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Ewe…dung beetles and poop: a nutrient cycling and population ecology lesson for elementary students

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Ewe … Dung Beetles and Poop: A Nutrient Cycling and Population Ecology Lesson for Elementary Students

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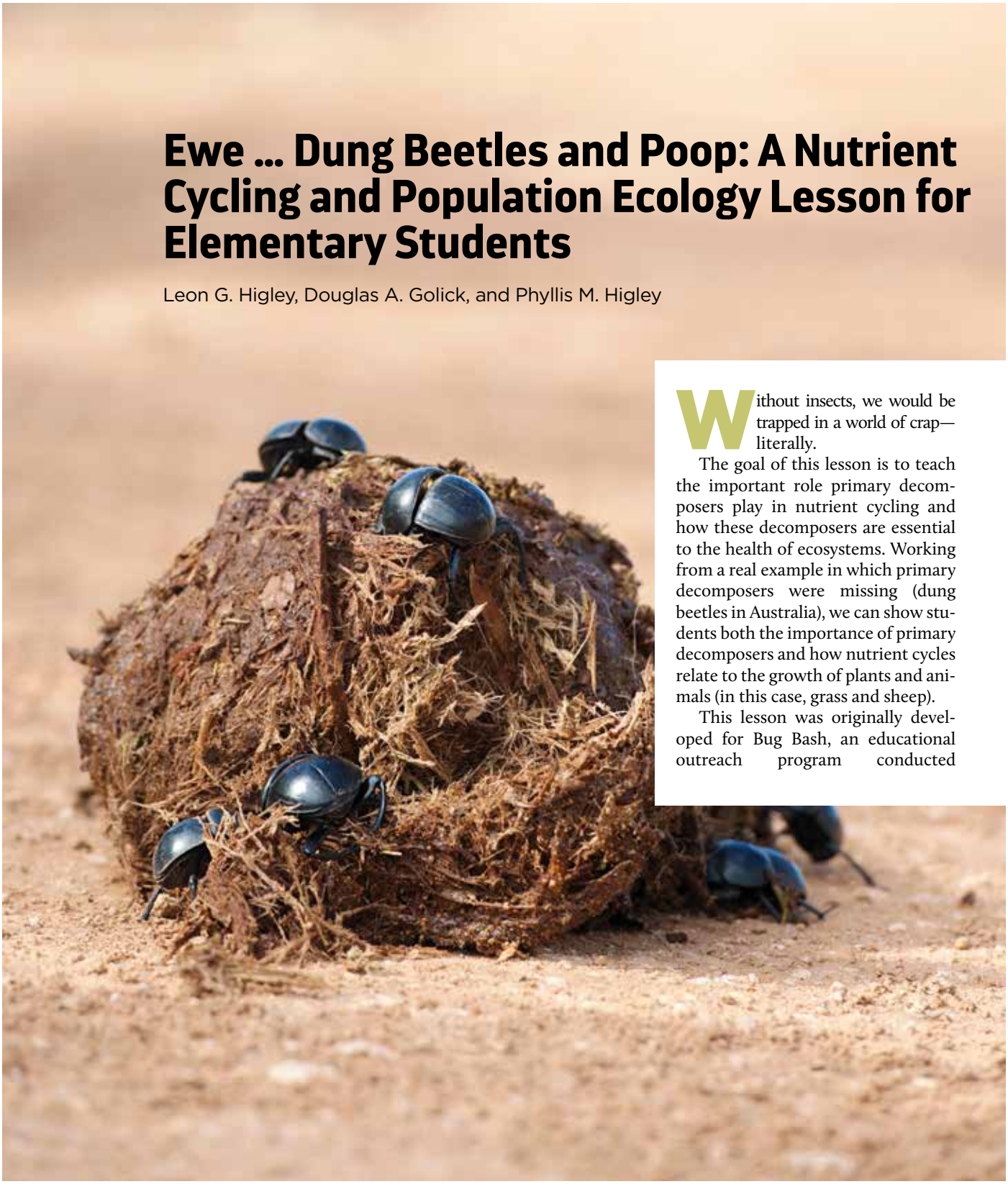

ELSAHOFFMANN/ADOBE STOCK

Without insects, we would be trapped in a world of crap—literally.

The goal of this lesson is to teach the important role primary decomposers play in nutrient cycling and how these decomposers are essential to the health of ecosystems. Working from a real example in which primary decomposers were missing (dung beetles in Australia), we can show students both the importance of primary decomposers and how nutrient cycles relate to the growth of plants and animals (in this case, grass and sheep).

This lesson was originally developed for Bug Bash, an educational outreach program conducted

in partnership by the Department of Entomology University of Nebraska–Lincoln, Lincoln Public School's Science Focus High School, and Lincoln's Folsom Children's Zoo. Bug Bash is an educational event in which fourth graders learn about insects through hands-on activities. A unique aspect of this event is that these stations are taught to the fourth graders by students of the Science Focus High School. Bug Bash activities are organized into eight thematic learning stations, with each focusing on an aspect of insect biology, importance, and cultural significance. "Ewe … Dung Beetles and Poop" is one of 12 stations that have been used in Bug Bash. For more information on Bug Bash, please refer to the Winter 1999 issue of *American Entomologist* (Ellis et al. 1999).

