Animal magic

Alan Tunnacliffe, AWG Senior Research Fellow at Pembroke College and the Institute of Biotechnology, is working on one means by which nature is able to cheat death. This is called anhydrobiosis, derived from the Greek for 'life without water', and occurs in organisms able to withstand almost complete desiccation.

Few scientists have opted to study resurrection, possibly because it is commonly believed to be a purely mythological phenomenon. However, some animals and plants are able to enter, and recover from, an apparently lifeless state of suspended animation. They may remain in this state for long periods, perhaps for decades, but can recover to resume their normal lives, seemingly unaffected.

Life without water

The ability to survive extreme dehydration is remarkable for a living organism since it is widely accepted that 'life is water', and usually there is a limit beyond which further loss of water is fatal. Humans are typical in this respect, since water comprises approximately two-thirds of our body weight, and loss of just 15% of this results in severe dehydration, which is life-threatening if not treated rapidly. Anhydrobiotic organisms, in contrast, are able to survive loss of most of their body water, which is reduced to 10% or less of body weight in the dried state. When dry, no signs of life can be detected; metabolism is completely shut down.

Even more surprisingly, once dry, anhydrobiotic creatures can tolerate a range of environmental stresses, including extremes of temperature and pressure: from –270°C to +150°C, and from the vacuum of space to a thousand atmospheres in a pressure chamber. After this mistreatment, they can still be revived by rehydration without ill effect. It is perhaps not surprising that one proposal for how life originated on Earth is that anhydrobiotic organisms were carried through space from another planet.

Rotifers: animal magicians

One type of animal which can perform the anhydrobiosis trick is the rotifer (*see left*), a normally aquatic creature less than a millimetre in size. Rotifers are ubiquitous in freshwater environments, particularly in temporary pools where the ability to survive desiccation offers a selective advantage: Dr Tunnacliffe's group are studying rotifers first collected from the bird bath in his back garden! Rotifers can be grown easily in the laboratory, feeding happily on bacteria or other small organic particles. They also reproduce asexually – no males have ever been found of the species shown – so that large cultures can be derived from single individuals. This results in a 'clone', i.e. a population of genetically identical animals; clones of many millions of rotifers have been produced by Jens Lapinski, the AWG Research Student in Dr Tunnacliffe's laboratory.

The ready availability of large numbers of rotifers allows biochemical and genetic studies to be carried out which should eventually unravel the mystery of anhydrobiosis. Initial work has focussed on simple sugars which are able to protect biological molecules against desiccation damage. For example, many of the plants which undergo anhydrobiosis, the so-called 'resurrection plants', contain large quantities of sucrose – the same sugar used to sweeten tea or coffee. Another related sugar, called trehalose, seems to be involved in protecting some animals and micro-organisms from dehydration stress. Rotifers appear to be different, however, and no evidence for the involvement of such sugars has been found. Presumably, they use some other molecular magic trick to survive dry summer days in Dr Tunnacliffe's bird bath.

ALYS TOMLINSON

Alan Tunnacliffe [left] in discussion with Jens Lapinski

A rotifer of the species *Philodina roseola*

JENS LAPINSKI

Biostable medicines

An understanding of this trick would not only be of scientific interest, but could have important medical applications. For example, many drugs and vaccines are fragile molecules which lose their potency if not kept cool. This limits their effectiveness in many developing countries where refrigeration is not always available. The difficulty in maintaining a 'cold chain' from point of manufacture of a medicine to its point of use has been highlighted by the World Health Organisation as a major hurdle in bringing some treatments, regarded as routine in the developed world, to less developed regions. A technique which allowed medicines to be dried, and which conferred on them the remarkable biostability of anhydrobiosis, could be of enormous benefit.

Anhydrobiosis was first described 300 years ago in 1702 by the famous microscopist Antony van Leeuwenhoek. He added water to sediment from his house roof gutters and observed rotifers, almost certainly of the same species shown in the image (*left*), emerging from the rehydrated dust. It would be particularly fitting if, on the tercentenary of van Leeuwenhoek's discovery, the secret of how these most harmless and inconspicuous of creatures repeatedly undergo resurrection was finally understood.