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The Contribution of Tunneling Dung Beetles to Pasture Soil Nutrition

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Abstract
The effect of dung beetle activity on soil nutrition was studied in three distinct soil types under laboratory conditions. Two tunneling dung beetles, *Onthophagus gazella* (Fabricius) and *Onthophagus taurus* (Schreber), were allowed to incorporate cattle dung, for brood production, into a piedmont Cecil clay soil, a coastal plain sandy-loam soil and commercially available play sand. Controlled treatments included soil alone and soil exposed to dung only. Soils were tested for primary nutrients (P and K), secondary nutrients (Ca and Mg), and micronutrients (Mn, Zn, and Cu), as well as other soil characteristics (pH, exchangeable acidity, etc.). Both *O. gazella* and *O. taurus* produced the most offspring in the piedmont clay soil; variable numbers of brood were produced in other soil types. Soils exposed to dung beetle activity were generally higher in nutrient content than both soils left untreated, and those that had been exposed to cattle dung only. In this manner, tunneling dung beetles can be considered vital to nutrient recycling and plant health in pasture systems.

Introduction: Dung Beetles in the Pasture Ecosystem
Dung beetles in the insect families Scarabaeidae and Geotrupidae play an important role in the pasture nutrient cycle, in part, by the removal and burial of dung from the surface to the soil, in the form of food for their young (9). Dung beetles exhibit many forms of nesting behavior, including dwelling (endocoprid), rolling (telecoprid), and tunneling (paracoprid) (17). The most common nesting behavior among dung beetles is tunneling, which refers to those species that burrow beneath the dung, either packing the tunnel with dung masses (each separated by a soil barrier) or excavating a chamber that houses one to several dung balls (17). These caches of dung contain the developing young, providing them with food and shelter. Tunneling species are the most beneficial to pasture health, enhancing the soil by increasing percolation, introducing organic matter into the soil, and nutrient cycling (10,31,33).

Dung can contain from 1 to 3% nitrogen by weight (23,30). In controlled studies, five pairs of dung beetles (*Onthophagus nuchicornis* L.) buried 37% of each dung pat, which when applied to pasture scale was a calculated return of 134 kg of N per hectare (23). Larger and more fecund or vigorous beetles may bury 80 to 95% of the nitrogen in dung (16).

A number of studies have demonstrated improved plant growth in response to dung beetle activities. Japanese millet, *Echinochloa frumentacea* Link, grown in the absence of beetle activity yielded 17.3 g in the tops and 12.7 g in the roots. When 20 pairs of the dung beetle, *Onthophagus australis* Guérin, were allowed to bury equal amounts of dung, plant yield was increased to 31.3 g in the tops and 14.7 g in the roots (5). This was equivalent to yields obtained through a fertilization rate of 150 kg of N (0.3 g NH_4NO_3) and P [0.3 g $Ca(H_2PO_4)_2H_2O$] combined per hectare of pasture (or 60 kg per acre) (5). In another study, Macqueen and Beirne (23) found that the amount of crude protein in beardless wheatgrass [*Pseudoroegneria spicata* (Pursh) A. Löve ssp. *inermis* (Scribn. &

J.G. Sm.) A. Löve] increased 38% over the control through dung beetle activity, compared to a 17% increase for dung added alone. Lastly, Fincher (10) recorded that plots of coastal bermudagrass [*Cynodon dactylon* (L.) Pers.] that received dung beetle activity had significantly higher yield over the season (7,791 kg DM/ha) than those without dung beetles (6,364 kg DM/ha) and those that received fertilizer at a rate of 112 kg N per ha (5,369 kg DM/ha). Yield from the dung beetle plots was not significantly less than plots that received fertilizer at a rate of 224 kg N per ha (8,305 kg DM/ha).

There is clear evidence that dung beetles in the pasture ecosystem facilitate the return of N to the soil resulting in improved plant growth. However, most nutrient studies do not quantify changes in other soil nutrients relative to dung beetle activity (1). The object of this study was to quantify and compare nutrient differences brought about by the dung burying activities of beetles in two field-collected North Carolina soils (piedmont Cecil red clay, coastal plain sandy-loam) and cleaned commercial sand. Native soils were used to determine levels of nutrient change affected by dung beetle activity and soil chemistry, while sand was used as a nutrient deficient control.

