'Goldilocks Zone' may go colder than previously thought

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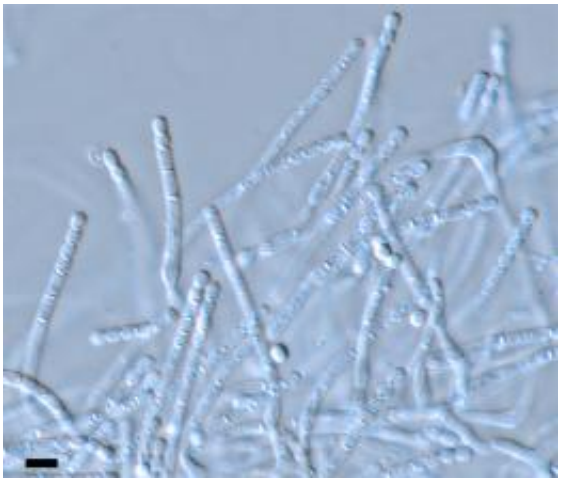

Wallemia sebi fungi making spores. Image credit: Mycology blog/Cornell University.

(PhysOrg.com) -- The survival of life on Earth is possible only within a relatively narrow temperature range known as the "Goldilocks Zone," which ranges from around 0 to 100°C. In many ecosystems life is limited by cold temperatures rather than hot because of the reliance on liquid water for survival. Now new research has shown that in the presence of a certain type of solution, large populations of microbes can survive at the incredibly low temperature of -80°C, which is far below the accepted Goldilocks Zone. Since similar solutions exist on cold planets and moons such as Mars and Europa, this increases the likelihood that life may be found there.

Microbes called “extremophiles” are known to thrive in extreme conditions such as near hot water vents on the seabed, where the temperature can rise to 120°C, but until now scientists thought cold temperatures were more limiting because at low temperatures cell membranes become increasingly rigid.

A team of microbiologists led by Dr John Hallsworth, Lecturer in Environmental Microbiology at Queen’s University Belfast in Ireland, thought a special type of solute might prevent the water in cells from freezing, and could also reverse the rigidity of cold membranes. The solutes are called *chaotropic* after their property of disordering cellular macromolecules.

The research team first confirmed that glycerol, a solute often used to preserve cells at low temperatures in the laboratory, becomes chaotropic when present in high concentrations. They then grew extremophiles on a medium supplemented with either chaotropic or *kosmotropic* solutes (which stabilize macromolecules rather than destabilize them).

Starting with four types of xerophilic fungi (aerobic extremophiles that thrive in environments with little water), the scientists found that at 30°C the fungi grew well in the presence of both chaotropic and kosmotropic solutes, but at 1.7°C the fungi on media supplemented with chaotropes grew better than those on kosmotropes, with some of the latter showing zero growth.

Hallsworth and his team then harvested spores from the xerophilic fungi and exposed them to temperatures as low as -80°C. Of the fungi from media supplemented with kosmotrope solutes, 60% died in the harsh conditions, while only 5% of the chaotrope group died. Hallsworth said the findings mean the so-called Goldilocks Zone may be much more extensive than previously envisaged because many cold planets and moons contain all the necessary ingredients for making chaotropic

solutes.

The findings are published in the *Proceedings of the National Academy of Sciences* (*PNAS*).

More information: Solutes determine the temperature windows for microbial survival and growth, *PNAS,* Published online before print April 19, 2010, doi:10.1073/pnas.1000557107