Lesson: “Do worms really eat dirt?”

VIDEO TRANSCRIPT

EXPLORATION VIDEO 1

Hi, it's Doug! The next time it rains, go out for a walk afterward and look closely at the sidewalk. You'll probably see lots of these. It's an earthworm. Earthworms seem to love to come out after the rain. Most of the time, though, you don't even think about them. Since they spend most of their lives underground, you hardly ever see them, but scientists have found something surprising. When they dug up soil looking for earthworms, they found that there could be as many as a million earthworms within just one acre, that's about this much land. That means that whenever you're walking around outside, there are probably several worms underneath your feet all the time. Now, it used to be that, a couple hundred years ago, people didn't have a very good opinion of worms. They thought that earthworms must be pests. They figured that earthworms probably kill plants in a garden, so whenever people found earthworms in their garden, they would even try to get rid of them. They'd do things like pour mustard and water into the soil, which they thought would irritate the earthworms and make them leave. Now, it was pretty understandable why people might have seen earthworms as pests. After all, earthworms are slimy and wriggly. People might see them as gross. But even more importantly, earthworms probably reminded people of another common pest: these. Caterpillars. Both earthworms and caterpillars have long, soft bodies with segments, but as you probably know, they're not the same animals. Caterpillars destroy plants in a garden by eating their leaves, but earthworms,

were they really harming garden plants? What were they even doing down in the soil? At the time, no one really knew whether earthworms were pests or not because they had hardly been studied, but in the 1800s, a scientist in England named Charles Darwin got really interested in this question. Darwin had noticed earthworms crawling in the garden at his home, and he wondered if people might be completely wrong about earthworms. Maybe earthworms are actually even helpful. If you were Darwin, how would you figure this out? How would you figure out whether worms are pests or whether they're maybe even helpful to a garden?

ACTIVITY INTRODUCTION VIDEO 1

In the first part of today's activity, you're going to learn about earthworms by watching one. If you observe carefully, there are lots of things to notice when you watch an animal, even a simple worm. Your worm observations will give you some ideas about the worm's role in the garden. Now, before you get started, you should know that worms might be a little slimy, but they won't hurt you. It's perfectly fine to pick up a worm with your bare hands. In fact, you have to be gentle so you don't hurt them. The more gently you handle the worm, the more of its behavior you'll get to observe. Otherwise, it may try to play dead. I'll show you how to get started, step by step.

ACTIVITY PART 1 STEP 1

Get these supplies. You'll get a worm later. When you're done with this step, press the arrow on the right.

ACTIVITY PART 1 STEP 2

Fold or tear your paper towel so that it fits in the middle of your plate. You don't want the paper towel hanging over the edge of your plate because then your worm might use it to crawl off.

ACTIVITY PART 1 STEP 3

Wet your paper towel by spooning a little water onto it. You want the towel to be damp but not dripping wet.

ACTIVITY PART 1 STEP 4

You want to give your worm some choices of where it can go. So what you'll do is lay your black construction paper on the plate, like this. Be careful not to press down on it because you don't want it to stick flat against the towel.

ACTIVITY PART 1 STEP 5

If you're in a class, take turns going to the worm station that your teacher has set up. Take your plate with you. Gently scoop up a worm, like this. Now you want to try not to pinch the worm because your worm might not like that. If you're too rough with it, it might decide to play dead. It's okay if you scoop a little bit of dirt too, but try to get some off. Then use water and the spoon at the station to rinse the rest of the dirt off, like this. Once your worm is clean, put it on your paper towel. You can wipe your hands off if they're dirty. Then take your worm back to your desk.

ACTIVITY PART 1 STEP 6

Your worm might take a couple of minutes to start moving, so try to be patient. Eventually, answer questions 1 and 2 on your worksheet. Now, if your worm is taking a while to move, you can look at other worms at your table to see what they're doing. By the way, you don't need to touch your worm anymore or poke it. You want to see what the worm does all on its own.