Dung Beetles Used for Study

We conducted this study using two exotic, dung-burying beetles that were introduced to North America during the last 40 years. *Onthophagus taurus* (Schreber) (Fig. 1) was accidentally introduced from an unknown location into Florida circa 1971 (11). *Onthophagus gazella* (Fabricius) (Fig. 2) was imported into Texas in 1970 for pasture improvement and pest fly reduction (4,5). Since their introduction, populations have spread over much of the southeastern U.S. (12,20,24). Recently both species were found abundantly in cattle pastures in North Carolina (2). Regionally there is significant interest among cattle producers as to the benefits of both species in pasture health management.

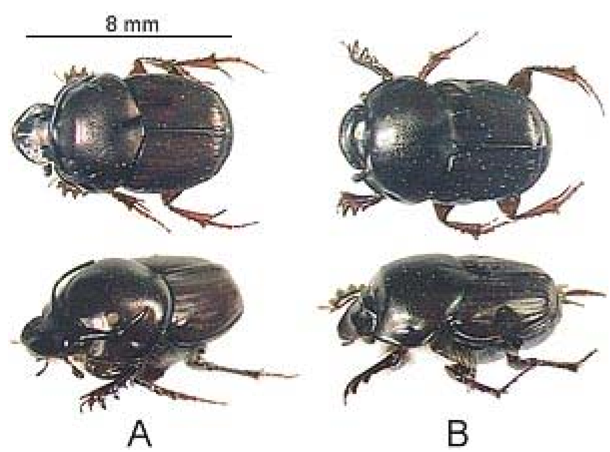

Fig. 1. *Onthophagus taurus* (Schreber): (A, top) male dorsal view, (A, bottom) male lateral view; (B, top) female dorsal view, (B, bottom) female lateral view. Line = 8 mm (5/16").

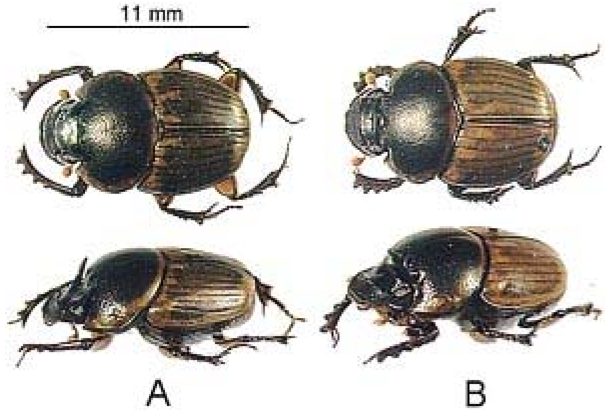

Fig. 2. *Onthophagus gazella* (Fabricius): (A, top) male dorsal view, (A, bottom) male lateral view; (B, top) female dorsal view, (B, bottom) female lateral view. Line = 11 mm (7/16").

Soil Preparation and Treatments

Coastal plain, sandy-loam soil was collected from the Center for Environmental Farming Systems (CEFS), in Goldsboro, NC (Wayne Co.; 35.44° N, 78.09°W). Piedmont Cecil clay soil was collected from Lake Wheeler Road Field Laboratory, North Carolina State University, Raleigh, NC (Wake Co.; 35.7° N, 78.7°W). Playground sand, purchased at a local home improvements store, was selected as a nutrient-deficient substrate for comparison. Nine 8-liter plastic planting pots (23 cm in diameter × 23.5 cm deep) were filled with 6.5 liters (19 cm) of each soil type. Water was added initially to the play sand to correct for natural moisture found in the other soil types (10% by weight). Soils were tamped to increase density and frozen (-18°C) for 4 days to kill any insects. Soil pots were thawed and acclimated to a controlled temperature (28°C) before use.

Dung beetles were collected from the CEFS wild population. Beetles were caught using dung-baited pitfall traps and a black light trap (2,13). Collected *O. gazella* and *O. taurus* were sorted by gender and held separately.

Fresh dung was collected from pesticide-free dairy cattle fed on pasture and silage at the CEFS farm. The dung was frozen to -18° C to kill any insects feeding on the dung, including other dung beetles. Thawed dung was homogenized by hand and added to each treatment pot in 550-g aliquots. Three pots containing each soil type received a dung-only treatment, three pots received 16 *O. gazella* (8 male and female pairs) and three pots received 16 *O. taurus* (8 pairs). To measure pre-treatment nutrient levels, three pots containing each soil type were left untreated. All pots were covered with fiber hair-nets to prevent beetle escape. The pots were kept in a controlled room (50% RH; 28° C; 12/12 photoperiod) for the duration of the experiment. Beetles were allowed an initial 4 days to incorporate dung. After the initial 4 days all dung remaining on the surface of all pots was replaced with an additional aliquot of 550 g of fresh dung. The beetles were allowed an additional 4 days to incorporate the second portion of dung. After that period, the second aliquot of dung was removed from the soil surface (Fig. 3).

