

# TARDIGRADES

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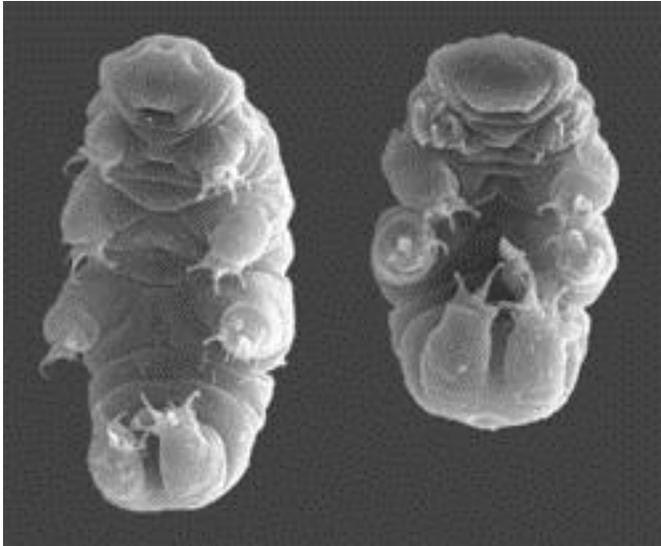
NASA Endeavor Science Teacher Certificate Project

I have a high interest in extremophiles. They are very interesting to me because of their ability to exist in environments that would kill us. I wanted to take a closer look at Tardigrades. They have the ability to survive extreme environments but these environments can also lead to their death. They have been named water bears because of the way they move, but oddly I think that they look like a microscopic sort of polar bear. Tardigrades are microscopic, water dwelling, segmented animals with eight legs. There are more than 1000 species of Tardigrades and they occur over the entire planet. The largest adults may reach a size of 1.5 millimeters and the smallest would be about 0.1mm. They can survive temperatures as low as -459 degrees F and as high as 304 degrees F. They can survive more than 1000 times more radiation than other animals and can live for almost 10 years without water. Tardigrades have returned alive from studies in which they were exposed to the vacuum of outer space in low earth orbit. Tardigrades are one of a few species that can reversibly suspend their metabolism and go into a state of cryptobiosis. An organism in a cryptobiotic state can essentially live indefinitely until environmental conditions are better. Tardigrades are oviparous. They can live from three to thirty months. Most Tardigrades are plant or bacteria eaters but there are a few that are predatory. Not only can a Tardigrade survive low pressures of a vacuum but can survive pressures that are more than 1,200 times atmospheric pressure. They can withstand lethal doses of radiation and environmental toxins. Tardigrades are found most often in moist environments, but can stay active wherever they can retain at least a little bit of moisture. Tardigrades are eutelic. Adult Tardigrades of the same species have the same number of cells. They do not have respiratory organs. Gas exchange

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can occur across the body. The brain of a tardigrade has multiple lobes and is attached to a large ganglion. They have numerous sensory bristles on their head and body.



As you can see by the above pictures, they have a barrel shaped body. They have four pairs of short legs. The body has four segments, four pairs of legs without joints and feet with four to eight claws each. Their cuticles contain chitin and are periodically molted.



Astrobiologists are always investigating the possibility of life somewhere else in our universe. However, they do not have any alien organisms to study. Scientists have subjected tardigrades to a lot of investigational tests. They have determined that their survivability shows

that animals can survive extreme conditions, and may indicate how humans could adapt to the rigors of space. Scientists now believe that if a simple animal like tardigrades can survive extremes that there is credence to the theory of panspermia. Panspermia is the theory that organisms could move from world to world after travelling through space. Some of the following tests were conducted on the Tardigrades by scientists: Some of them were heated up to high temperatures and others were frozen. Some were given massive amounts of radiation and others were covered in a dissolving chemical. The results of this testing were that if the water bear was in a suspended state, it survived everything. If it was more active, some died and some survived. Knowing how the water bears survive could be the way to enable human exploration of space. Water bears ability to live in extreme environments is related to their adaptive strategies. These include anhydrobiosis and cryobiosis, characterized by a complete metabolic standstill. Results on Tardigrades open a window on the future perspective in astrobiology and in their applications. The discovery and identification of the metabolites synthesized by tradigrades to perform protection against damages to cellular components and DNA due to desiccation, radiation, microgravity and oxidation stresses will be used to define countermeasures to protect organisms, including humans, not naturally able to withstand extreme stresses under space conditions, for the future exploration of our solar system.

In looking at the NASA Astrobiology Roadmap, studying tardigrades fits right in. Understanding habitable environments is an important factor for future space exploration. Not

only is it necessary for us to understand habitable environments but what kinds of environments can we withstand. Goal number two really relates to the study of tardigrades. Determining past and present environments for tardigrades can help us to determine habitable environments elsewhere in our solar system. Although I feel like the entire roadmap can be associated with the study of tardigrades, understanding how life emerges is the most important. Learning physical and chemical principles related to how a tardigrade survives extreme environments can help us to understand origins of life and how life survives particular factors. There is also the theory that tardigrades could have come from asteroids or travel on asteroids to other places in our solar system. We can use some of this speculation to apply to the theory of evolution. Specifically we can use tardigrades to study metabolic diversity to give us methods that we can apply to humans for space travel. Our continued study of microbial life is the key to us unlocking long distance space travel and survival on other planets. These animals are amazing.

## References

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