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Commentry

THE PHYLUM TARDIGRADA AND THE PANSPERMIA THEORY – CAN THE TARDIGRADES BE LIVE CAPSULES CARRYING A VARIETY OF DNA SEQUENCES INSIDE AS FOOD PARTICLES, ENDOSYMBIOTIC ORGANISMS AND PARASITES?

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Panspermia is a hypothesis proposing that microscopic life forms that can survive the effects of space, such as extremophiles, become trapped in debris that is ejected into space after collisions between planets and small Solar System bodies that harbor life. If met with ideal conditions on a new planet's surfaces, the organisms become active and the process of evolution begins. Panspermia is not meant to address how life began, just the method that may cause its distribution in the Universe (Hoyle & Wickramasinghe, 1981; Wickramasinghe, *et al.,* 2010).

While this idea may seem straight out of a science fiction novel, some evidence suggests that an extraterrestrial origin of life may not be such a far out idea (Joshi, 2008).

Bacteria: According Joshi (2008) the best candidates to act as "seeds of life" are bacterial spores, which allow bacteria to remain in a dormant state in the absence of nutrients. Bacteria constitute about one-third of Earth's biomass and are characterized by their ability to survive under extreme conditions.

Scientists at the German Aerospace Centre in Cologne designed experiments using the Russian FOTON satellite. They mixed bacterial spores with particles of clay, red sandstone, Martian meteorite or simulated Martian soil to make small lumps a centimeter across. The lumps were then exposed via the satellite to outer space. After two weeks of exposure, researchers found that nearly all of the bacterial spores mixed with red sandstone were able to survive. Another study showed that bacterial spores could survive the extreme conditions of outer space for six years if they were protected from extraterrestrial solar UV radiation. This would be possible if the spores traveled within comets or meteorites (Joshi, 2008).

There are two main problems during transportation of bacteria in the space–the UV radiation and the extreme temperatures in a meteorite entering an atmosphere of a planet.

But some bacteria grow at temperatures as high as 113°C. At the other end, microbes can thrive at temperatures as low as -18°C; many can be preserved in liquid nitrogen at -196°C. They can also tolerate high doses of ionizing and UV radiation, extreme pressure, etc. (Joshi, 2008).

Viruses: In 2013, Dale Warren Griffin, a microbiologist working at the United States Geological Survey noted that viruses are the most numerous entities on Earth. Griffin speculates that viruses evolved in comets and on other planets and moons may be pathogenic to humans, so he proposed to also look for viruses on moons and planets of the Solar System (Griffin, 2013).

Tardigrades: All species of tardigrades are aquatic as they require a film of water to be active but many species are able to enter a latent state when environmental conditions become unfavorable. Most of species are not considered extremophilic because they are not adapted to exploit such conditions (Northcote-Smith, 2012). By entering this latent state called cryptobiosis they are able just to withstand the extreme conditions in temperature, desiccation, low oxygen and high salinity variations. Cryptobiosis is mostly seen in terrestrial tardigrades although it is also seen in a few marine species. It can be divided into distinct types that relate to the environmental conditions for example anhydrobiosis, anoxybiosis or osmobiosis (Northcote-Smith, 2012). During periods of latency, reproduction, metabolism and growth are suspended or slowed (Bertolani, *et al.,* 2004). Whilst in a latent state tardigrades have been subjected to a vacuum and ionizing radiation they survived. In 2007 two tardigrade species were sent into space and survived the exposure to low temperatures, cosmic and solar radiation and microgravity. In laboratory experiments, some species had a survival rate of 96-100 percent when exposed to a vacuum and survived instant freezing to -195.8°C (Persson, *et al.,* 2009).

Theoretic situation involving the tardigrades as "live life capsules" travelling through space

It can be speculated that tardigrade cysts can be brought somehow in space and carry a variety of DNA sequences inside as food particles, endosymbiotic organisms and parasites. And most important: they possibly can carry

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photosynthetic organisms as algae cells in their intestinal tract, and release them in a new planet.

Investigations for checking the theory needed

Does the tardigrades have endosymbiotic microfauna and parasites, and which are they?:

There are few studies registering some parasites but no any endosymbiotic fauna. *Pyxidium tardigradum* is a protozoan that has been reported on a few occasions as an epizoan symphoriont living on eutardigrades (Vicente, *et al.,* 2008).

Could some food particles as algae cells or tissue survive through the digestive tract of a tardigrade? Most of the tardigrades are phytophagous or bacteriophagous feeding on algae or bacterail colonies (Morgan, 1977).

The ability to survive digestion by grazers seems to be a general adaptation of benthic algal propagules. The phenomenon is frequent for the algal species found in the guts of common intertidal and shallow subtidal sea urchins (Santelices, *et al.,* 1983), and intertidal grazing molluscs (Santelices & Correa, 1985). The research of Santelices & Ugarte (1987) indicates that it is also evident among species grazed by amphipods and spores ingested by filter feeders.

How is the longevity of the tardigrades and their endo-fauna and parasites?

Two studies involving the isolation of bacterial spores, either from the abdomen of extinct bees preserved in amber or from a brine inclusion in an old salt crystal from the Permian Salado formation, suggest that bacterial spores can remain viable for up to 250 million years (Joshi, 2008).

Which is the speed of the tardigrade cysts though the space?

For example, microbial payloads launched by solar sails at speeds up to 0.0001 c (30,000 m/s) would reach targets at 10 to 100 light-years in 0.1 million to 1 million years. Fleets of microbial capsules can be aimed at clusters of new stars in star-forming clouds, where they may land on planets or captured by asteroids and comets and later delivered to planets. Payloads may contain extremophiles for diverse environments and cyanobacteria similar to early microorganisms. Hardy multicellular organisms (rotifer cysts) may be included to induce higher evolution (Mautner, 2005).

And the last but important questions are: Does the cuticule itself protect the tardigrade as a shield during extreme conditions, and are the other organisms in the tardigrade body protected and survive such extreme conditions?.

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