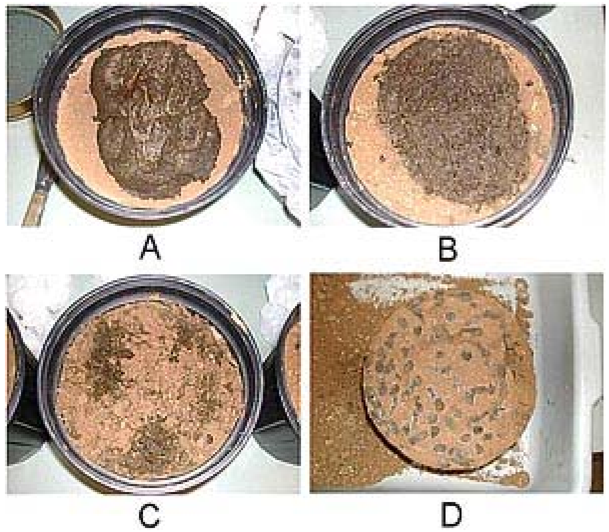

Fig. 3. Example of activity after four days (piedmont clay soil): (A) Dung-only treatment, (B) *Onthophagus taurus* treatment, (C) *Onthophagus gazella* treatment, (D) *Onthophagus gazella* treatment inverted to show multiple brood masses at bottom of pot.

After 8 days of activity, adult beetles were trapped and removed using small pitfall traps baited with dung. After 30 days the emerging teneral adults were removed and counted. Each pot was then emptied onto a clean surface and the soil carefully examined for brood balls. Each brood ball was evaluated to determine lifestage of the beetle or if brood masses failed to develop. All soil, brood masses, dead adults and pupation chambers were processed by hand through a 2-mm sieve. Soil from each pot was homogenized for 5 min in a large-capacity (90-kg) grain mixer.

Soil Analyses

Homogenized soil from each pot was subsampled by collecting three 300-cc samples. Subsamples were analyzed for nutrient content by the NC soil test laboratory, North Carolina Department of Agriculture & Consumer Services (NCDA & CS). A Mehlich-3 extractant was used to analyze primary nutrients (P and K), secondary nutrients (Ca and Mg), and micronutrients (Mn, Zn, and Cu) (26). Exchangeable acidity and humic matter of each soil were tested using Mehlich-buffer acidity and photometric determination, respectively (25,27). Cation exchange capacity (CEC) was calculated by the summation of the extractable K, Mg, Ca, and the exchangeable acidity. Base saturation was calculated by dividing the sum of K, Mg, and Ca into the CEC, resulting in a percentage of the CEC occupied by K, Mg, and Ca. Nitrogen was not included.

Statistical Analyses

Data were analyzed using analysis of variance SAS 8.2 (ANOVA, PROC GLM; SAS Institute Inc., Cary, NC). Treatment comparisons were separated using Tukey's Studentized Range Test ($\alpha = 0.05$).

Soil Type and Dung Beetle Brood Production

The rate beetles incorporate dung into soils directly influences nutrient cycling. Factors include soil type, beetle reproductive capacity, size of the insect, and relative abundance of dung beetles. In our study piedmont clay soil was the most favorable for brood production for both species (Table 1). *O. taurus* produced the least brood in the sandy-loam soil and produced a similar number in play sand. *O. gazella* produced no viable brood in commercial play sand whereas mean brood production in sandy loam soil for *O. gazella* was 26.0 ± 4.6. We found the variation in brood production was similar to other laboratory studies in which beetles competed for dung resources (3,17,19).

Table 1. Brood production (mean ± SEM) of *Onthophagus gazella* and *Onthophagus taurus* in different soil types after 30 days of development.

