CAN MICROORGANISMS WITHSTAND THE MULTISTEP TRIAL OF INTERPLANETARY TRANSFER? CONSIDERATIONS AND EXPERIMENTAL APPROACHES

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From the concept of evolution, "life" can be considered as a natural consequence of certain characteristics of matter in the course of cosmic evolution provided,the right conditions of the environment, the time, and the statistics are given. So far, the Earth is the only planet in our solar system known to support abundant life today. However, meteorites of lunar and probably of Martian origin,recently detected in the Antarctica indicate that matter can be exchanged by natural processes between bodies of our solar system. Planetary missions provide additional means of transportation. The Earth no longer can be considered as an isolated system in the universe.

The question arises, whether resistant microbial systems, such as bacterial spores, are capable of coping with the multistep trial of an interplanetary transfer. Under the aspects of current knowledge of comparative planetology, solar system chemistry and physics, abiotic organic chemistry, fossil findings, and from comparative studies of present-day organisms, respectively, a stepwise analysis has been attempted, as follows:

Step 1: Prebiotic evolution and origin of life

Organic matter has been detected in the dense clouds of interstellar medium, in comets, in meteorites and in the atmospheres of the outer planets. Their role in the evolution chain towards origin of life still is a fundamental question. From comparative studies of the planets and moons of our solar system it is concluded that for life to emerge narrow limitations might be set. Therefore, in the hypothetical concept of the chain of events of interplanetary transfer of life, the Earth has been considered as potential starting point.

Step 2: Biological evolution

On Earth, life has developed strategies to adapt to changes and fluctuations of the environment. Mutation and natural selection are powerful forces to model communities to fit even extreme environments.

Step 3: Escape

Dynamic forces like gravitation, meteorological drifts, thermal movements, magnetic and electric fields, and solar radiation pressure, are considered insufficient to accelerate small particles of the size of a microorganism or small rock fragments to escape velocities. Potential candidates are volcanic eruptions, fly-by meteorites or meteorite impacts. It has been found that spores survive a simulated meteorite impact.

Step 4: Interim state in space

In space, microorganisms have to cope with an interplay of various adverse environmental factors, like high vacuum, a complex radiation and extreme temperatures, which represent a definite barrier for active biological processes. The limits for life in an anabiotic state to survive such unfavorable conditions are being determined by in situ experiments and in laboratory facilities simulating free space parameters.

Step 5: Entry

Captured by the gravitational force of a planet or moon, space travelling microorganisms have to survive entry and landing.

Step 6: Infection

The physical and chemical boundary conditions for life are indicated by the environmental extremes life on Earth has adapted to. Extreme ecological niches are still being discovered pushing the conceptions of the limits of life to further extremes. From current knowledge on the properties of the planets and satellites of our solar system, only few condidates remain - if any at all - that potentially favorize life to grow and develop.

Step 7: Biological evolution

Further adaptation and coupling of life to its new environment may follow the Darwinian concept of evolution through random heredity fluctuations and natural selection, eventually allowing a new cycle in the chain of events.