Worms in the College Classroom: More Than Just a Composting Demonstration

By Rebecca L. Kelley

Although worm bins have been used by K–12 and nonformal educators for decades, there is little evidence of their use in postsecondary education. The ease of use, maintenance, affordability, portability, and diversity of scientific concepts that can be demonstrated with a worm bin make it a valuable tool in college science classrooms. The purpose of this article is to report on the use of worm bins in introductory environmental science classes to demonstrate and promote discussion about the biological processes and environmental benefits of composting. It also describes adaptations for using the worm bin in other science courses.

Background

A *vermicomposting system,* commonly called a worm bin, is a method of indoor composting with red wigglers (*Eisenia foetida*). Tolerant of shallow conditions and confined spaces (Appelhof 1997; The Worm Dude; Wonderworman), *E. foetida* consume their weight in waste daily, digest it, and expel a waste rich in nutrients (Ganeshmurthy, Manjaiah, and Subba Rao 1998) and microbes (Gorbenko, Panikov, and Zvyaginsev 1986; Tiwari, Tiwari, and Mishra 1989). These castings are a popular organic fertilizer among gardeners because the nutrients release slowly (Appelhof 1997). The biological processes involved in, and environmental benefits of, turning kitchen garbage into a nutrient-rich soil additive in an artificial ecosystem makes the worm bin a valuable teaching tool for educators.

Worm bins have been used by K–12 and nonformal science educators for decades but are perhaps a forgotten tool in postsecondary education. McGuire (1987) introduced first and second graders to making observations, asking questions, and designing studies with worm bins. Nonformal educators, such as education specialists with conservation districts, use worm bins to demonstrate composting and soil quality issues for elementary-school outreach programs (G. Roth, personal communication, December 3, 2008). As part of their teacher training curriculum, Melear and Lunsford (2007) created activities and inquiry exercises using worm bins that address several K–12 content areas of the National Science Education Standards. With the exception of Melear and Lunsford's (2007) work, no publication was found that describes using worm bins in the college classroom.

This article details how a worm bin was used in introductory environmental science classes to demonstrate and promote discussion about waste management, soil production, respiration, nutrient cycling, air pollution, exotic and invasive species, and reducing fossil fuel consumption. Directions for preparing and maintaining a worm bin are provided along with examples of how it can be used in a variety of science classes.

Materials

Materials needed for classroom demonstration include a properly functioning worm bin and a garden scoop (see Figure 1). Directions for setting up and maintaining a worm bin are in Table 1, and accompanying pho-

tographs are in Figures 1 and 2. For best results, start the bin two to three months in advance of planned demonstration. Always have a second bin for backup in case of fruit fly infestation or moisture damage (see Table 1).

The classroom demonstration

Waste management is usually discussed in environmental science classes after such topics as photosynthesis, respiration, element and nutrient cycling through ecosystems, species interactions, agricultural issues, soil erosion, soil quality, fossil fuel supply and consumption, and air quality. This is the perfect time to utilize a worm bin because it provides the opportunity to reinforce and integrate concepts discussed throughout the semester. A review and discussion of environmental issues and their relation to the worm bin can be accomplished in about 30 minutes if time is limited or can be extended to occupy one lecture period.

To stimulate discussion, take the bin into the classroom and pick up a scoopful of worms and compost. Ask questions to spur discussion about the environmental benefits and concepts covered in class that can be connected to the bin.

1. What is this? (Students usually understand that it's a demonstration of composting and waste stream reduction, though few are aware of indoor composting.)
2. What are the benefits of composting? (This can lead to a discussion about soil quality, soil production, nutrient cycling, reduced fossil fuel consumption, and air pollution associated with transporting waste to a landfill. Some usually ask about putting waste down a garbage disposal; point out that a garbage disposal consumes both electricity and water.)

FIGURE 1

A typical worm bin setup, consisting of an 18-gallon (68.1-liter) plastic container and lid, with holes drilled (using drill bits ranging from 5/32" to 3/16") in the top of the container for ventilation and in the bottom for drainage; a shallow plastic container to serve as a drain tray in the event of excess moisture buildup and drainage; and a garden scoop.

Photo Credit: Rebecca L. Kelley

3. Why is the bedding moist? (Review respiration and remind students that water vapor is a by-product, and refer back to earlier lectures on energy transfer and nutrient cycling through ecosystems.)
4. Does it smell like rotting garbage? (The only smell is that of soil. This opens up discussion about aerobic versus anaerobic conditions of decaying organic matter and the benefits of oxygenation in ecosystems, both aquatic and terrestrial.)
5. What are the definitions of exotic and invasive species? (Discuss *E. foetida* and how they may not be native to your area, but that they are intolerant of freezing temperatures and, though exotic, are not likely to become invasive in northern climates. This can lead to a review of species adaptation and evolution in nature.)

