Decomposition Education Module
Teacher Guide

This activity is designed to allow students to study decomposition over an extended period of time, from weeks to months or even an entire school year. It is not meant to be conducted within one class period or day. It is designed for teachers in the Phoenix area, in the urbanized Sonoran Desert, but could easily be adapted to any ecosystem.

I. Introduce the students to decomposition

Several accompanying videos lay the foundation for students to understand why decomposition is important and how researchers study it. This hopefully opens their eyes to the wonderful world of decomposition. There's a lot more going on during decomposition than most people realize!

The videos can be found in this YouTube playlist:
https://www.youtube.com/playlist?list=PLHtFombeGdD2kdjenqrgRwbaVs_cXUTxa

After showing students the videos and introducing them to decomposition, lead them to ask scientific questions they might want to explore about decomposition. For example:

- If you wanted to guide them towards asking a question about how various plant species decompose differently, you could pick several leaves from a number of different species. In the Phoenix area, you could pick some from a mesquite tree (a legume high in nitrogen), a creosote bush (with very tough, waxy leaves), and maybe a few other species that look very different from each other. Let the students look at the leaves and guess which would decompose fastest. Which would decomposer organisms be more likely to eat quickly? Which has the most nutritious content without a lot of complex compounds that are hard to decompose (like wax, lignin in wood, etc.)?

- If you want to guide them towards asking a question about native desert species versus introduced ornamental species, you could pick some leaves from native desert plants (such as mesquite, bursage, creosote, etc.) as well as some from ornamental plants in your yard (commonly in Phoenix these could include oleander, lantana, bougainvillea, bird of paradise, palm trees, etc.). Ask students which they think will decompose more quickly or change the most over time.

- If you want to guide them towards asking questions about how the environment influences decomposition (i.e., using only one species of plant but changing where it's being decomposed), you could go for a walk around your schoolyard and ask them where they think plants will decompose the fastest. Close to the grass where there's a sprinkler and probably extra fertilizer (but often depleted decomposer communities from heavy management)? On the edge of the school yard, probably away from irrigation but below some native shrubbery? Or would plants decompose faster either in the shade or a place that receives a lot of direct sunlight (and therefore hot, dry conditions but with higher UV radiation)?

Once the students have decided on their research question, they can record it on their activity sheet. They can then suggest a hypothesis that will be tested to answer the question, as well as their prediction of what will happen, and identify their experimental variables.

Next, students can figure out the study design. Have students discuss the best methods by answering the following questions:

- What plant litter will they put into the bags? How many different types of litter are needed? Which types?
- Where will the litterbags be placed to decompose?
- How long will they have to allow the litter to decompose to answer their questions?
- How often will they collect litterbags?
- What will they measure on the litterbags each time they are collected?

The length of the study will depend on what type of litter is being decomposed and in what environment. Below is a list of *suggested* lengths that would allow students to see noticeable results. The times listed are an estimate of the minimum amount of time to measure significant amounts of mass loss.

Litter type	**Location**	**Duration**
Plant leaves that are easy to decompose (e.g., legumes)	Natural desert	6 months
Plant leaves that are tough to decompose (e.g., creosote)	Natural desert	1 year
Plant leaves	Moist location (e.g. irrigated area or compost bin)	3 months
Fruit or vegetable scraps	Moist location	10 weeks

After the students have designed the study, they can record the independent and dependent variables on their student activity sheet.

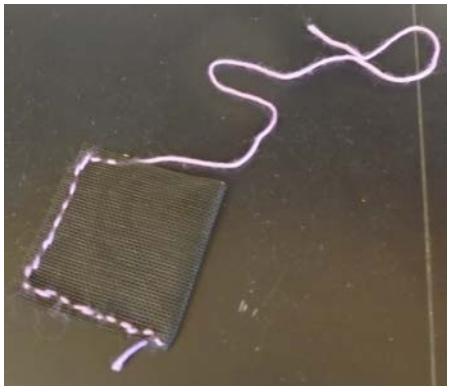
II. *<u>Collecting plant litter</u>*

Once students have selected the type of leaves or plant material they'd like to study, they can make the litterbags and begin the experiment. First, you will need to collect a lot of the leaves that you want to put into the litterbags. These may be leaves of a particular species, or just a "natural" composition of leaves from the ground. It is best to collect freshly-fallen leaves or even ones from off of a live plant, so that you can study the fast changes that happen during the early stages of decomposition. The litter should be dry, so if necessary it should be air-dried by spreading them out on a table in the classroom, or leaving them in paper bags and "fluffing" them by hand daily to allow them to air out. After a few days of drying, they are ready to get put into litterbags.

