Exploiting a hostile world

Life at the Limits: Organisms in Extreme Environments
by David A. Wharton
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Extremely difficult: heat and cold pose challenges to survival, but life seems to have the problem licked.

It is a lovely day in the San Francisco Bay area. But then, I'm a *Homo sapiens* with a rather parochial definition of 'lovely' — roughly 20–27 °C, mostly sunny, atmospheric pressure of 1 bar, 21% O_2 and so on. "Frigid!" cries the thermophile. "I can't take the low pressure," declares the barophile. "Too much oxygen," gasps the anaerobe. Whole biotas exist in the environmental extremes, having already boldly gone where no human could.

Life in extreme environments is, forgive the pun, a very 'hot' subject. The idea that life can live at physical and chemical extremes thought previously to be well beyond the capabilities of life has enormous implications for fields as disparate as biodiversity and biotechnology. And what could be more exciting than the possibility that we Earthlings — from archaeans to anthropoids — are not alone in the vastness of space? The environmental space of life on Earth defines for us the minimum limits for life. From what we now know, it's not the sky that's the limit, but the availability of liquid water.

Life at the Limits is written with a disregard of current dogma. Life in extreme environments is far more than just which Archaea can stand the hottest bath, although the thought of *Pyrolobus fumarii* happily metabolizing at 113 °C is astounding.

The book begins with a philosophical discussion of what is extreme, and comes to the conclusion that there are certain chemical and physical extremes that should make life increasingly difficult. I agree, but differ from Wharton in how oxygen is treated. Certainly an aerobe that finds itself in a low-oxygen environment is stressed (if not dead), but Rocco Mancinelli and I argued in a review (*Nature* **409**, 1092–1101; 2001) that the ability to be an aerobe is a response to an extreme stressor: oxygen, along with its reduced by-products such as the hydroxyl radical and superoxide anion. So even humans can be considered as extremophiles because of their superior ability to thrive in an atmosphere containing as much as 21% oxygen.

The great strength of Wharton's book lies in his expertise in zoology. Most workers on extremophiles focus on microbes, often just on Archaea. But this bias is unjustified, as Wharton clearly demonstrates here. One of my favourite parts is on life in deserts, where desert vertebrates (yes, including the camel), invertebrates and plants are given more attention than the microbes.

But perhaps this bias has gone a bit far for a balanced view of life in extreme environments. In some chapters a brief discussion of microbes appears almost as an afterthought. And I would be stripped of my space-microbiology credentials if I didn't question Wharton's uncritical acceptance of the Apollo 12 myth. In 1969 the Apollo 12 astronauts recovered the Surveyor 3 camera body, which had been on the moon since 1967. The human respiratory bacterium *Streptococcus mitis* was found in the camera body. However, after double-checking with NASA's planetary protection officer, John Rummel, I was able to confirm that this story is almost certainly incorrect — the source of the bacterium was probably a breach in sterile technique during the sampling of the camera. But the discussion of microbes in ice nucleation, and even in snow and ice-cream production, was fascinating. And there are ample alternative sources of information on extremophile microbes.

Would I have purchased this book? Probably not, because I was smug enough to think that I already had an excellent grasp of the field. But that would have been my loss, and I know that my students and I will enjoy consulting this book in the years to come for its coverage, enjoyable style and background material. ■

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