		Piedmont Mean ± SEM[x]	Coastal Plains Mean ± SEM[x]	Play Sand Mean ± SEM[x]
***O. gazella*[y]**	Larvae	0.3 ± 0.3	0.0 ± 0.0	0.0 ± 0.0
	Pupae	1.3 ± 1.3	5.7 ± 4.7	0.0 ± 0.0
	Adults	90.3 ± 12.7	20.3 ± 8.8	0.0 ± 0.0
	Total Brood	92.0 ± 11.6	26.0 ± 4.6	0.0 ± 0.0
***O. taurus*[y]**	Larvae	0.0 ± 0.0	2.0 ± 0.0	11.3 ± 5.8[z]
	Pupae	5.3 ± 1.5	3.7 ± 2.0	0.3 ± 0.3
	Adults	50.0 ± 6.7	6.0 ± 3.0	2.0 ± 1.2
	Total Brood	55.3 ± 7.7	11.7 ± 1.8	13.7 ± 5.3

[x] N = 3.

[y] Brood from 8 pairs of beetles.

[z] Includes brood with dead, early instars.

Reproductively, some dung beetles appear to prefer certain soil types. Fincher (9) observed that the distribution of three species of *Phanaeus* was limited by soil type. In our study *O. gazella* brood production was clearly superior in piedmont clay and play sand was unsuitable. *O. taurus* performed best in clay soils but produced fewer offspring in play sand and sandy-loam soil. The presence of clay in the soil likely contributes to tunnel structure and depth (9). *Phanaeus vindex* MacLeay increased reproduction in soils with more clay content, and although brood were formed in construction site sand, all died presumably from desiccation. This suggests clay deposition may protect *Phanaeus* brood masses (9) unlike *Onthophagus* species that do not coat the brood.

O. taurus and *O. gazella* are of particular interest for their ability to bury large amounts of manure. Both exhibit tunneling nesting behaviors in which one or both of the parent beetles burrow beneath or near the dung. Tunnels may contain several brood masses, each containing one egg and separated by soil barriers (17). *O. taurus* measures 8 to 10 mm in length and constructs brood masses weighing an average of 1.6 g (19). *O. taurus* produces about 23 brood masses over 14 days, approximating 36.8 g of dung buried per pair (19). *O. gazella* is a larger species (10 to 13 mm) and produces about 90 offspring per female (3,18). These beetles bury around 4 to 5 cc of dung, which is compacted into a brood mass measuring 2 cc, about twice the size of *O. taurus* brood masses (5). Paired adult *O. gazella* may bury up to 180 cc of dung in their lifespan. In addition to size and fecundity, dung beetle abundance contributes to the total amount of dung buried and nutrient cycling (30).

Dung Beetle Activity and Soil Nutrition

Primary soil nutrients, including N, P, and K are the most limiting and commonly deficient nutrients needed by forage crops (15,28). One of our goals was to demonstrate a relationship between the activity of *O. gazella* and *O. taurus*, and nutrient cycling. Because much of the nitrogen present in bovine dung is lost to volatilization, we excluded N from our test of primary nutrients (8,28).

Although dung beetle activity as measured by brood production was variable, an increase in primary nutrients, secondary nutrients, and micronutrients was observed in the beetle treatments. For example, phosphorus was numerically increased over the dung-only treatment in all soil types by beetle activity (Fig. 4). Statistically significant increases in P were seen in the beetle treatments in sand and in the *O. gazella* treatment in the clay soil. Though there was no significant increase in P between the beetle and dung-only treatments in the coastal plain soil, the increase in P seen in the dung-only treatment may have been attributed to excess dung remaining on the soil surface before homogenization (since P is generally bound to soil minerals, leeching of this nutrient is limited and thus mechanical incorporation is often needed) (15) (Fig. 4).