FIGURE 2

Vinegar trap made with a standard Drosophila culture vial 1 ¼" diameter × 4" high, apple cider vinegar, and a paper funnel.

Photo Credit: Rebecca L. Kelley

Extensions of the demonstration

In addition to a tool for demonstration and discussion, assignments for lecture and laboratory courses can be developed using the worm bin. In a lecture class, it could be used to have students write detailed responses to questions like those presented above as a method of material review or an in-class activity for points. The microbes involved in breakdown of organic matter and contained in the worm castings make worm bins excellent sources of microbe isolation, culture, and identification exercises in microbiology classes. Many exercises designed to provide hands-on experience in analytical techniques and applying the scientific method can be developed using worm bins, such as population growth studies, limits to growth, analysis of nutrient concentration of the vermicompost, and seed germination and plant growth experiments comparing vermicompost to commercial potting soil.

Student response

Many students come by my office to inquire about vermicomposting after seeing the demonstration, and some even bring their friends from other classes to show them the worm bin. In fact, on average, about four students (10% of the class) per semester will start their own bin. I provide them with worms, instructions (Table 1), and assistance with initial setup.

Conclusions

As college science educators, we are always looking for methods of capturing the attention of students, demonstrating concepts, and providing students with examples that apply the material we want them to learn. Worm bins have long been used in K–12 and nonformal educational settings but are not commonly used in college science courses. Vermicomposting is a portable, affordable, adaptable teaching tool that can be utilized to encourage discussion and interaction in the lecture class or to design laboratory experiments and student assignments.

References

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Ganeshamurthy A.N., K.M. Manjaiah,

TABLE 1

Instructions for setup and maintenance of a vermicomposting system.

Establishing a bin: Obtain an 18-gallon (68.1-liter) plastic storage bin with lid (see Figure 1). Drill holes (using drill bit sizes 5/32 to 3/16 inch) in the bottom for drainage and at the top for ventilation (see Figure 1). Red wigglers can be purchased from internet suppliers and some local bait shops, or they are sometimes available for free from a local outreach education program such as those offered by conservation districts. Add 1 pound of red wigglers (*Eisenia foetida*) and a scoop or two of standard potting soil to the bottom. Add some kitchen waste and 6 to 10 inches of shredded paper for bedding. Mist the bedding with tap water from a spray bottle to make it damp but not wet. This will need to be repeated several times per week until the bin is active enough to maintain moisture. Once established, the worm bin requires very little attention aside from weekly feeding and periodic maintenance.
Feeding: Add up to 3 pounds of food each week. This can be done all at once or two or more times throughout the week. Food can include anything from the kitchen other than meat, bones, fats and oils, milk, cheese or other dairy products. Egg shells are an important source of calcium for the worms, and one dried egg shell should be added to the bin each week.
Moisture: The bin should be damp but not wet. Often this requires no added moisture once the bin is established as the worms expel water vapor as a by-product of respiration. If a little moisture is needed, simply use a spray bottle and "spritz" the bedding with tap water.
Bedding: Shredded paper is recommended for the bedding as this keeps the paper out of the waste stream as well as the garbage that is composted. The worms need several inches of a bedding material to cover their food. This gives them the illusion of being in the dark and below ground. It also provides a place for condensation to collect rather than pooling at the bottom and drowning the worms. As the bedding material disappears into the compost, simply add more as needed.
Harvest time: Every 3 to 6 months, depending on how active your bin is, you will need to remove the compost. When you are ready to do this, just scoot everything to one side of the bin. In the empty half add some fresh soil, food, and clean bedding. Stop adding food to the half of the bin containing the "old" pile and transfer the bedding from this old pile to the new one. Over the next couple of weeks the worms will migrate to the new pile and you will be able to remove the older compost and use it for houseplants, gardens, etc.
Preventing over population: Eventually, you will need to remove about half the worms to prevent the population size from getting too large and fouling their environment. To remove worms, scoop up some of the compost, sift through it with your fingers, and collect the worms. Use excess worms to start a new bin or go fishing. A good rule of thumb is to pull out about 100 worms every 3 months.
Trouble shooting: Foul odor—usually means the bin is too wet and anaerobic. Stop adding water and moist foods until odor clears. Fruit flies—keep a small container of apple cider vinegar covered by a small paper funnel (see Figure 2) in or near the bin to prevent fly infestation. If infestation does occur, take bin outside and remove lid for several hours to allow the flies to escape. You may need to repeat this several times. Make sure to keep the bin out of direct sunlight as this could overheat and dry out the bin, killing the worms.

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The worm dude. *www.thewormdude.com.*
Wonderworman. *http://wonderworman.com.*

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