

huge duration of their existence. In this case, they should have special structural and biochemical features which are different from other microorganisms as we know them and which have a life expectancy many orders of magnitude less. They might have something like the smaller chromosome and two DNA rings found recently by specialists at the Institute for Genomic Research (Battista et al., 1999) in *Deinococcus radiodurans*, which can survive a dose of radiation 3,000 times greater than that needed to kill a human being.

Conclusions

Frozen soils contain bacteria which reproduce on the thawing of the material around them. For those found at depth, among mineral particles and ice, it seems impossible that they have originated at the surface of the ground in recent time and then migrated down to where they were found. It is also difficult for these organisms to reproduce while in the permafrost - at least they could do so only rarely and possibly at great intervals of time.

Thus, the living microorganisms in permafrost, in common with other extremophiles, apparently have special mechanisms of repair of cell structures, necessary for their survival. They may have the key to a life lasting for thousands of years. A life, that is, which could be terminated by an external event, but not by internal failure of the organism. Comparison of the structure, genetic apparatus, and biochemical features of permafrost's microorganisms to those of 'normal' microorganisms as we know them, could reveal this mechanism.

Understanding these permafrost organisms and their relationship to their cold environment has immediate practical implications. The fact that very old, viable bacteria occurring at depth in permafrost can be prompted to reproduce, presents imaginative possibilities, for example for the decontamination of buried contaminants. At the very least, in applying microbiological techniques to the expensive problems of cold regions decontamination, we should be exploring the extraordinary nature of these permafrost organisms and the possibilities they present for application of biotechnological procedures.

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