Learning Outcomes

Participants will:

1. Learn the ecological importance of insects;
2. Understand the importance of a single species in the functioning of an ecosystem;
3. Understand the importance of insects in the role of organic cycling; and
4. Learn how species interact and causing populations to change over time.

Problematic Poop and Dung Beetles to the Rescue!

Before European colonization in the late 1700s, the continent of Australia was devoid of ungulates. This was probably due to a long period of isolation during which marsupials evolved to fill niches that ungulates occupy on other continents such as Africa and Europe. After colonization, the newly introduced ungulates brought with them an unexpected problem: dung! The ungulate dung was much larger than marsupial dung, and Australia's native primary decomposers were not adapted to process the new dung type. With Australian cattle producing between 350–400 million pats per day (Waterhouse 1974), the dung piled up quickly. Nutrients in heavily grazed pastures were now largely contained in the dung and were not being efficiently cycled back into the soil. Without the proper primary decomposers, the dung dried out and changed little from year to year. Soon, the dung began to cover the pastures, preventing new grasses from growing. The piles of dung on the ground also led to the increased abundance of the blood-feeding buffalo fly (*Haematodia irritans exigua*), which infests cattle, and the ubiquitous bush fly (*Musca vetustissima*), which pesters both humans and beasts (Hanski and Cambefort 1991). As the number of ungulates increased over the decades, so did the dung problem. Pastures became unfit for grazing, and the health of cattle was compromised. The Australian cattle industry might have collapsed if a solution had not been found.

DANITA DELIMONT/ADOBE STOCK

A TOTAL OF FORTY-ONE SPECIES OF EXOTIC DUNG BEETLES WERE RELEASED IN AUSTRALIA, WITH TWENTY-TWO SPECIES EVENTUALLY ESTABLISHING BREEDING POPULATIONS

Researchers in the 1960s realized that dung beetles might solve the dung dilemma. Exotic dung beetle species were introduced into Australia from both Africa and Europe. Dung beetle species were chosen based on temperature, rainfall, and diversity considerations. A total of forty-one species of exotic dung beetles were released in Australia, with twenty-two species eventually establishing breeding populations (Hanski and Cambefort 1991). Today, at least one exotic species of dung beetle occurs in almost every Australian pasture. The new dung beetles greatly increased the burial and shredding of dung and reduced survival of flies in ungulate dung (Moon et al. 1980). Dung beetles, efficient primary decomposers, have made the ungulate dung more accessible to secondary decomposers, alleviating much of the dung problem in Australia.

Materials

1. An illustration of a dung beetle
2. For the Australian sheep and dung beetle exercise:
   a. Yellow rope (to mark pasture)
   b. Aussie hat (for presenter—a good Australian accent helps set the mood)
   c. 20 drawstring bags (to simulate sheep large intestine/bowels, sort of; large Ziploc® bags will also work)
   d. 360 plastic golf practice balls (to simulate sheep dung and beetle food)
   e. Dung beetle armbands (Fig. 1). These can be made of felt or cardboard with elastic straps sewn or glued to the back. The pattern approximates the digging (fossorial) forelegs of dung beetles.

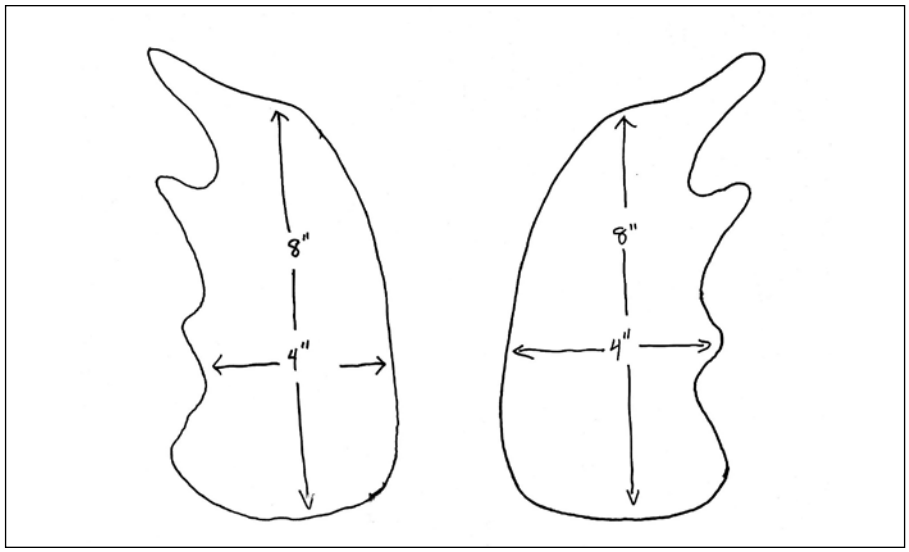

Fig. 1. Patterns for dung beetle forelegs. These can be made of felt or cardboard and should have elastic loops on the back for attachment to students' forearms.