ACTIVITY PART 1 STEP 7

Did your worm find a place to rest or hide? Answer question number three on your worksheet. If you're in a class, talk with the other people at your table about what each of their worms did.

ACTIVITY PART 1 STEP 8

Discuss, then watch the next video.

EXPLORATION VIDEO 2

In order to figure out whether worms were pests or helpful, Darwin started by closely observing worms' bodies and their behaviors, just like you did. Maybe you observed some of the same things that Darwin did. First, Darwin noticed how worms have soft, flexible bodies made of these circular ring segments. Earthworms move by squeezing and stretching these segments of their body, one by one, inching their way across the surface or squeezing themselves through tiny openings. When Darwin watched worms outside, he saw that they burrowed down into the soil. They didn't like being exposed to the air. Probably because it dried them out. Here's a sped-up video of when we did the experiment. Notice the worm didn't have anywhere to burrow since it was on a plate, but it probably would have burrowed if it had a choice. Instead, some of our worms went underneath the paper towel, where it was damp. Some of them also went under the piece of black paper, trying to get away from the light. Even though worms don't have eyes, they can still sense light. Darwin figured this out by shining candlelight on worms in a container to see how they would react. He shined light on just half of a container full of worms and found that the worms always crawled away from the light and tried to find somewhere dark to hide. Did you figure out which end of the worm was its head? They do have a head and a tail, but it can be

hard to tell which end is which. Usually, when worms move, they go forward, so you could figure that end is the head, but they sometimes go backward, too. So it seems like nearly everything about a worm's body makes it ideal for living in the soil. It likes dark and damp places, it's flexible and soft so it can squeeze into small places, and it can move forward and backward. But out of all of these characteristics, nothing seemed to suggest that worms were pests that would kill plants in a garden. They really seem harmless. They don't have ears or eyes and their mouths are tiny. Maybe they could eat dead leaves, which are soft and easy to chew, but earthworms don't have strong jaws to chew through tough living plants the way that caterpillars do. At the end of all of his observations, Darwin found no evidence that worms were harming his garden. In fact, Darwin found something that made him think plants might actually do better when there are worms around. Darwin observed that worms were coming to the surface and leaving behind what looked like little mounds of soil. They're called worm castings. Turns out, castings are what the worm excretes. They're worm poo. Worms, when they move through the soil, bring soil from lower down in the earth upward, creating a new layer of soil on the surface. This reminded Darwin of something he knew farmers already did to mix the soil on their farms. They plowed the soil like this in order to mix the layers and loosen it up for plants to grow. It looked like worms were doing exactly the same thing, just on a smaller scale. After almost 30 years of researching earthworms, Darwin published a book about them. In that book, he claimed that worms were actually helpful to a garden. They were like nature's plows, mixing up the soil and loosening it so that plants could grow better. Most scientists were convinced by Darwin's book that worms weren't pests after all, but not everyone was convinced. After all, worms are so small and weak, they couldn't possibly be doing that much, thought some scientists. What do you think would convince these other scientists of Darwin's claim that earthworms are actually helpful to a garden?

EXPLORATION VIDEO 3

Darwin learned a lot about worms and their importance, but he didn't figure out the whole story. Worms are helpful, but they aren't just helpful because they move the soil. It's because of what they do to the soil. Remember how worms leave castings behind? Castings are what's left behind from what worms are eating that goes through their bodies, gets digested, and then gets excreted as waste, But it turns out, this waste isn't bad. It actually makes the soil even healthier than before. It's a fertilizer. Scientists since Darwin's time have studied earthworm castings and discovered that they have even more nutrients than the soil around them. So when worms poop, they're actually releasing nutrients into the environment. And plants need these nutrients in order to grow. You might remember from an earlier mystery that the main two nutrients that plants need are carbon dioxide, a gas that they get from the air, and water that they take in from their roots. Plants use carbon dioxide and water to grow and build their own bodies. But it turns out that's not all they need. Plants also take in a small amount of nutrients from the soil. And because they only need these nutrients in small amounts, we call them micronutrients. It's a lot like how people need vitamins in their food. If you only ever ate potato chips, you wouldn't starve, but you would slowly get sick because you weren't getting the vitamins that your body needs. Plants are similar. They'll slowly get sick if they don't get micronutrients from the soil. But instead of vitamins like our bodies need, plants need micronutrients that go by names like nitrogen, phosphorus, and potassium. Here's what a plant looks like if it's not getting enough micronutrients from the soil. Notice how its leaves are yellow and it looks wilted. So Darwin had discovered that worms mix and break up the soil like a farmer's plow, making it easier for plants' roots to grow. Darwin thought worms were important because they move soil. But what Darwin didn't realize is that worms are even more important for releasing micronutrients into the soil for

