Tardigrades: Water bears in space

By Emma Brennand

In 2007, a little known creature called a tardigrade became the first animal to survive **exposure** to space. It prevailed over sub-zero temperatures, unrelenting solar winds, and an oxygen-**deprived** space vacuum. On Monday, this microscopic cosmonaut has once again hitched a ride into space on the Nasa shuttle Endeavour. Its mission: to help scientists understand more about how this so-called "hardiest animal on Earth" can survive for short periods off it. Tardigrades join other microscopic organisms selected to be part of a project into extreme **survival**. Project Biokis is sponsored by the Italian Space Agency and will investigate the **impact** of short-**duration** spaceflight on a number of microscopic **organisms**. The project will use seven experiments to investigate how spaceflight **affects** organisms on a molecular level. The team will be using molecular biology to **evaluate** any changes in the organisms' genetic information, as well as investigating how cells **physically** adapt to cope with extreme dehydration, caused by the space vacuum, and damage caused by cosmic radiation. One of these experiments, the Tardkiss experiment, will **expose** colonies of tardigrade to different levels of ionising radiation, determined using an instrument called a dosimeter, at different points during the spaceflight mission. The results from Tardkiss will enable researchers to **determine** how radiation **dosage** effects the way cells work. Tardigrades are of particular interest following the 2007 European Space Agency (Esa) Foton-M3 mission, during which their ability to survive space **conditions** was discovered.

Stocky bodies

Tardigrades are microscopic animals more commonly known by their non-scientific name, the water bear. Their stocky bodies and gait have all the hallmarks of a bear. But this isn't a typical bear **encounter**. These bears are less than 1mm long and are found in the sea, in fresh water and on land. Genetic studies have shown that they **originally** lived in freshwater environments before **adapting** to colonise the land, **seeking** out moist habitats such as soil, mosses, leaf litter and lichen. Tardigrades earned the "hardiest animal on earth" tag having evolved **elaborate** dormancy strategies that allow them to shut down all but the essential biological **processes** when conditions are not **conducive** to supporting life. Professor Roberto Guidetti from the University of Modena and Reggio Emilia believes their ability to **suspend** life and withstand freezing and desiccation may explain why they can survive in space. "Tardigrades can be found all over the world from the Arctic to the Antarctic, from high mountains to deserts, in **urban** areas and backyard gardens," he explained. "In terrestrial environments, they always require at least a film of water surrounding their bodies to **perform** activities necessary for life." But if these conditions change, tardigrades are capable of entering an **extreme** form of resting called cryptobiosis. In this state, they are capable of withstanding freezing, a process called cryobiosis, and desiccation, a process called anhydrobiosis.

Arid state

"This **capability** [to withstand desiccation] **involves** a **complex** array of factors working at molecular, physiological and structural levels," Professor Guidetti told BBC News. "The physiology and biochemistry of anhydrobiosis is bound to a complex system that involves many different molecular **components** working together as bioprotectants." Sugars and heat stress proteins, which are expressed when cells become stressed, act as "molecular chaperones" protecting important molecules within the cell.

The disaccharide sugar called trehalose plays a role in the protection of cells and biomolecules from dehydration by **replacing** water that is normally bonded to hydrogen. During dehydration, loss of water increases the ionic concentration leading to the **formation** of reactive oxygen species (ROS) which damage important biomolecules including DNA. To counter this attack, organisms produce antioxidants that can mop up ROS **minimising** cell damage. The regulation of antioxidant metabolism represents a **crucial** strategy to avoid damage during dehydration. "Tardigrades can **persist** for months, or even for years, in the anhydrobiotic state. When in the desiccated state, tardigrades show a high **resistance** to physical and chemical extremes," explains Professor Guidetti. "For example, very low and high temperatures, exposure to high pressure or vacuum, as well as contact with organic solvents and ionising radiation." Exposure to the conditions found in space **induces** rapid changes in living systems.

The TARDKISS study may help researchers such as Professor Guidetti develop **techniques** to protect other organisms, including humans, from the extreme stresses found under space conditions. It may also help with the future **long-term** goal of **extending** the exploration of the Solar System.

Adapted from BBC Nature