The Lesson

1. Prior to beginning the lesson, place the rope on the ground in a circle to mark the boundaries of the "pasture."
2. Begin by introducing the importance of primary decomposers (dung beetles) in nutrient cycling, using the information in the teacher background ("Problematic Poop").
3. Assign the roles (dung beetles and sheep) to students. We suggest a 1:2 ratio of beetles to sheep. Give the dung beetles the armbands to wear. Give the sheep the bag of plastic golf balls representing the sheep intestine and dung.
4. Tell the sheep to enter the pasture. Ask the dung beetles to wait outside of the pasture until given further instructions.
5. Ask the sheep to wander and graze throughout the pasture. This is to ensure that the sheep do not stay in one spot.
6. After a short period of time, ask the students, "What do sheep do after they graze or eat?" "Poop" is the answer. Ask students to take one plastic golf ball out of their intestinal bag and drop it on the ground. If you wish to prevent students from inappropriately simulating defecation, tell students to defecate by holding one ball out in front of them at arm's length as they drop the ball. If you don't have a problem with simulated defecation, have the students hold the golf ball on their rears and "poop away" by dropping the golf ball—the kids will laugh and love you for it. It is also important that students do not kick or step on the plastic golf balls as a safety precaution and to ensure that they stay inside the pasture. Commands like "digest" and "poop" are helpful during this step because they give the students a sense of the biological process going on (and it makes them laugh). You should repeat the cycle 3–5 times. Adjust the number of cycles as appropriate for class size and time constraints. The goal is to fill the pasture area with poop.
7. *Winter:* After 3–5 cycles of grazing and pooping, tell the students that it is now winter. Ask the sheep to stop where they are, crouch on one knee, and stick their arms straight out to their sides. Then ask the students to look down and count the number of plastic golf balls under their arms (in an "arms radius" around them). Sheep with more than 3–4 plastic golf balls under the area of their arms must leave the pasture. Too much dung is covering this area and grass cannot grow, leaving nothing for these sheep to eat.
8. *Spring:* Do another feeding cycle and repeat sheep removal as in Step 7. In addition, sheep with fewer than two plastic golf balls can now reproduce; instruct one previously removed sheep to return for each remaining, reproductive sheep.
9. Repeat until the pasture is full of dung, so it can only support a few sheep.
10. Ask the class what is happening to the pasture and the sheep.
11. Add the dung beetles into the pasture. Tell them to feed when the sheep produce dung. (For younger students, it may be necessary to instruct both the sheep when to poop and the dung beetles when to feed).
12. Repeat steps 5–11. Instructions for the sheep are as before. In winter, beetles who collect fewer than 3–4 dung balls do not have enough food and die. Remove these beetles from the pasture. In spring, beetles with more than 4–6 dung balls can reproduce, and another beetle may be added to the pasture.
13. Repeat as time permits to illustrate how populations change, and how beetles and sheep come into balance.
14. Ask students to return all dung balls to intestinal bags.
15. Reconvene the students as a group to review the lesson. You may ask the following questions to cover the concepts of the lesson:
    a. Why did dung initially build up in the pasture?
    b. What happens to the sheep when too much dung is present?
    c. What happened to the dung when dung beetles were released in the pasture?
    d. When the dung levels declined, what happened to the sheep population?
    e. When dung levels were high, what happened to the beetle population?
    f. How important are dung beetles to nutrient cycling in ecosystems?

Our Experience and Extensions

This lesson was originally intended for third to sixth grade students, but it may be

modified for younger and older students. We've used this exercise with students five to 18 years old, and with groups of eight to 28 people. For younger students, you may wish to use fewer sheep grazing cycles (two instead of four). For older students, you may wish to focus the discussion on the ecological importance of insects and the impact that extinction of species may have on an entire ecosystem. A greater portion of the discussion could focus on the introduction of exotic or non-native species on the environment (i.e., the introduction of sheep in Australia).

This lesson may also be modified for smaller groups of students by reducing the numbers of sheep and beetles. When reducing the number of sheep, you should also increase the number of "poops" that students drop during the end of a grazing cycle. A smaller pasture may also be used for small groups or to decrease the length of the lesson.

An exercise where students are encouraged to defecate (while pretending to be sheep) and eat feces (while pretending to be dung beetles) seems fraught with possibilities for irate parental phone calls. Our experience is just the opposite. We found that offering a light-hearted, fun game to teach an important lesson is completely disarming for students and their parents. As a public education exercise, the kids love it when the parents play too and have to poop as sheep. As a school exercise, the kids love it when the teacher says "sheep poop" or "beetles eat poop." The exercise breaks a social taboo (talking about defecation and feces), which is a core element of juvenile humor (Carr and Greeves 2006). Using feces as a focus for a nutrient cycling exercise not only relates to a historical situation, but also ensures that kids have fun. Also, we like the implied messages in this exercise: science must look at everything, and things we rarely think about (like poop and where it goes) can be very important.

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