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How can tardigrades survive without water?

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Abstract

Tardigrades (also called water bears) are tiny, eight-legged animals that live all over Earth. They need water to be active, but have an amazing ability to survive long times without water. Tardigrades can even survive being in space! They survive by drying out into a hard little lump called a tun. We wanted to know how different species of tardigrades handle drying out. We found that some tardigrade species recover from their tun stage faster than others.

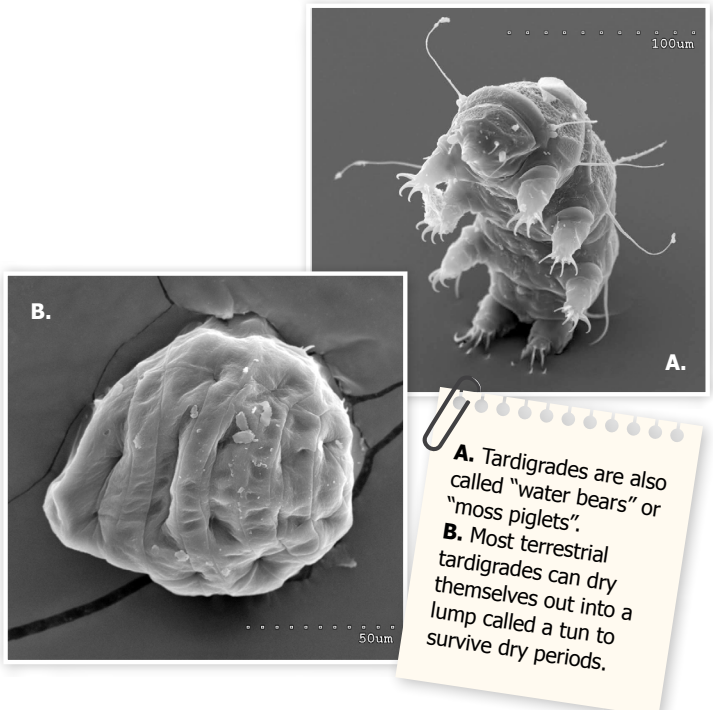
Introduction

Eight legs, grasping claws, a body like a caterpillar, and a round mouth, probing for food. Is it an alien? A late-night monster movie? No, it's a tiny creature called a **tardigrade**, one of the most resilient animals on the planet! Tardigrades can be found almost everywhere on Earth, from the tropics to polar regions. They live in mosses, lichens, the roots of grasses, soil, or water sediments. The biggest tardigrades are only a little more than 1 millimeter long.

Tardigrades are extremely tough. Even though they need to be in water to be active, eat, and reproduce, they can survive for months or even years without a drop of water! They can survive intense heat and cold, and can even survive being in outer space! Scientists keep learning more about how tardigrades perform such amazing feats of survival.

Water bears have a trick they use to survive dry spells. They curl up into a small lump and push all the water out of their bodies. Scientists call this transformed tardigrade a **tun**. Then, when water is available again, the tardigrade **rehydrates**. There are over 1,400 **species** of tardigrades. Some are herbivores and some are predators. But most **terrestrial** tardigrades have the ability to form a tun.

Scientists have conducted lots of experiments with different tardigrade species. But it's hard to compare the results because the experiment methods can be very different from each other. This is why we wanted to see how different species of tardigrades recover after being without water, using the same experimental conditions.



A. Tardigrades are also called "water bears" or "moss piglets".
B. Most terrestrial tardigrades can dry themselves out into a lump called a tun to survive dry periods.

Methods

Most tardigrades in our study came from soil and moss samples collected in different regions of Poland. We found some next to a railroad, on a concrete wall, in the soil at a national park, and on the lawn of a university. We also studied some that originally came from Madagascar. We made sure that all the tardigrades were healthy adults. In total, we studied 2,450 tardigrades!

Our research included five **populations** of tardigrades from four different species. We divided the tardigrades into seven **experimental groups**. Each group included 70 specimens from each population. We put the tardigrades into **petri dishes**. Then we placed the dishes in a special box called an **environmental chamber** and let the dishes dry inside for three days.

We let each experimental group stay dry for a different amount of time, ranging from 0 to 240 days. Next we rehydrated the tardigrades by adding a small amount of water to the petri dishes. We then used a microscope to examine the tardigrades until we saw them move. We wrote down how long it took for them to start moving. We also counted how many tardigrades didn't move after 24 hours of being in water.

Results

The longer each tardigrade was in its tun stage, the longer it took for us to see the first movement after adding water. When the tardigrades were only in their tun stage for a short time, they came back to activity in 3 to 13 minutes. After 240 days without water, the first sign of movement took longer. The differences between species were larger, too. The first movement for *Macrobiotus pseudohufelandi* happened after 33 minutes on average, while the urban population of *Echiniscus testudo* took 96 minutes.

The groups that spent the longest time without water had the smallest number of tardigrades survive (Figure 1). For some species, we saw hardly any difference between the number of tardigrades that survived for a few days and the number that survived after 120 days. We saw larger differences among species after 240 days. For that group, only 1% of the *Pseudhexapodibius degenerans* started moving again within the 24-hour observation period, compared to 43% of *Paramacobiotus experimentalis*.

If someone told you how many tardigrades in a group survived, could you tell them how long they had been in their tun stage? Why or why not?

