Caser Mallett

Chris Jenson

Ecology, Environment, & the Anthropocene

2 May 2025

Term Project Summary

This project was centered around the dung beetle. To understand the importance of this project and the pursuit to protect dung beetles I will discuss their significance. Dung beetles can be seen as fairly versatile organisms that have been seen to cycle nutrients, disperse seeds, prevent some levels of air pollution, and reduce pests. And to go into more detail for these processes you must first briefly understand how they influence nutrients.

Dung beetles consume, roll, and place their larvae into dung. These processes introduce bacterial and fungal organisms through the channels left by the aftermath of these activities, creating ample conditions for rapid decomposition.[4] The dung beetle's dependency on this waste allows for consistency in the decomposition of the dung pats (fecal piles) present on pastures and other grazing areas for cattle or other animals.[3] These dung pats contain vital nutrients for soil such as ammonium, methane, nitrogen, phosphorus, and carbon.[4,5] And when dispersed by dung beetles and other decomposers they can enrich the surrounding soil. These increases can also be seen to vary amongst dung beetle species, with dweller, tunneler, and roller dung beetles — in their different interactions with dung — affecting different depths of soil.

These varying interactions, from the active tunneling of tunneler dung beetles through soil in search of dung, to the rolling and burial of dung from rollers, allow dung beetles to contribute to the secondary dispersal of seeds. This stems from the presence of seeds in dung due to an inability for most cattle to digest them. The decomposition of animal manure through dung beetles provides an extremely favorable situation for these seedlings, both due to the distance and means through which they were moved, vertically (rolling) and horizontally (burial)[1,4], and the removal of *excess* dung that could otherwise impede their germination.[5] This removal is the result of the aeration (and subsequent decomposition) of dung pats through dispersal, burial, and consumption from the dung beetles. This aerating effect brings a reduction in carbon dioxide, methane, and nitrous oxide emissions from said dung pats during grazing periods.[4]

And to touch on a service provided by dung beetles that leads to more direct human involvement, dung beetles also maintain pest reductive qualities. Dung beetles, as they move and consume dung, often encounter and compete with pests such as flies and gastrointestinal parasites. These interactions often include the burial of larvae alongside dung without proper means of escape or the consumption of these pest eggs as they are contained within dung. This creates a role for dung beetles to act as a natural barrier to pest overabundance as they curtail the reproductive cycle of common flies and parasites at the larval stage. This, in turn, prevents cattle and other mammals from contracting health threatening infections and illnesses. This makes dung beetles a natural solution to pest issues.[2]

However, this is a process that has been disrupted with the use of antiparasitic medicine on cattle. One kind of antiparasitic medicine is classified as anthelmintics, otherwise known as dewormer, a medicine known to target and cause the expulsion of parasitic worms from within the gastrointestinal tract. In these instances, anthelmintics are essentially being used as a

man-made method to combat cattle illness through the prevention of parasitic infection. But, the presence of anthelmintics not only overshadows(which is to say that they cause the overlooking of the pest reduction properties of dung beetles due to their prevalence) the natural antiparasitic properties of the dung beetle, but has been shown to harm dung beetles when present in significant quantities.[2] This comes from anthelmintics doubling as insecticides, which when coming into contact with dung beetles (via significant enough quantities in dung), have been shown to act as a toxin.[2] This is especially important to note as the reduction in dung beetle populations harms their ability to cycle nutrients and reduce waste, allowing for the growth of parasite populations while doubly harming soil richness.[4]

This is not the only instance of anthropogenic change harming dung beetles. On top of the use of resources for human interests there is also the "renovation" of areas for those same purposes. Dung beetles make use of shrubbery as supporting flora. The shade provided by shrubbery acts as a very delicate supporter of the appropriate temperature for dung beetles. The removal of shrubbery detrimentally impacts the dung beetle's diversity in affected areas.[3] Presenting one of many shifts as these ecosystems are being transformed from diverse and heterogeneous mixes of shrubbery to a monoculture of tall grasses made to satisfy the basic needs of cattle.

