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Bears in space

How do water bears survive dehydration, freezing, boiling and radiation? It's in their genes, as **Liz Sheffield** explains

Water bears are a huge, very successful, group of tiny animals. All live in water or damp places. They have been found everywhere from the tops of mountains to the deep sea, from Antarctica to tropical rainforests. Some can survive in the vacuum of outer space, temperatures ranging from near absolute zero (-273°C) to boiling, pressures six times greater than the deepest ocean, years of dehydration, and radiation lethal to pretty much every other animal on Earth. They survive some of these extremes through their ability to enter a state of suspended animation when dried out — their metabolism simply shuts down. This is vital to those that live in surroundings

that can dry up for decades, such as among mosses and lichens. Rehydrate them and they quickly resume their former charismatic movement and behaviours. See 1.20 to 1.30 in the following link: [youtube.com/watch?v=XOxXHJGKsYI](https://www.youtube.com/watch?v=XOxXHJGKsYI). This real time sequence will explain the scientific name of water bears, which is tardigrades (tardigrada = 'slow stepper').

Water bears were the first animals known to survive without protection in space. In September 2007, dehydrated water bears were taken into low Earth orbit. For 10 days, they were exposed to the vacuum of outer space. After being rehydrated back on Earth, more than 68% revived within 30 minutes, a figure that was not significantly different from controls which had not been exposed (see Figure 1). Eggs exposed to space vacuum were similarly unaffected. Earlier this year water bears were successfully revived after being frozen for over 30 years. But until recently we did not know if such

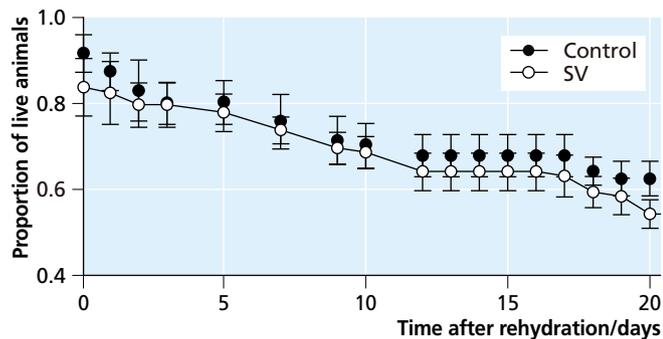


Figure 1 Survival of tardigrades which had been dehydrated and then either kept under usual laboratory condition (controls) or exposed to the vacuum of space (SV)

phenomenal abilities reflected efficient mechanisms that mend damage caused by harsh environments, or mechanisms that prevent the damage in the first place. Research published last week provided strong evidence for the latter, which could have exciting implications for humans both on Earth and in space.

DNA protection

A group of Japanese scientists have now sequenced the genome of some particularly hardy water bears. They found several DNA sequences that had never been seen before — they are unique to tardigrades. They were able to show that these sequences of bases in water bear DNA code for proteins that protect DNA from stress during harsh treatment. Radiation usually causes damage to cells by breaking the strands of DNA. If only a single strand is broken, most cells can repair the damage, given time, as there are mechanisms that can read from the opposite strand to fill in the gap. But if both strands of DNA are broken, it usually spells the end for the cell in which this has happened. But radiation has little effect on the DNA of water bears. Their cells can survive huge doses of radiation, undamaged, thanks to the protective proteins.

The scientists took their research a step further. They generated a laboratory line of human cells with tardigrade genes that code for the unique protein. In tests using X-ray radiation, the human cells with the protein showed about half as much damage as those without the protein. If we could harness such abilities

for whole humans, we could perhaps find ways to combat the effects of some of the environmental hazards we face here on Earth (see the upcoming November issue of *BIOLOGICAL SCIENCES REVIEW*, Vol. 29, No. 2, which includes an article explaining what causes skin cancer, for example). And maybe the (currently science fiction) possibility of transporting astronauts to other planets in a state of suspended animation could become science fact.

Activity

Go to the scientific paper here: <http://tinyurl.com/hw2tqc5> to find out what happened to tardigrades exposed to both space vacuum and solar radiation. Design an experiment that would test the ability of tardigrades to withstand other environmental extremes.

Weblinks

Read 'Survival secret of "Earth's hardest animal" revealed': <http://tinyurl.com/jmosax4>

'Meet the water bear, the most resilient creature on Earth': <http://tinyurl.com/hp65jpk> (includes film of rehydration).

For more about the phenomenal abilities of water bears see: <http://tinyurl.com/hxbx37l> (includes a movie of a live animal, inside which you can see the remains of the plant material it has eaten).

For more about water bears in space: www.bbc.co.uk/nature/12855775

Listen to a 5 live science podcast on water bears and other organisms exposed to environmental extremes: www.bbc.co.uk/programmes/p02w3603

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