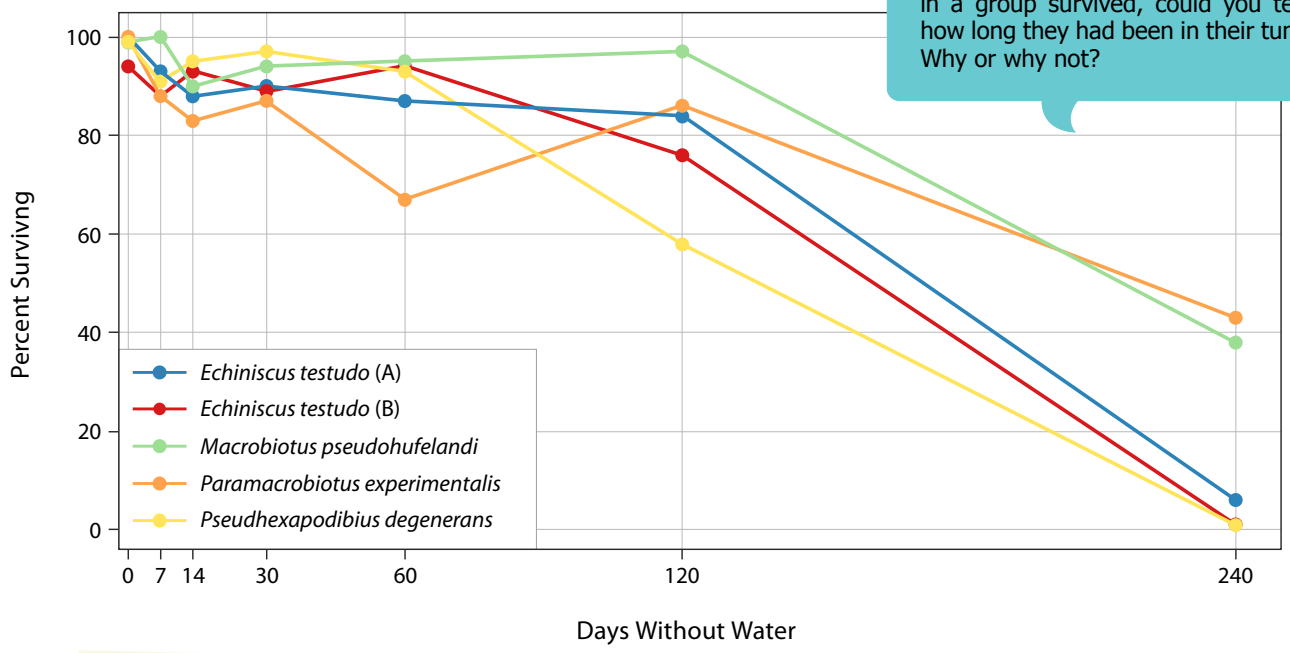


Figure 1: Percent of each tardigrade population that survived for each experimental group. The vertical lines mark the number of days the group spent without water in the tun stage. For the species *E. testudo*, we looked at populations from two places. Group A: specimens collected in a national park and Group B: collected in a city.

Discussion

Our study showed some interesting similarities and differences between tardigrade species. All the populations we studied had more success returning to activity after short dry periods than after long dry periods. Most tardigrade species in our study only needed a few minutes to recover – even after a few months of dry conditions! Responding quickly to water helps tardigrades survive. It can be hard to know how long water will be available. By acting quickly, tardigrades can make sure to find something to eat before the water dries up again.

We were surprised to see some differences from early studies. In our study, *E. testudo* had a low survival rate compared to the other species. But earlier studies showed *E. testudo* reviving after being in their tun stage for many years. We think that it might be due to differences in how quickly the tardigrades were dried in our experiment compared to earlier experiments. In the natural environment, the drying out process is probably not as harsh as it was in the laboratory.

Conclusion

Animal species have to adapt to survive in their environment. When the environment changes, animals have a harder time surviving. People change the environment in many ways. One way we can help animals survive is by helping to restore habitats. If your family has access to a garden, you can choose native species to plant. You can help clean up litter at a local nature area. You can also help limit habitat destruction by being careful about how much water and electricity you use.

Glossary of Key Terms

Environmental chamber - a box used in biology labs that lets scientists control temperature, humidity and other environmental conditions.

Petri dish - a shallow, round, clear plastic dish scientists use to cultivate microorganisms, microscopic animals, algae, etc.

Population - a group of organisms of the same species that live in the same area.

Rehydrate - to absorb water after having insufficient water, or to add water to something dried out to bring it back to its former state.

Species - a group of organisms of the same kind that reproduce and produce fertile offspring.

Specimen - an individual organism considered typical of the whole species

Tun - the hard, round, and dry form of a tardigrade after it curls up and dehydrates itself.

Tardigrade - a small eight-legged animal (invertebrate) that lives in water sediments, mosses, lichens and soil. The smallest tardigrades are less than 1/10 of a millimeter and the largest are 1.5 millimeters.

Terrestrial - living on the land. Most terrestrial species of tardigrade can form a tun, while most freshwater and marine species cannot.

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Check your understanding

1 Why do tardigrades form tuns?

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2 Why did we include more than one species of tardigrade in our research?

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3 We found tardigrades in a park, in a city, and even in moss on a cement wall. Think of your neighborhood. Where do you think you would find tardigrades, and why?

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4 Tardigrades aren't the only animals who can survive tough times. Can you think of another animal who is able to live in a harsh environment? What do they do to survive?

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