III. Instructions for making litterbags:

A video demonstrating this process can be found on the YouTube playlist mentioned in section I, or at this link:
https://www.youtube.com/watch?v=4AF66atFpXE

Ecology Explorers has materials available for making litterbags. You may select to use either the nylon mesh (which allows invertebrates and water to enter the litterbags), or the plastic sheets (that allow you to control UV radiation). Most desert plants have small leaves, so you do not need to make large envelopes. We recommend using a 10 cm x 10 cm square litterbag, which is described and demonstrated in the accompanying video. However, they can be made in any size of your choosing. In the video, I make the litterbags with nylon mesh, which students can sew closed using yarn or embroidery floss and a yarn needle. (Yarn needles are larger than normal needles so easier to handle, and not sharpened so less hazardous. They are available at most craft stores for about $1.) If you're using the plastic sheets to block UV radiation, you can seal them with tape.



Make the litterbags according to the video demonstration, leaving one of the edges unsealed so that you can add the plant material. It is best to put a known amount of leaves in each bag. Around 3 grams is recommended, but you might want more or less, depending on the size of your bags and how much plant material is available. Weigh that mass of leaves into each of your litter bags, and seal the open edge. Students should record this initial weight, then seal the open edge of the litterbag. If necessary, label the bag using aluminum tags or some other method of remembering which bag is which. Tags can easily be made by cutting up disposable pie pans or roasting pans into squares that get attached to the bags by wire. Label the tags by using a pen or pencil to indent on the aluminum. (Ink and marker will fade over time, especially in the sun.)

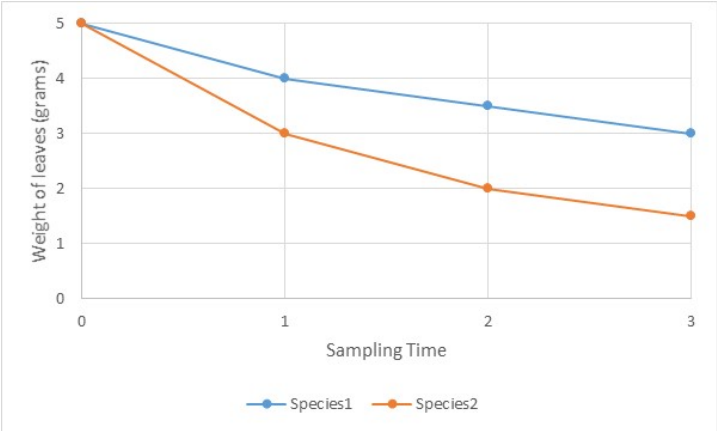
How many litterbags will you need to make? It depends on what you decide to do. Let's say, for example, you'll compare the decomposition of two different plant species. You'll need bags to stuff with species1 and species2. You'll want enough bags for each species to allow you to occasionally pick some up over the duration of the entire experiment. Each time you collect a litterbag, it'll be destroyed, so you need to make enough of each species to accommodate all of the sampling periods. It's also beneficial to pick up a few replicates of each species each time so that students can take the average of the replicates. Three is a recommended number of replicates. (More is better, but time consuming!) So, if you plan to have 3 sampling periods, you might make 9 bags of species1 and 9 bags of species2. They all get placed into your test location outside at the same time, and at the first sampling time, you'll pick up three of each species. At the second sampling time, you'll pick up three more, and then the final three on the last sampling date.

IV. Measuring decomposition on your litterbags

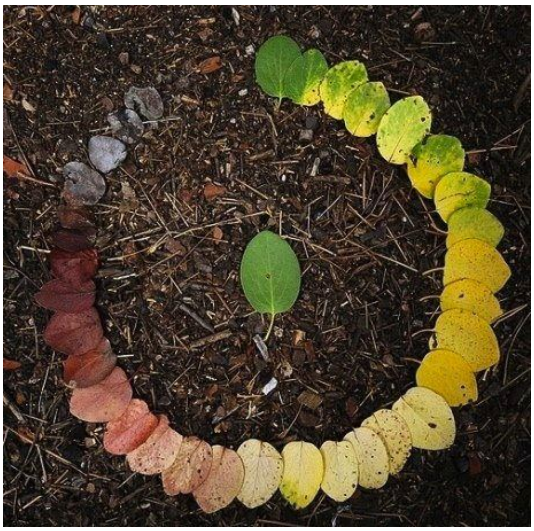
What do you do with the bags when you pick them up? That depends on how much time and resources you have. Here are a few ideas:

1) MASS LOSS To track how much of the leaf has disappeared (referred to as "mass loss"): open the bags and dump the leaves onto a paper towel. Allow them to air dry for a couple of days. (I recommend doing this on a table in the classroom rather than outside, because the sunlight could change your measurements!) Once they are dry, weigh the leaves.

   Students can use the "data sheet" handout to track the mass loss of their litterbags. Each time litterbags are collected and weighed, have students mark the weight on the graph for that time period, and connect those points with lines. You should be able to notice a decrease in the weight over time. Often there are differences between different species, with one losing weight more quickly than the other, which is an interesting thing to discuss with students.



2) LEAF CHANGES If a scale for measuring mass is not available, you can ask students to do visual assessments. Do the leaves look or feel different? Have they changed color? Are they more fragile and crumbly? Are the veins becoming more noticeable? Are pieces of the leaf missing?



   Students can record a color scale of the changes happening to the plant material (for example, with colored pencils), or make smears of the leaves on their worksheet to record the color change. (Note, not all leaves will smear easily, and as an alternative they can tape a leaf to their activity sheet from each time step.) Students can also draw the shape of the leaf on their activity sheet and estimate the amount of surface area that is missing at each time step.

3) MICROARTHROPODS The Ecology Explorers program has equipment that can be borrowed to extract the small, microscopic invertebrates that live in leaf litter. You will need dissecting microscopes available in your classroom to view the samples, but the items you

need to collect the microarthropods are available on loan. These contraptions are called Tullgren Funnels, or also Berlese Funnels, and they use heat to drive the invertebrates out of the soil, down a funnel, into a collection cup. A tutorial on how to setup these funnels is available on the YouTube playlist mentioned in Section I.

Students can be introduced to the wonderful world of microarthropods using the short video available in the same YouTube playlist. For more information to share with your students about the organisms, you can learn about the soil food web here: http://ecoplexity.org/soil_model.