plants to use. Other scientists have done experiments to test just how important worms are for plants. Here's one way scientists test this. They took two pots. In one pot, they put worms in the soil, and in the other pot, they put no worms. That way, they could compare how plants grew with and without worms. When they grew the plants, they found that the plants in the pot with the worms grew better. They were healthier and bigger when the worms were there. This evidence would've helped convince the other scientists in Darwin's time that worms really were important; they weren't pests. But there's one last question. What are worms eating in order to release micronutrients into the soil? Do they really just eat dirt like you may have heard? Or do they eat other things as well?

ACTIVITY INTRODUCTION VIDEO 2

In part two of today's activity, you'll plan an experiment that will help you find out more about earthworms. Scientists often start by making close observations of animals and their behavior, just like you did earlier. Then, they may design experiments to test the explanations they come up with. You're going to do the same thing now, but before you start planning your own experiment, you'll try a simple one that shows you some of the ways scientists think when they're planning an experiment. If you have time, you might do an experiment you thought up in class or on your own at home. I'll show you how to get started, step by step.

ACTIVITY PART 2 STEP 1

Form a team with a few friends. You'll each do your own experiment, but you'll share your ideas. If you're working alone, that's okay too. When you're done with this step, press the arrow on the right.

ACTIVITY PART 2 STEP 2

Get these supplies.

ACTIVITY PART 2 STEP 3

You observed worms and you saw that they crawled on or under the damp paper towel. Here are some possible explanations for why the worms did that. Discuss.

ACTIVITY PART 2 STEP 4a

Discuss this question. If you want to see an idea we had, go to the next slide.

ACTIVITY PART 2 STEP 4b

Here's an idea we had. We want to give the worm a choice between damp and dry. Where the worm goes will tell us what it likes. So let's try it out. Go to the next slide.

ACTIVITY PART 2 STEP 5

Try our experiment using your worm. Write your name by number one on your worksheet. Then, put a dry paper towel on the plate and get half of it wet, like this. Now, it's okay if it's not perfectly half-wet and half-dry, just do your best.

ACTIVITY PART 2 STEP 6

Okay, don't do anything yet. Just listen to what you're going to do. You're going to put the worm in the middle of the paper towel so that about half of the worm's body is on the dry part and half

of it is on the damp part. Now, it's hard to get it exactly in the right place, so that's okay. Then, you'll watch for one minute to see what your worm does. Finally, you'll record where your worm ended up by shading how much of the worm was on the damp side. For example, if your worm crawled so that it was about 3/4 on the damp side, you'd shade it in like this.

ACTIVITY PART 2 STEP 7

Gently scoop up your worm from your last experiment and get ready. When I say, "Go," I'm going to start a timer and you'll put the worm so that it's about halfway on the damp side and halfway on the dry side. All right, I'll give you a second to pick up your worm. All right, I'm about to start the timer. Ready, set, go. Now watch where your worm goes. Okay, time's up. It's time to shade in how much of the worm is on the damp part in question number one of your worksheet.

ACTIVITY PART 2 STEP 8

You recorded what your worm did, but did other worms do the same thing? Have each person at your table say where their worm went. You can record the results in questions number two through four on your worksheet.