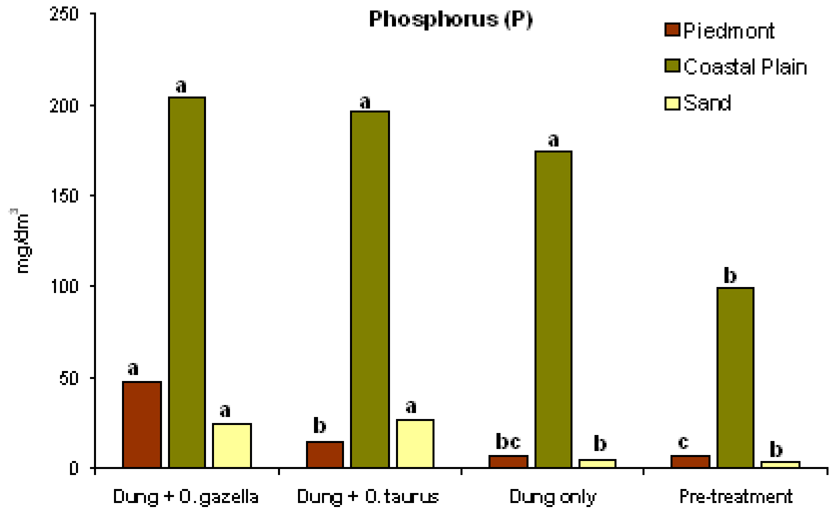

Fig. 4. Phosphorus (P) levels in piedmont clay, coastal plain sandy-loam and sand after treatments. Bars with different letters represent statistically different values using Tukey's Studentized Range Test ($P \leq 0.05$).

Like phosphorus, potassium levels were increased by dung beetle activity in all soil types (Fig. 5), though not statistically between all treatments. Dung beetle activity significantly increased levels of K in the coastal plain soil and play sand, but only in the *O. gazella* treatment were the levels of K in the clay soil statistically higher than in the dung-only treatment (Fig. 5).

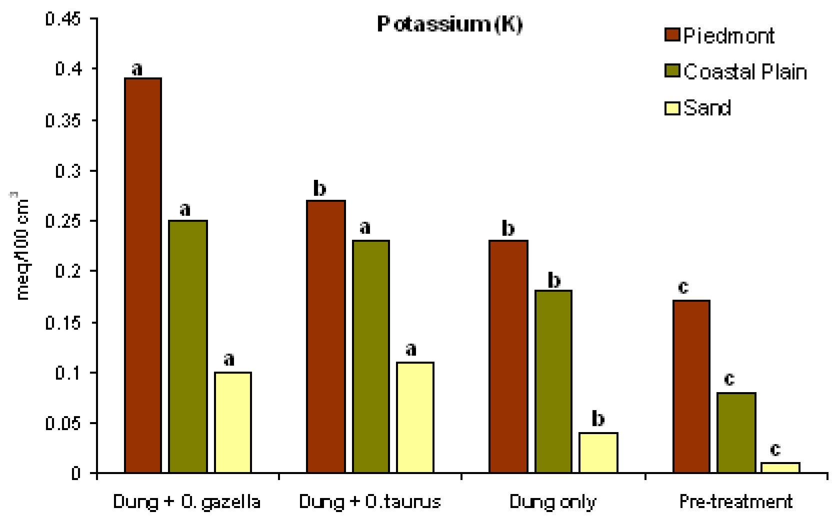

Fig. 5. Potassium (K) levels in piedmont clay, coastal plain sandy-loam and sand after treatments. Bars with different letters represent statistically different values using Tukey's Studentized Range Test ($P \leq 0.05$).

Secondary plant nutrients, including Ca, Mg, and S, are essential to plant health, but are needed in smaller amounts than the primary nutrients discussed above. Sulfur was not included in the testing process and, thus, the effects of dung beetle activity on S are uncertain.

Calcium levels were variable between treatments. Coastal plain soil exposed to both species of beetles had significantly higher levels of Ca than both the pre-treatment and dung-only treatment (Fig. 6). Calcium levels in the play sand were numerically higher in the beetle treatments than in the non-beetle treatments, but only significantly higher in the *O. taurus* treatment. Calcium was most abundant in the piedmont clay soil to begin with (as compared to the other soils), and, though there was a numerical increase in the amount of Ca in the *O. gazella* treatment, there was no significant increase of this nutrient in the clay soil due to dung beetle activity (Fig. 6).