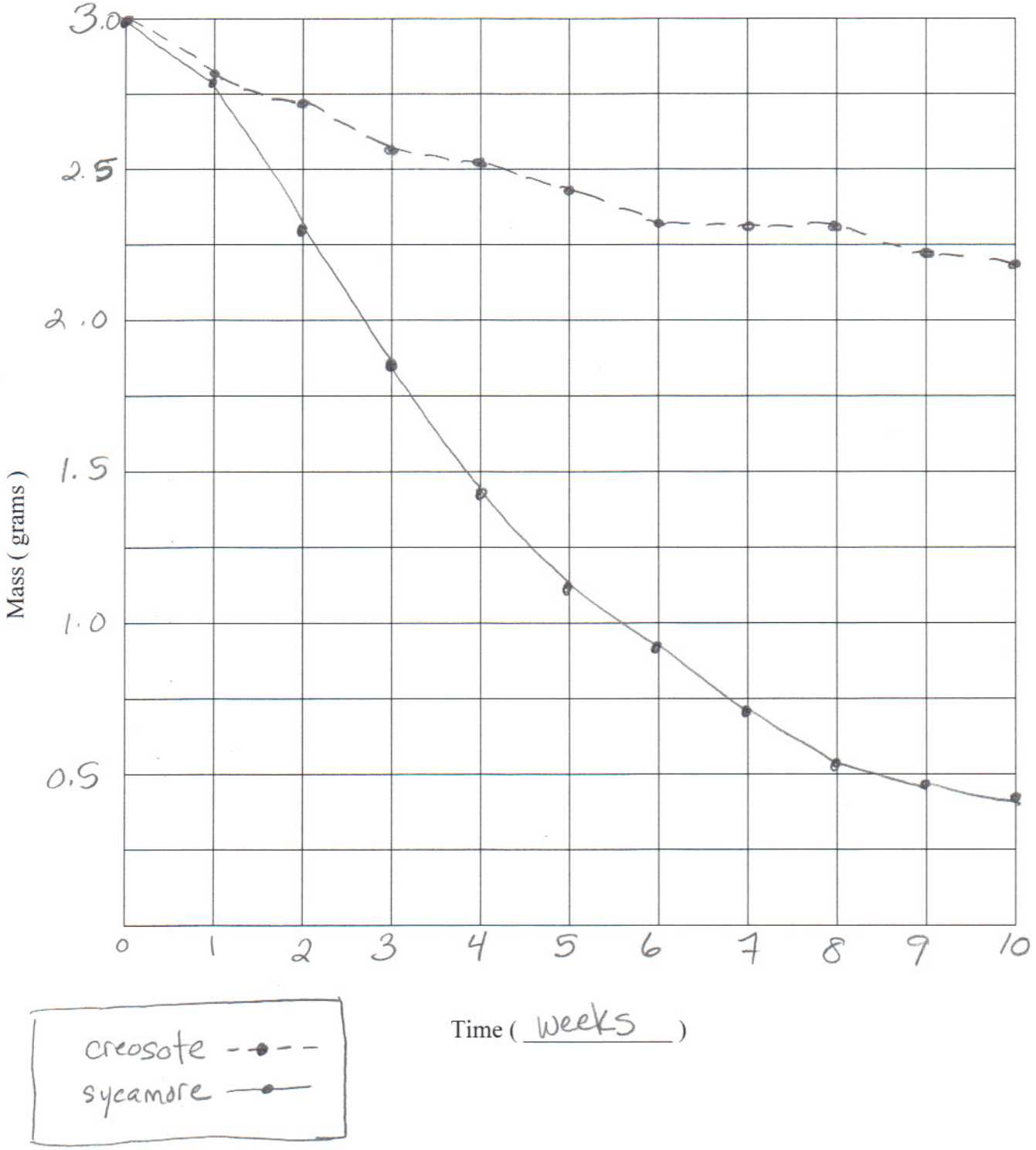
Soil microarthropods require a lot of expertise to identify, and most K-12 students would struggle to learn them all. It is probably most interesting for students to just count overall numbers of individuals they can find in the sample, and perhaps the numbers of different kinds that they see (diversity).

V. Analyzing and interpreting the data

The Student Activity Sheet walks students through the process of recording and interpreting their data. The “Analyzing your data” section contains questions for students to answer about each of the three measurements suggested above, and will need to be modified to suit your classroom and the measurements you selected. The “Interpreting your data” section helps guide students through the process of assessing their question and hypothesis to make scientific conclusions based on their data.

Plot your results on the graph below.

1) The x-axis represents the amount of time that the litterbags have been outside decomposing. First, fill in the units of time that you used. For example, if your litterbags are going to decompose outside for 30 weeks, the unit would be filled in as "Time (weeks)". If you followed decomposition for 12 months, the unit would be filled in as "Time (months)".
2) The y-axis represents the mass of leaves that are inside the litterbags. You should see the mass decrease over time.



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2) The y-axis represents the mass of leaves that are inside the litterbags.

Mass (grams)

Time (_____)

Decomposition Education Module
Student Activity Sheet

Designing your experiment

What is your scientific question? In other words, what question will be answered by your decomposition study?

What is your hypothesis? A hypothesis is a proposed explanation for an observation, which can then be tested with experimentation or other types of studies. To identify your hypothesis, consider your question. What do you think is the explanation for the answer?

What do you predict? Given the hypothesis, what do you predict you'll see happen in your litterbags?

What is your independent variable?

What is (are) your dependent variable(s)?

Analyzing your data

Mass Loss

1. Look at the graph you made. Did your litter change in mass over time? Why do you think this is?

2. If you used multiple different types of litter, did the different types change mass over time at the same rate? How did they differ? Why do you think this is?

Visual Changes

1. How did the litter change over time? How did they change in color, texture, and size? Why do you think this is?

Microarthropods

1. Did organisms move into your litterbags? Why are they there? What do they do?

2. Did the numbers of organisms change over time? Why do you think that is?

3. Did the number of organisms differ among all of your different litterbags? In what way did they differ? Why?

Interpreting your data

Using your data, make a claim that answers the scientific question.

Support your claim using data as evidence.

Describe your scientific reasoning to explain how the evidence supports your claim.

Your next steps as a scientist: Science is an ongoing process. What new question do you think should be investigated? What future data should be collected to answer this question?