Investigating the Dung Beetle Population at the Beef Grazing Farm, UW Arlington Research Station

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Introduction

Dung beetles may sound like disgusting insects, but their value to the beef grazing and cattle production industry should not be overlooked. This project was conducted at the UW Arlington Agricultural Research Station (AARS) Beef Grazing unit during the summer of 2012 (May through August) by Mr. Mack Daeda. The objective was to identify the various dung beetle species represented in the existing dung beetle populations, and make further observations on their activity and behavior to determine potential positive impacts to pastures and cattle production.

Pasture managers are interested in dung beetles because these insects have beneficial roles in the microenvironment of a dung pat that positively impacts the larger pasture ecosystem. Dung beetles may play a significant role in controlling horn fly populations. Horn flies also use dung to reproduce and the adults are biting insects that feed on the blood of cattle and other grazing livestock. Their pesky biting behavior can greatly reduce cattle weight gains, reduce vitality, and may cause animal injuries as the cattle try to stop their annoying blood-sucking bites. An Australian study reported that the introduction of 23 dung beetle species in a particular area resulted in a 90% reduction of bush fly populations (a species similar to horn flies). Dung beetles maneuvering around the dung pat can physically damage the eggs of horn flies and evidence exists that *Sphaeridium scarabaeoides* larvae can feed on fly larvae in the dung pat.

Photo 1.

Dung beetle nesting activities assist in redistributing and recycling nutrients from the dung pat as well as improving soil structure and water absorption, activities that are important to pasture soil health. ***Photo 1*** shows a hole that was found underneath a dung pat, and represents the beginning of a tunnel leading to a beetle nest.

Beetle Species Identified

Dung beetles belong to the Order ***Coleoptera*** and Superfamily ***Scarabaeoidea***. The majority of species can be further grouped into the Subfamilies ***Scarabaeinae*** and ***Aphodiinae***, with a few species representing various other families. For the current study, dung beetles were sampled by digging through dung pats layer by layer and picking out beetles individually for later identification. Eight species were collected at the UW AARS Beef Grazing Farm (Table 1).

Table 1. Identification and Brief Description of Dung Beetle Species Found at UW Arlington Agricultural Research Station Beef Grazing Farm	
	***Aphodius badipes*** (‘big black beetle”)—an all black scarab beetle >1 cm in length with fossorial legs
	***Aphodius fimetarius*** (“red backs”)—a mostly black, non-native scarab beetle of European origin with red elytra; less than 1 cm length, with fossorial legs
	***Aphodius granarius*** (“small black beetle”)—an all black, non-native scarab beetle of European origins; less than 5 mm length, with fossorial legs
	**Aphodius rubripinnis** (“brown backs”)—a scarab beetle chararcterized by brown elytra, less than 1 cm length, with fossorial legs
	***Onthophagous hecate***—an all black scarab beetle less than 1 cm length, with fossorial legs, characterized by sexual polymorphism
	***Onthophagous nuchicornis***—Non-native beetle of European origin characterized by yellow and black elytra, 5 8 mm length, with fossorial legs, characterized by sexual polymorphism
	***Sphaeridium scarabaeoides*** (“half brown backs”)—beetle representing the family Hydrophillidae, characterized by brown, red and black elytra, and legs with spines; 5 – 7 mm length
	***Xestipyge conjunctum*** (“headless beetle”)—beetle representing the family Histeridae, an all black, glossy beetle less than 1 cm length, with fossorial legs

Life Cycle

The life cycle of dung beetles is very interesting and unique from other types of beetles. Most species of dung beetles spend 95% of their life in dung or in the soil beneath dung pats. The only time that dung beetles may be observed outside this environment is when they are searching for a new dung pat to start preparing and laying their eggs. Since each dung beetle species exhibits different adaptations to their preferred environments, they will have somewhat unique life cycle characteristics.