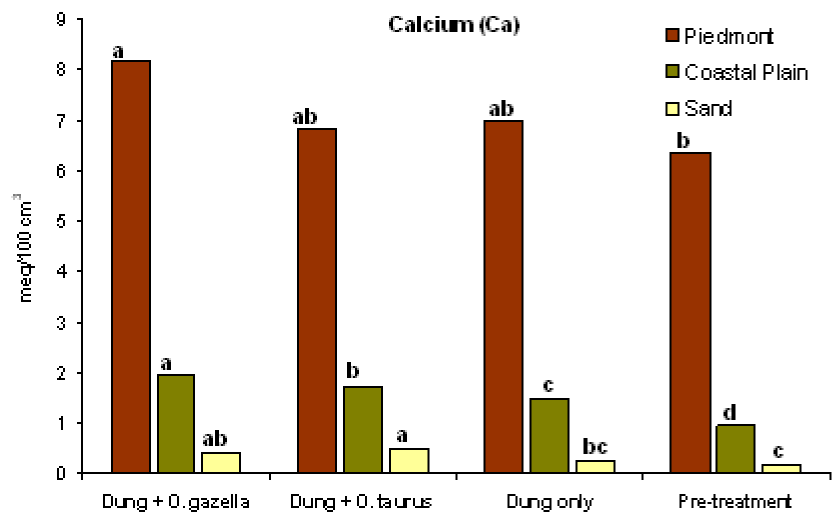

Fig. 6. Calcium (Ca) levels in piedmont clay, coastal plain sandy-loam and sand after treatments. Bars with different letters represent statistically different values using Tukey's Studentized Range Test ($P \leq 0.05$).

Magnesium was numerically increased by beetle activity in all soil types (Fig. 7). *O. gazella* activity yielded significant increases of Mg over both the dung-only and pre-treatment soils. *O. taurus* activity, though significantly increasing Mg levels over the pre-treatment soil, only statistically increased Mg over the dung-only treatment in the sand soil.

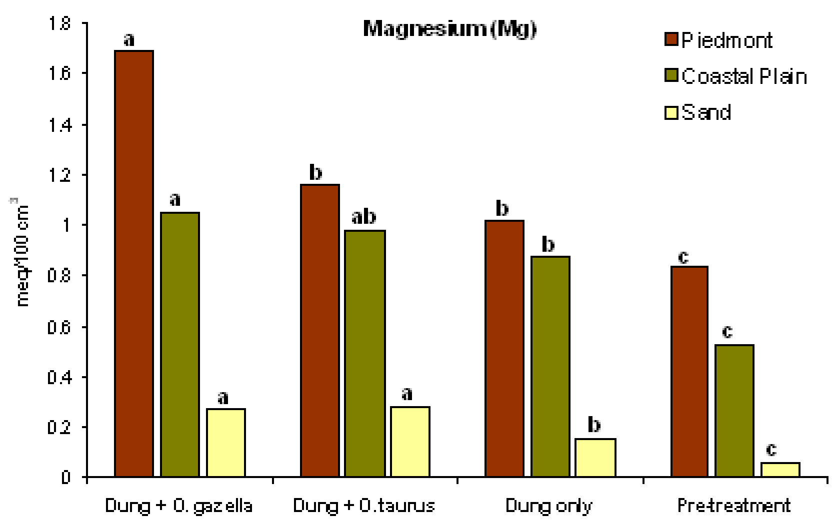

Fig. 7. Magnesium (Mg) levels in piedmont clay, coastal plain sandy-loam and sand after treatments. Bars with different letters represent statistically different values using Tukey's Studentized Range Test ($P \leq 0.05$).

Micronutrients, represented in this study by Mn, Zn, and Cu, are only needed in very small amounts by plants. Statistically, there was little effect on micronutrient levels due to dung beetle activity (Table 2). Zinc levels were increased significantly by the beetles in both the sand and coastal-plain soils. However, there was no significantly increased effect of beetle activity on other micronutrients, above the dung-only treatment. Since, however, plants need minute amounts of Mn, Zn, and Cu, small numerical increases in these nutrients caused by beetle activity may have beneficial effects on plant health and quality.

Table 2. Micronutrient levels (mean ± SEM[x]) of each soil type before (pre-treatment) and after exposure to *Onthophagus gazella*, *Onthophagus taurus*, or dung only.

