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Life on Icy Worlds

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Abstract

Bacteria, algae and also metazoans may live at temperatures below 0°C and survive ice formation in body compartments. Astrobiology studies, as models of possible life on Mars or Jovian and Saturnian moons, ecology, evolutionary biology, industry, will benefit from a greater knowledge of these life forms. In order to identify and characterize new species we suggest to use, at low cost, very common device used for biomedical purposes in every country of the world.

1. Introduction

On Earth, psychrophilic microorganisms represent an amount of biomass much higher than that living in temperature conditions that humans consider normal. Not only bacteria, fungi and algae, but also metazoans, live at temperatures below 0°C and survive ice formation in all body compartments.

The Himalayan insect *Diamesa* Meigen sp. is cold-tolerant down to -18°C (while at a few degrees over 0°C it's paralysed within about 20s), [1] . The little insect lives on micro-plants such as aquatic blue-green algae , which live together with different species of bacteria on the glacial ice, in melt-water drainage channels and in cavities in the snow and ice.

The Antarctic nematode *Panagrolaimus davidi* survives complete intracellular freezing without any problem. When the increase in temperature melts the ice, the little nematode is again able to grow and reproduce [2].

In effect, on Earth life exists in all niches where water exists in liquid form for at least a portion of the year. We may recall that, with a high saline concentration, water may remain liquid down to -56°C, as demonstrated in the Antarctic Dry Valleys, a place where many prokaryotic and eukaryotic microorganisms, bacteria and fungi, are present at temperatures between -30° and -35°C [3].

Psychrophilic microorganisms are also present below the soil, where a deep cold biosphere of microbial life exists. They live detached from the solar energy, having evolved the ability to consume the abundant energy contained in hydrogen, a gas originated by natural serpentinization [4].

2. Icy worlds

Huge number of icy worlds are present in the Solar System and in the Universe.

NASA's 2001 Mars Odyssey and Phoenix spacecrafts have demonstrated the presence of ice under the surface in Mars. Ice that can be melted deeply below the Martian regolith.

Galileo spacecraft has given indications of the possibility that three of Jupiter's four large moons, Europa, Ganymede and Callisto have a large quantity of liquid water under an ice cover.

Titan, the largest satellite of Saturn, has such ocean also, together a dense nitrogen atmosphere, a complex atmospheric photochemistry and possible cryogenic volcanism. Liquid water, organic chemistry and energy, all the conditions needed for the origin of a biosphere.

3. Conclusion

The potential of psychrophilic microorganisms is very high. They are relevant to not only to astrobiology studies, but also to biology studies, e.g. in ecology, and they have an enormous economic potential (detergent additives, food industry,..) [5].

Very little is known about this microbial life. We suggest, in order to identify new species and better

characterize known species, to perform a molecular phylogenetic analysis, as a first step for deeper genomic studies. It may be performed at low cost, by means of very common devices at Departments of Molecular Medicine and Pathological Institute, using selective cloning of 16 S rRNA genes by PCR, electrophoresis to isolate genes, subcloning, propagation and sequence analysis.

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