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Crazy Creatures

“If, at first, the idea is not absurd, there is no hope for it.”

Albert Einstein

I have a natural tendency to favor slightly eccentric stories from science over the ones where a relevant question has been investigated and answered in a straightforward, almost predictable way. The craziness that interests me can arise from the random walks that evolution takes across time, or it may be found in the mind of the scientists who take on challenges so daunting that no sane person would bother with them. Or it could be both or somewhere in between. There is a whole spectrum of scientific craziness and crazy science.

But then again, some of the areas covered here started out as a blip of craziness in the margins of modern science but have since evolved to become mainstream research fields, possibly even with commercial potential. You never know what might happen, that's part of what makes eccentric topics so rewarding.

Squeezy Little Bears

The crazy creatures at the extreme ends of life on Earth have fascinated me for many years. As both my PhD thesis and one of my books dealt with life under extreme conditions, I'm no longer that easily impressed by tales of life in boiling water, sizzling deserts, or permanent ice. However, the following story (which unfortunately came up too late for the original edition of *Life on the Edge*) beats them all. If anybody wants to send animals to Mars, I suggest they try the "little bears" or tardigrades. The following text is adapted from a postscript included in the paperback edition of *Life on the Edge*.

Tardigrades are microscopically small animals reminiscent of down-sized bears, at most half a millimeter long. They live in water droplets suspended in moss and lichens and can be found on all continents. Now if you're such a tiny little bear exposed to the elements, you need some very special survival skills.

Tardigrades have at least two major emergency routines. If their habitat is flooded and there is a risk of oxygen shortage, they inflate to a balloon-like passive state that can float around on the water for days. If, however, the threat comes from a lack of water, they shrink to form the so-called tun state (because it looks like a barrel), which could be described as the animal equivalent of a spore. Researchers have managed to resuscitate tardigrades by rehydrating moss samples after up to 100 years of storage on museum shelves, which proves the quite remarkable long-term stability of this state.

It was this tun state that Kunihiro Seki and Masato Toyoshima (Kanagawa University, Japan) used in their studies of resistance against high pressures. As the presence of water would have convert-



Figure 1 Electron micrograph of a tardigrade. Tardigrades or water bears are the most resistant animals known.

ed the animals back to the active state, the researchers suspended the tuns in a perfluorocarbon solvent before they applied pressures of up to 6000 atmospheres (more than five times the pressure found in the deepest trenches of the oceans). While active tardigrade populations in water are killed off by 2000 atmospheres (already an implausibly high threshold for an animal), the tun state allowed 95% of the individuals of one species and 80% of another to survive the maximum pressure of 6000 atmospheres.

This observation is unprecedented for any animal species. Only some bacterial spores and lichens could hope to compete with that. Still, tardigrade experts may have been only mildly surprised, as they knew already that the tuns can be revived after freezing in liquid helium – they are frost resistant down to 0.5 Kelvin. Detailed mechanistic explanations for these record-breaking achievements are not yet available. One thing that is known for sure is that the tuns contain high concentrations of the sugar trehalose, which is known to improve the stress resistance of baker's yeast.

The phenomenal shelf life of the tuns has aroused the interest of researchers in medical technology. Some are trying to copy the tardigrades' recipe to achieve similar long-term stability for human organs to be used in transplantation.

(2000)

Further Reading

M. Gross, *Life on the Edge*, Plenum, 1991.

What Happened Next

I am pleased to report that researchers actually followed up on my suggestion and sent tardigrades into space. The TARDIS (Tardigrades in Space) experiment was part of the FOTON M-3 mission, that launched on 14 September 2007 and returned safely on the 26th, after 189 orbits. At the time of writing, the tardigrade passengers were awaiting detailed analyses that will surely reveal how well they are suited to withstand space conditions.

<http://tardigradesinspace.blogspot.com/>