Treatment		**Micronutrient levels** (mg/dm^3)		
		Mn	**Zn**	**Cu**
Piedmont	Dung + *O. gazella*	76.97 ± 1.82a	8.45 ± 0.43a	5.72 ± 1.05a
	Dung + *O. taurus*	66.57 ± 1.95a	5.82 ± 0.40b	3.00 ± 0.27b
	Dung only	71.85 ± 4.59a	6.73 ± 0.80ab	3.26 ± 0.26ab
	Pre-treatment	68.23 ± 2.70a	6.79 ± 0.24ab	3.37 ± 0.02ab
Coastal Plains	Dung + *O. gazella*	1.91 ± 0.16a	2.04 ± 0.29a	0.39 ± 0.01a
	Dung + *O. taurus*	1.73 ± 0.12a	1.52 ± 0.13ab	0.37 ± 0.04ab
	Dung only	1.58 ± 0.22ab	1.14 ± 0.22b	0.33 ± 0.04ab
	Pre-treatment	0.98 ± 0.01b	0.88 ± 0.10b	0.26 ± 0.01b
Play Sand	Dung + *O. gazella*	0.92 ± 0.09a	1.82 ± 0.21a	0.12 ± 0.01a
	Dung + *O. taurus*	0.91 ± 0.02a	1.73 ± 0.04ab	0.24 ± 0.08a
	Dung only	1.03 ± 0.55a	1.25 ± 0.02bc	0.05 ± 0.02a
	Pre-treatment	0.43 ± 0.02a	1.05 ± 0.06c	0.08 ± 0.02a

[x] Different letters within columns and within soils indicate significant differences using Tukey's Studentized Range Test (α = 0.05).

Dung Beetle Activity and Additional Soil Characteristics

Not only did beetle activity increase nutrient levels in the test soils, but other characteristics of the soil were affected by dung burial as well. Additional soil characteristics measured included pH, exchangeable acidity, cation exchange capacity, base saturation, and humic matter content (Table 3).

The pH of the soils before treatment ranged from slightly acidic in the coastal-plains soil to slightly basic in the piedmont clay (Table 3). The pH of the clay soil did not significantly differ among all treatments. However, dung beetles increased pH significantly relative to the sandy-loam baseline. The greatest difference in pH was found in the play sand, ranging from 6.15 ± 0.02 in the pre-treatment to 8.34 ± 0.07 in the *O. taurus* treatment.

The exchangeable acidity was not significantly different between treatments in both the clay and sandy-loam soils (Table 3). The exchangeable acidity of the play sand, however, was reduced in the beetle treatments.

The cation exchange capacity (CEC) of the clay soil was significantly increased over the dung-only treatment and pre-treatment by the addition of *O. gazella*, but not *O. taurus* (Table 3). All treatments significantly increased CEC over the pretreatment baseline. However, only *O. gazella* significantly increased the CEC above the dung-only treatment in this soil. The greatest increase in play sand CEC was observed in the *O. taurus* treatment, while *O. gazella* did not increase CEC significantly relative to the dung-only treatment or the baseline (Table 3).

Table 3. Additional characteristics (mean ± SEM[x]) of each soil type before (pre-treatment) and after exposure to *O. gazella*, *O. taurus* or dung only.

	pH	Exchangeable acidity (meq/ 100 cm^3)	Cation exchange capacity (meq/ 100 cm^3)	Base saturation (%)	Humic matter (g/100 cm3)
Piedmont					
Dung + *O. gazella*	7.54 ± 0.02a	0.00 ± 0.00a	10.26 ± 0.27a	100.0 ± 0.00a	0.18 ± 0.00a
Dung + *O. taurus*	7.39 ± 0.05a	0.02 ± 0.01a	8.29 ± 0.29b	99.9 ± 0.11a	0.15 ± 0.01a
Dung only	7.39 ± 0.03a	0.02 ± 0.02a	8.27 ± 0.40b	99.8 ± 0.22a	0.15 ± 0.01a
Pre-treatment	7.35 ± 0.04a	0.06 ± 0.03a	7.39 ± 0.14b	99.3 ± 0.38a	0.07 ± 0.01b
Coastal plains					
Dung + *O. gazella*	5.64 ± 0.03ab	1.08 ± 0.04a	4.32 ± 0.06a	75.1 ± 0.78a	1.62 ± 0.11a
Dung + *O. taurus*	5.73 ± 0.04a	1.09 ± 0.02a	4.02 ± 0.09ab	73.0 ± 0.96a	1.58 ± 0.15a
Dung only	5.48 ± 0.02c	1.18 ± 0.01a	3.71 ± 0.09b	68.1 ± 0.97b	1.64 ± 0.08a
Pre-treatment	5.55 ± 0.02bc	1.10 ± 0.04a	2.64 ± 0.05c	58.6 ± 0.78c	1.08 ± 0.04b
Play sand					
Dung + *O. gazella*	8.31 ± 0.08a	0.00 ± 0.00c	0.79 ± 0.09ab	100.0 ± 0.00a	0.07 ± 0.02a
Dung + *O. taurus*	8.34 ± 0.07a	0.02 ± 0.01c	0.90 ± 0.02a	97.8 ± 1.11a	0.00 ± 0.00b
Dung only	7.70 ± 0.18b	0.09 ± 0.01b	0.54 ± 0.07bc	82.8 ± 2.42b	0.09 ± 0.00a
Pre-treatment	6.15 ± 0.02c	0.18 ± 0.02a	0.40 ± 0.00c	55.8 ± 5.78c	0.00 ± 0.00b

[x] Different letters within columns and within soils indicate significant differences using Tukey's Studentized Range Test (α = 0.05).

