung pat as they tunnel into the soil to deposit dung balls at the bottom of the tunnels. They improve soil conditions by improving permeability by their burrowing, and soil tilth by mixing soil and dung together. Soil from the tunnel digging is forced up on top of the dung pile. Nutrient cycling is done by the adults and their larvae ingesting the dung and excreting their wastes and by the burial of dung balls by the adults a few inches into the soil.




Dr. Watson noted that there has been some limited research on the positive impact that dung beetles have on yield and quality of plants - three studies in all, one from Georgia on coastal bermudagrass and two from Australia. Therefore, two annual pasture grasses were selected for study by NCSU, annual ryegrass and sorghum-sudangrass. Three mediums were used to grow the 2 forages, Coastal Plain loam, Piedmont red clay, and play sand. A dung beetle, *Onthophagus taurus*, was selected as it is the most common dung beetle at two sites in NC, Goldsboro (Coastal Plain) and Salisbury (Piedmont). It makes up about two-thirds of the dung beetle population at those two sites. This was a pot study, but it mimicked a rotational grazing system. There was a sequence of deposition of dung and a grass growth period (40 days) followed by a grazing period with a deposition of dung and then another rest period as if cattle were moved to another paddock. This was repeated a second time to yield two cuttings. On each of the 3 soil types, the experiment had a control, a dung only treatment, a dung plus dung beetles treatment, and an ammonium nitrate fertilizer treatment. The pots were in a randomized arrangement. The dung plus dung beetles treatment had 5 pairs of dung beetles placed in the pots after each manure treatment. The two annual grasses were planted and allowed to grow 40 days before being cut to leave a 3-inch stubble height then treated again with dung only or with dung beetles and allowed to grow another 40 days before being cut and treated again. The cuttings were dried and weighed to determine yield. The first cutting sorghum-sudangrass yield was significantly higher on the sterile play sand when treated with dung plus dung beetles. The Coastal Plain loam yield was higher with dung plus dung beetles but the variability of the data kept it from being significantly different from the dung only treatment or the control. On the Piedmont clay, the dung plus dung beetle treatment was not significantly different in yield from the dung only treatment, but was significantly different from the control. At the second cutting of the sorghum-sudangrass, yield differences were more pronounced on the play sand and the Coastal Plain loam, the dung plus *O. Taurus* yield of sudangrass was significantly higher than the dung only and control yields showing a cumulative effect of dung beetle activity of recycling nutrients and improving soil health. The Piedmont clay dung plus *O. Taurus* was higher in yield but not significantly over the control and dung only treatments. When both cuttings were pooled together, it was very similar to the second cutting results with the dung plus *O. Taurus* being significantly higher in yield than the control and dung only treatment on the play sand and Coastal Plain loam while becoming significantly different in yield over the control on the Piedmont clay and higher in yield but not significantly over the dung only treatment.




Meanwhile, the annual ryegrass results were opposite of the sorghum-sudangrass. The dung plus *O. Taurus* treatment was significantly different in yield on the Piedmont clay for both cuttings, first and second cut, than the control or the dung only treatment as well as the fertilizer treatment used on this grass. It also produced a significantly higher yield on the play sand over the control and dung only treatment at the first cutting, but only over the control in the second cutting. It also yielded higher than the fertilizer treatment, but not significantly. On the Coastal Plain loam, the dung plus *O. Taurus* treatment yielded annual ryegrass significantly higher than the control but not against the dung only treatment. The fertilizer treatment yielded more than all the other treatments, but only significantly over the control. At the second cutting of ryegrass, the fertilizer treatment was significantly higher than the other three treatments. The dung plus *O. Taurus* treatment came in second in yield being significantly different than the control while yielding more than the dung only treatment but not significantly. When both ryegrass cuttings were pooled together, the dung plus *O. Taurus* out-yielded the other three treatments significantly on the Piedmont clay and on the play sand. However, on the Coastal Plain loam, the fertilizer treatment out-yielded significantly the dung plus dung beetle, the dung only treatment, and the control in order of descending yield. The dung plus *O. Taurus* out-yielded the dung only and control treatments significantly even though it yielded less than the fertilizer treatment. Bottom-line, *O. taurus* significantly increased total dry weights from two cuttings of Sudan and Ryegrass over the control and dung only treatments.

More regional studies on dung beetle role in ecosystem services are needed. Soil types, microbes, forages, and species complex must all be taken in account to gauge how dung beetles influence different ecosystem services as a result of the situation involved. There are still a lot of unsolved questions yet to get a better understanding of dung beetles and what it takes to keep them abundant. Dung beetles must be homegrown in your own pastures. They cannot purchased for introduction. Do not overstock pastures with animals to avoid trampling dung piles which would destroy their suitability for dung beetle habitat.