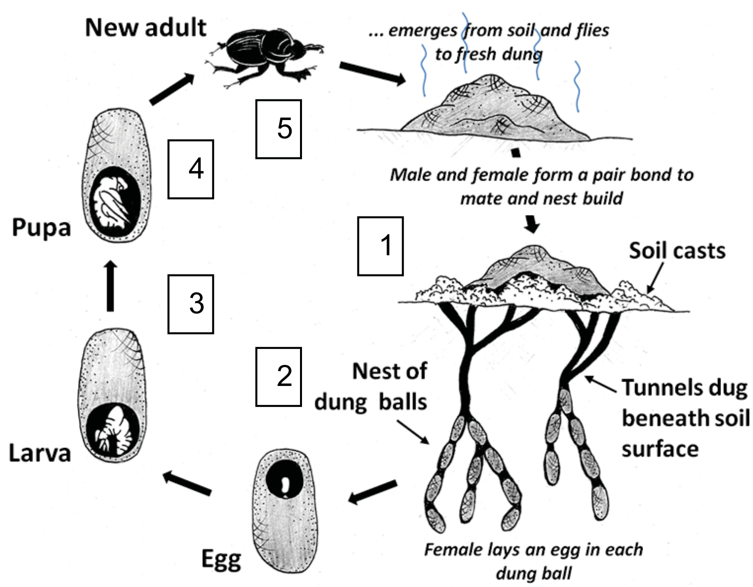
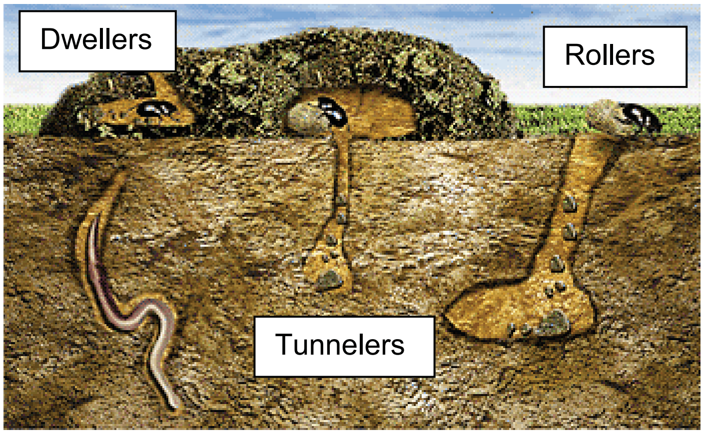


Figure 1. General life cycle of dung beetles.

Figure 1 shows the general life cycle processes of dung beetles, described as follows:

1. Male and female dung beetle pairs create a *nest environment* that will give their eggs the best probability of development and survival.
2. *Eggs are laid*. All dung beetles lay their eggs in dung, either in the dung pat itself, or in a a dung ball or a brood ball (refers to dung ball in which egg has been laid). Beetle species differ in how eggs are laid. Some species lay their eggs so they remain attached to their backs. Once they partition a ball of dung from the pat, they place a single egg in that ball of dung and close it up. Other species lay their eggs and then individually wrap eggs in dung until it forms a ball shape. Usually, an egg hatches in 1 – 2 days, entering the larval stage. A female dung beetle can lay from 10 – 80 eggs in her lifetime.
3. *A majority of the development occurs during the larval stage.* Beetle larvae do not resemble the adult insect form. Instead, larvae resemble a worm with six legs and a mouth and is “C” shaped. Entomologists call this form of larvae “scarbaeiform”. The larvae feed on dung while it develops and grows. It normally consumes only about 40 – 55% of the dung ball, leaving the remaining particles behind. After 1 – 4 weeks, the larvae pupate and move into stage 4.
4. *The transition from larva to adult form begins during pupation.* The pupal stage may last from two weeks to several months and is the most variable stage among different dung beetle species. The pupal stage determines the population spikes seen among dung beetles. The pupa remains in the original dung pat. At the conclusion of the pupal stage, the beetle emerges as an adult form.
5. *In the final stage of the dung beetle life cycle, adults are ready to relocate to a fresh dung pat to start the life cycle process again.* They must find a mate with which to pair bond, and start preparing a new nesting environment. Even though dung beetles are fairly small insects, they can fly up to 30 miles in search of fresh dung.