Interestingly, the CEC of each soil was increased by beetle activity, effectively increasing the ability of the soils to hold basic cations (including Ca, K, and Mg). Theoretically, dung beetles may have a role in mediating Al toxicity. CEC, in conjunction with a lowered exchangeable acidity and increased pH, results in an increase in the availability of beneficial nutrients and a decrease in the amount of soluble Al. In acid soils (pH $\leq$ 5.5) the phytotoxic effects of Al is caused by the interruption of P, K, Ca, and Mg homeostasis resulting in the inhibition of cell division and root elongation (7,32). Dung beetles may mediate the effects of environmental stress through enhanced Ca, Mg, and K incorporation into soils. Because soil pH for the piedmont clay was 7.35 ± 0.04, the possible benefits of dung beetle incorporation would be less than sandy loam soils with a pH of 5.55 ± 0.02.

The base saturation of the clay soil was not significantly different between treatments (Table 3). However in sandy-loam soil and the play sand the base saturation was increased by beetle activity.

Humic matter content was lowest in the pre-treatments of the clay soil and the sandy-loam soil (Table 3). All other treatments in these soils were not significantly different. In the play sand, the humic matter content was lowest in both the pre-treatment and *O. taurus* treatment. The *O. gazella* treatment was not significantly different from the dung-only treatment.

Dung Beetle Populations in Managed Pasture Systems

In our study the contributions of *O. gazella* to nutrient changes in soils appeared superior to those of *O. taurus* when comparing fixed populations. It is difficult to understand the role of dung beetles in pasture ecology without including their relative abundance. *O. taurus* is the predominant dung beetle inhabiting North Carolina cattle pastures (2). Dung beetle populations in eastern NC were > 70% *O. taurus*, while *O. gazella* comprised only about 6% of the beetles collected. Currently, the northeastern range of *O. gazella* appears to be limited to central and eastern North Carolina. Considering the relative abundance of *O. taurus* (> 70%) from field collections, this species likely contributes significantly to pasture ecology.

It is extremely difficult to encourage dung beetles to exist in a particular pasture through augmentation. Laboratory rearing is complicated and does not compare to pasture-raised dung beetles (3). Often the geographical location of the farm is the main factor determining dung beetle abundance and diversity (2). While changing the location of a farming system is hardly ever feasible or practical, there are management strategies that can greatly improve the survival of an existing dung beetle population – the most important of these practices being pesticide usage.

Managing cattle pests while promoting dung beetle populations is a delicate balancing act. Pesticides formulated in an ear tag tend to have minimal impact on dung beetles. Pour-on formulations have a greater effect on beetles if the insecticide is excreted in the manure. Parasiticides (those that are used for internal worm control) in the macrocyclic lactone class (abamectin, ivermectin, eprinomectin, doramectin) can kill dung beetles in manure (14,22). Similarly, manure excreted by cattle treated with pour-on pyrethroids can be toxic to dung beetles for one week following treatment (21). Persistent use of these compounds will have a long-term negative impact on dung beetle populations. In contrast, moxidectin is less toxic to dung beetles and does not reduce dung beetle survival (14,22). Occasionally, horn fly and/or face fly pressure on cattle will require treatment to provide relief, so some impact on dung beetle populations may be unavoidable.

Dung beetles are secretive animals, leading many cattle farmers to believe that they do not exist on their land. However, unless there is a long history of pesticide use (especially those listed above), dung beetles are probably present; walking pastures while examining dung pats for certain signs is the only way to be certain. If you find holes in the surface of cattle pats, 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. Otherwise, simply walk behind 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°F.

Maintaining healthy and productive pasture forage relies, in part, on an awareness of the role of dung-burying beetles. This study shows that tunneling dung beetles are not only responsible for the removal of dung, but also play a critical role in the nutrient cycle of cattle pastures.

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