Tardigrades traveled to space and survived

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Abstract. This paper is a short news article on the most resilient animals known on Earth: "water bears" or "moss piglets". Cryobiologists from Tokyo's National Institute of Polar Research recently cemented the resilient reputation of these tiny creatures when they revived some "moss piglets" that had been frosted for thirty years. Not only did they survive being frosted for three decades, but one of them even laid eggs, fourteen of which actually hatched. In another research the team coordinated by K. I. Jönsson from Kristianstad University launched tardigrades into space on the FOTON-M3 spacecraft on low-Earth orbit in 2007. Exposed to open space conditions, most of the water bears survived exposure to vacuum and cosmic radiation, with some even surviving deadly levels of UV rays.
Key Words: tardigrades, outer space, water bears, moss piglets, resistant, resilient, astrobiology.

Tardigrades, or "water bears", are tiny invertebrates with eight legs which require water in their environment for optimal development. Tardigrades have barrel-shaped bodies with four pairs of stubby legs. Most tardigrades range from 0.3 to 0.5 mm in length, although the largest species may reach 1.2 mm. The first tardigrades were discovered in the 1700's.

The German researchers described them as looking like small bears because of the strange way they move. Tardigrades were first described by J. August Ephraim Goeze in 1773. The name of the group, Tardigrada, can be translated in English as "slow walker" (tardi= slow, grade= walker) and was given by the well known scientist Lazzaro Spallanzani in 1777. This group of polyextremophiles is also commonly known as "moss piglets" (Gagyi-Palffy & Stoian 2011).

Tardigrades form the phylum Tardigrada, part of the superphylum Ecdysozoa. It is an ancient group, with fossils dating from 530 million years ago, in the Cambrian period (Middleton 2016). About 1,150 species of tardigrades have been described (Zhang 2011), and can be found throughout the world, from the Himalayas (above 6,000 meters), to the deep sea (below 4,000 meters) and from the polar regions to the equator (Hogan 2010).

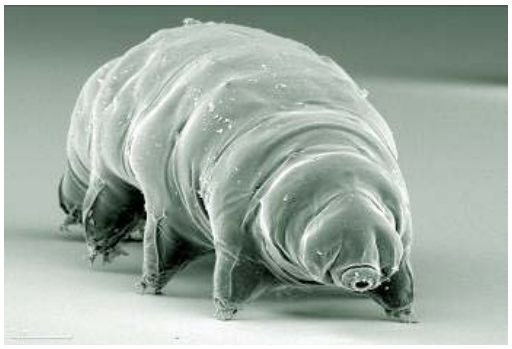

Figure 1. How tardigrades look like (teamtardigrades.blogspot.ro/p/videos.html).

Cryobiologists from Tokyo's National Institute of Polar Research recently cemented the resilient reputation of these obscure creatures when they revived some water bears that had been frosted for thirty years. Not only did they survive being frosted for three decades, but one of them even laid eggs, fourteen of which actually hatched. There is no other animal group known to survive to such extreme environmental conditions. Apparently, water bears survive by entering a state of hibernation called cryptobiosis, where its metabolism slows down to less than 0.01% of its normal rate. It curls itself up into what is called a "tun" state, and it is believed that it replaces the water in their cells with either natural antifreeze (glycerol) or crystalline saccharides (state called anhydrobiosis), in order to prevent cellular damage due to water freezing in their cells (Mok 2016).

To test the true resilience of these strange animals, Swedish researcher K. I. Jönsson from Kristianstad University launched tardigrades into space on the FOTON-M3 spacecraft on low-Earth orbit in 2007. Exposed to open space conditions, most of the water bears survived exposure to vacuum and cosmic radiation, with some even surviving lethal doses of UV radiation (McDermott 2014; Jönsson et al 2005, 2008).

The high adaptability of tardigrades to various extreme environmental conditions was subject for many investigations and explaned by scientists through several hypotheses. A recently published analysis of the genome of the tardigrade *Hypsibius dujardini* by Boothby et al. (cited by Koutsovoulos et al 2016) concluded that horizontal acquisition of genes from bacterial and other sources might be key to cryptobiosis in tardigrades. Koutsovoulos et al (2016) independently sequenced the genome of *H. dujardini* and detected a low level of horizontal gene transfer. New research trying to solve the problem are in progress.

Although the Tardigrade research cannot be easily extrapolated to animals *lato sensu*, "water bears" are increasingly considered highly valuable model organisms for understanding the potential of living organisms to adapt to extreme conditions of outer space (Jönsson 2007; Jönsson & Rebecchi 2002), which a real challenge in the field of astrobiology. Tardigrades are the most important candidates to become the first extraterrestrial colonists.

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