And with climate change, we can observe that increases seen in both temperature and greenhouse gases are also producing harmful effects on beetle abundance, diversity, and health.[4] The increase in temperature in dung beetle habitats was found to slow beetle reproduction, showing an inverse relation with brood numbers as temperatures rose.[4] And in terms of greenhouse gases, an increase of carbon dioxide from external sources has been seen to increase dung beetle mortality. Such increases have shown decreases in beetle size while also impeding

larval development, causing this negative change.[4] And on top of this direct effect on dung beetle mortality, the increase of carbon dioxide has also affected the plants present in those ecosystems, lowering nitrogen and phosphorus levels within plants which are eaten. These plants act as nutrient providers within cattle waste, and their loss lowers nutrient availability for dung beetles and other organisms who rely on waste.[4]

My research into dung beetles began to mold my main concepts for my creative work. In my work I strived to:

1. Present the benefits of dung beetles on their environment and how they're often undervalued;
2. Show how our actions in livestock rearing have been detrimental to dungbeetle survival and their duties; and
3. Demonstrate how our hand in climate change has altered dung beetle survival and capabilities as decomposers and nutrient cyclers, showing just how influential humans are in habitat health and prosperity.

I did this by representing human impacts through the desecration of a mural. The mural itself displayed dung beetles in a way similar to medieval mythos paintings. Consisting of 4 main beetles portraying different services and interactions between their environment and themselves. With the leftmost beetle holding up a ball of dung containing a seed above a sprouting plant, angling it towards a cow bell. This depicted the dung beetle's role in being secondary seed dispersers through their interactions with dung. The top middle dung beetle poses under a plant leaf showing their reliance on plants for both shade and stability within their environment. The bottom middle dung beetle is shown tying a worm-like parasite into a knot, symbolizing their

ability to dispose of pests in dung, protecting grazing mammals. That said, the depiction here is exaggerated to a theatrical degree for the sake of getting the message across. And for the top right beetle, we view them blowing life (air) into the soil, representing their ability to aerate soil through their activities, promoting the breaking down and dispersal of nutrients found in dung through microbial activity. As for the human impact, I made use of posters, covering and almost mocking what beetles are already capable of doing within the mural. These posters included:

1. A broken thermostat and a shining (burning) earth to convey climate change;
2. Cows and various medicines to show the use of anthelmintics on cattle to curb pest populations;
3. The crushing of grass through a tractor tire and advertisement for timber (clearcutting) showing the altering of environments for human needs;
4. And a poster depicting a smiling face over the earth covering a much sadder one underneath, showing how certain alterations to the ecosystem, while beneficial to humans in the short term, have negative effects looming underneath them with longer use.

The work itself would, in theory, be seen painted on a brick wall (primarily for that added texture) on or around a school. Or to be more specific, on or around a city (urban) school (which may not actively concern themselves with the lives of dung beetles due to their prevalence in more rural areas). This audience is important as the dung beetle's survival isn't just influential in rural areas. Urban areas rely on rural farms for food and organic products and those same rural farms rely on services provided by organisms like the dung beetle to keep their ecosystem stable and reliable for further farming. This mural would put something colorful and striking in front of a relatively younger audience which may be more open to changing their mind on dung beetles than adults would. It would be my hope to encourage this younger audience to avoid negative

stereotypes about dung beetles due to their methods of survival. Or, if this is their first time encountering the topic, introducing them to dung beetles with the benefits of their existence and bringing intrigue to the topic of keeping them safe. All while hopefully bringing any gained empathy towards dung beetles by younger viewers towards their guardians or peers (older or younger), potentially leading those individuals to then act towards or research the preservation of the species. And in spite of the cartoony style seen in this mural, which lends itself to approachability by a younger audience, the message is meant to be a fairly heavy one.

A mural gives a sense of greatness and fantasy to a viewer. These are works that incorporate themselves into a given space to tell a story or symbolize something great. I wanted to tell the story of the dung beetle, how they have both benefited from and aided the environment they inhabit. We often find ourselves respecting things that seem human to us. We respect these characteristics no matter how far removed from ourselves they are. We adore motherly instincts in animals and recoil when those instincts are gone or not up to par to our standard. I am placing the actions of the dung beetle into a level of importance akin to a culture. We often respect a culture when they act to the benefit of their environment while carrying out their lives. It is often these same cultures who create murals describing their lives and beliefs.

This connection being made to dung beetles makes people feel more inclined to think beyond themselves and their human centered moral focus. The mural is to be fantastical but decrepit, with portions plastered over with conflicting messages, attempting to overshadow and take hold of the viewer's attention in a way. This "culture" has stood longer than human society and yet we have not taken into consideration how we undermine that culture and ignore how they have lived and benefited their home. In a way we've colonized nature and have taken what we

deem beneficial while leaving behind permanent marks that act as evidence of human involvement.