Beetle Nests



The most valuable trait of dung beetles in pasture ecosystems is in the way they prepare the nest environment and lay their eggs during stage 1 of their life cycle. ***Figure 2*** illustrates three ways that different dung beetle species prepare the nest environment and lay their eggs to ensure successful development of the next generation of dung beetles.

- **"Dwellers"** do not penetrate the soil and dig out chamber for their eggs. Instead, they dwell in the dung pat above the soil and lay their eggs directly in the dung pat. Eggs of dwellers are more prone to physical damage from fly larvae and other predators, but the larvae have an abundant food source for growth. In the current study at the UW Arlington Beef Grazing Farm, only *Sphaeridium scarabaeoides* is a dweller.

- **"Tunnelers"** get their name from their tunneling behavior underneath the dung pat. Male and female beetles work together to excavate egg chambers beneath the dung pad where they eventually place brood balls containing their eggs at the end of the tunnels. Different dung beetle species dig different types of tunnels. Some create branched tunnels while others create a single tunnel deep within the soil. Multiple brood balls may be packed into a single tunnel and once they are in place, the beetles secure them in their places with soil. This is the most common dung beetle nesting behavior observed at AARS Beef Grazing Farm because the remaining seven species of dung beetles identified are all considered tunnelers, and are characterized by fossorial legs, specifically designed for digging.

- **"Rollers"** are dung beetles that roll their eggs into a dung ball and roll it some distance away from the dung pat. These beetles guild underground nests away from the dung pat and roll their brood balls to this remote location. Aside from the rolling behavior, nest tunnels have the same general characteristics as those excavated by tunnelers. No rollers were identified during the AARS Beef Grazing Farm study. Most roller species are native to Africa and Australia.

Observations on Tunneling and Nesting Behaviors

In order to gain a better understanding of each species' tunneling behaviors, several observational experiments were conducted to help visualize exactly how each beetle prepares the egg chamber. Six "beetle farms" were constructed to compare and contrast environmental conditions that may affect larval development and tunneling behaviors.

The first experiment attempted to address whether or not the beetle farms needed to be mechanically populated with dung beetles and what types of tunneling behaviors the different beetle species utilized. Two beetle farms were filled with dirt and dung and placed, uncovered, near a corral of cattle (UNPF = unpopulated farms). The remaining four beetle farms were filled with soil and a dung layer and populated with 5 – 7 beetles of one species harvested from dung pats in a nearby pasture (POPF = Populated farms). Covers were placed on top of the farms and they were left outside in an area that would receive direct sunlight for only half a day. All soil that was used to fill the beetle farms was collected from a nearby ditch at one time. Due to extremely high temperatures and drought conditions, no beetle activity was recorded in this experiment. We observed that the dung in the UNPF lost all moisture within 3 days. Over a two week period, we recorded soil temperatures and moisture diffusion into the soil from dung pats. Our results suggested that dung beetles are not active in soil temperatures exceeding 90ºF and moisture from dung was found to be absorbed into dry soil as much as 2.25 inches from the dung-soil interface.

Concurrently, animals were removed from the pastures due to the extremely dry conditions. We observed that beetle populations declined when their source of fresh dung was removed. We conducted one additional experiment with the beetle farms at a lower temperature range and dark conditions. We compared two beetle species and two types of soil: potting soil in one farm and topsoil in the second farm for each species. All 4 beetle farms were maintained in a cool dark room at 75ºF for two weeks. At the end of this experiment, larval counts were conducted on all 4 beetle farms. Larvae developed only in the potting soil environments, even though both soil types had relatively similar moisture content (52 -53%). Beetles did not seem to need sunlight to carry out normal reproductive behavior.