ACTIVITY PART 2 STEP 9

Discuss.

ACTIVITY PART 2 STEP 10a

Suppose your friend tried this experiment at home. In their experiment, the worm went to the dry side. Look at this picture of their setup when they started out, and discuss. If you want to see what we think, go to the next slide.

ACTIVITY PART 2 STEP 10b

I don't know what you came up with, but to us, this doesn't seem like a fair test of whether the worm liked damp or dry. Look at the plate. The dry side is partly shady. The damp side is sunny. But a fair test should test one thing at a time. Discuss this question.

ACTIVITY PART 2 STEP 11

In the drawing we showed, there were too many things going on to figure out why the worm ended up on the dry side. Was it because of the dryness or because of the shade? Differences in dampness and light affect a worm's behavior. Discuss this question, then do number 5 on your worksheet.

ACTIVITY PART 2 STEP 12a

Now it's your turn to design an experiment. Discuss, then fill out question number six. You won't do the experiment right now, but you'll think about it and make a plan. You can work alone or with others at your table. If you're stumped for ideas, go to the next slide.

ACTIVITY PART 2 STEP 12b

Here are some possible experiment questions; you can keep the question you thought of or you can change it to one of these.

ACTIVITY PART 2 STEP 13

Write the question you want to answer on number seven on your worksheet. Discuss, and then fill in question number eight on your worksheet.

ACTIVITY PART 2 STEP 14

What can you do to make sure your experiment is a fair test? Fill in question number nine on your worksheet.

ACTIVITY PART 2 STEP 15

I hope you'll have time to do your experiment later, even if it's at home. Here at Mystery Science, we're always doing experiments. For now, we'll show you the experiment that we did. Take your worms back to the worm station, then watch the final video.

WRAP-UP VIDEO

There are lots of different experiments you could do with earthworms. You can learn a lot by watching closely and you can experiment by changing one thing at a time. Here's just one example of an experiment we designed. We wanted to figure out, what exactly do worms like to eat? I mean, do they actually eat dirt or do they eat stuff that's in the dirt? We decided to give worms a choice between dirt with no dead stuff in it and dirt with dead stuff in it. Now, to create a fair test, we made a worm bin out of a plastic box and we put dirt on one side and a mixture of dirt and dead plants on the other side. We thought about other things that might affect what the worms did, like light and dampness, or how wet it was in there. So we made sure the whole box was damp, and we decided we would put it in the dark. Then we put 100 earthworms in the

middle of the box and waited for two full days for the worms to move in the box and make their choices. Then we counted the worms in each half of the box. Are you ready for this? After two days, when we counted the worms on each side, we found 11 worms on the side with only dirt. On the side of the box containing dirt and dead plant material, we found 89 worms. Our experiment supported the claim that earthworms prefer dirt and dead stuff. This evidence fits with what scientists have observed. Worms eat dead leaves and dead plant roots. That doesn't hurt the plants at all, the way caterpillars do. Earthworms really aren't pests. If you think about it, earthworms are actually decomposers. They have something in common with fungi, things like mushrooms and mold, and microscopic organisms like bacteria. Decomposers are responsible for breaking down all kinds of dead or decaying matter to make it usable again as soil with micronutrients for plants. Scientists also found out that if you observe soil up close through a powerful microscope, you will find all kinds of microscopic organisms. It turns out that worms eat those tiny living things, too. So to answer the question, do worms eat dirt? The answer is: not exactly. Worms eat stuff in the dirt, like decaying plants, tiny living organisms like bacteria, and also animal waste. If you were to take out all of the living things and all of the decaying material from the soil, earthworms wouldn't be able to survive on just the rocks and minerals left behind. Scientists like to distinguish between dirt, which doesn't have any dead or living material in it, and soil, which does. Worms prefer soil to dirt. Scientists are currently working to figure out even more ways that decomposers like worms can help us in the future, like breaking down garbage into great fertilizer for plants. Have fun, and stay curious!