Annotated Bibliography

1. ***Milotić, Tanja, and Maurice Hoffmann. "Cost or benefit for growth and flowering of seedlings and juvenile grassland plants in a dung environment." Plant Ecology 217.8 (2016): 1025-1042.***
    - Dung acts as seed carriers allowing for the dispersal of plants over an area through a process known as endozoochory. This is done through the presence of undigested seeds in manure being transported by the tunneling and rolling of dung by dung beetles.
2. ***Beynon, Sarah A., Warwick A. Wainwright, and Michael Christie. "The application of an ecosystem services framework to estimate the economic value of dung beetles to the UK cattle industry." Ecological Entomology 40 (2015): 124-135.***
    - Human use of anti-parasitic medicine (anthelmintics) on cattle has been shown to detrimentally impact dung beetle populations due to their toxicity (to dung beetles).
    - Ecosystem services of pest fly control, prevention of pasture fouling (could be related to previous source's discussion of plant damage via fresh dung, could illustrate dung beetle's ability to maintain a balance in nutrient cycling alongside other insects and decomposers.), gastrointestinal parasite control (potentially discuss the human involvement in parasite prevention (anthelmintics) and the

natural approach which cannot be done with the currently prominent excessive cattle presence), and increased nutrient cycling.

3. ***Sarmiento-Garces, Rodrigo, and Malva Isabel Medina Hernández. "A decrease in taxonomic and functional diversity of dung beetles impacts the ecosystem function of manure removal in altered subtropical habitats." PLoS One 16.1 (2021): e0244783.***
    - Habitat destruction disrupts vital systems put in place to cycle nutrients, causing potentially irreversible damage to an already delicate and fine tuned ecosystem.
    - The explosive growth in livestock can be seen to harm the diversity present in dung beetles and the like by creating an unsustainable monoculture from landscape altering for grazing, removing crucial shade and fauna for the dung beetle.
4. ***Torabian, Shiva, A. Joshua Leffler, and Lora Perkins. "Importance of restoration of dung beetles in the maintenance of ecosystem services." Ecological Solutions and Evidence 5.1 (2024): e12297.***
    - Greater info on nutrient cycling. How their interaction with dung is carried out and how that process is capable of cycling the necessary nutrients for an ecosystem.
        - Dung beetles digest, bury, and roll pests and their larvae present in dung, reducing their overall presence in wildlife and livestock. These actions by dung beetles act as a barrier between pests and cattle by preventing the re-infection of cattle or the spreading of pests to previously unaffected cattle through dung contact.

    - Dung beetles reduce Carbon Dioxide emissions by 7%, Methane emissions by 14.5%, and Nitrous Oxide by 2% from dung pats made by cattle during grazing. This is done through the burial of dung, leading to their decomposition by microbes in the soil (instead of open-air decomposition) and the increased decomposition of dung pats through the movement done by dung beetles.
    - The presence of dung beetles such as dwellers has been seen to “increase organic matter and phosphorus concentrations by 50% at the soil surface”
    - Rollers were found to “ increase ammonium in deep soils by 60%”
    - And tunnelers, much like dwellers, were found to “increase organic matter, total nitrogen, and phosphorus throughout the soil profile by 50%”
- Climate change has caused higher mortality rates amongst dung beetles through higher carbon dioxide amounts, temperatures rising out of their tolerance range, and shrub reduction in areas going below 10%.

5. ***Menéndez, Rosa, Paul Webb, and Kate H. Orwin. "Complementarity of dung beetle species with different functional behaviours influence dung–soil carbon cycling." Soil Biology and Biochemistry 92 (2016): 142-148.***
    - Not only acknowledge the diversity in the dung beetle species but discuss their different approaches and benefits of their presence in ecosystems.
    - Discusses the Dweller species of dung beetles and Tunneler species.
        - Both are capable of being sufficient nutrient cyclers on their own.
        - When in the presence of one another additional benefits can be observed. (high soil microbial respiration)

- Use this discussion as a reason to burrow *(see what I did there)* into how biodiversity has allowed so many species, just like the dung beetle, to provide **different** avenues of environmental assistance while staying within their niche. (Possibly taking a step back to connect the protection of dung beetles to other, equally as important, species.)