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Southern remedies

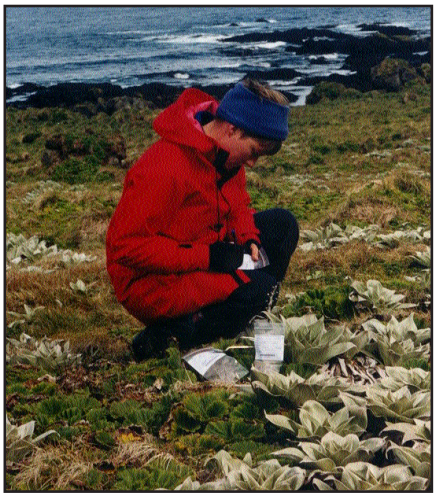
Wendy Pyper meets some cool contenders in the hunt for novel biological diversity.

The soils, sea ice and cold, saline lakes of Antarctica, are home to a unique microflora that promises to provide a wellspring of new pharmaceuticals, natural remedies, aquaculture feeds and industrial enzymes.

About 300 of these microbes form the Australian Collection of Antarctic Microorganisms in the Department of Agricultural Science at the University of Tasmania. A second collection of some 7400 microbes has been assembled by the Cooperative Research Centre (CRC) for Antarctica and the Southern Ocean, in collaboration with Cerylid Biosciences Ltd.

The Cerylid collection is expected to provide a source of new antibiotics and other pharmaceuticals. To this end, it is focussed on Antarctic Actinobacteria (widely distributed, thread-like bacteria that produce spores) as they are the source of many existing pharmaceuticals.

Carol A Mancuso-Nichols



Sharee McCammon samples soil material from Macquarie Island.

For example, the pharmaceuticals Tetracycline, Streptomycin, and Erythromycin were isolated from common Actinobacteria in the genus *Streptomyces*.

'We're at the stage where many of the "garden variety" Actinobacteria have been screened for potential pharmaceuticals,' Dr David Nichols, leader of the Antarctic CRC microbial biotechnology subprogram says. 'So the pharmaceutical industry is interested in finding new types of these bacteria.

'Our expertise lies in finding new biodiversity and we've done that by concentrating on the Antarctic microflora and, more recently, the microflora of the subantarctic Macquarie Island.'

Nichols' team has purified and identified 769 Actinobacteria to genus or group level. Ninety-three of these were further characterised using DNA sequencing technology, and 22 of these sequences were found to be novel.

'Antarctica is a rich source of both novel species and rare genera of Actinobacteria,' Nichols says.

'Many of the novel species belong to genera with strong track records for producing pharmaceutically active compounds (*Streptomyces, Nocardia, and Micromonospora*). So it will be interesting to see if this novel biodiversity translates into novel products.

'We've had a commercial agreement with Cerylid Biosciences since 1995, so obviously they think it's worthwhile.'

Fatty acid factories

Some Antarctic bacteria are a rich source of polyunsaturated fatty acids (PUFA), the presence of which in cell membranes is thought to assist in cold and salinity-adaptation.

The Antarctic CRC has identified five groups of PUFA-producing bacteria: *Shewanella*, *Colwellia*, *Flexibacter* and *Psychroflexus* from Antarctic sea ice, and *Moritella* from the deep sea.

In humans, PUFA are precursors to eicosanoid hormones, which mediate cardiovascular disease conditions and are essential for the development of retinal and nervous tissue. But humans cannot directly synthesise longer chain PUFAs such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA).

One way to obtain these fatty acids would be in the form of tablets, but pure EPA, which is extracted and purified from a mixture of sources, costs about US$5000 per gram.

'The real benefit of biotechnology applications from bacteria is that you could take advantage of the fact that bacteria, unlike many other sources (such as algae), only produce a single PUFA component,' Nichols says.

Joanne Cavanaugh

David Nichols and John Grey sample sea ice at Ellis Fjord, near Davis Base in Antarctica. Antarctica is a rich source of Actinobacteria, many of which contain pharmaceutically-active compounds. Other Antarctic bacteria are rich in polyunsaturated fatty acids, the presence of which in cell membranes is thought to assist in cold and salinity-adaptation.

'So you could use PUFA-producing bacteria as PUFA factories, to produce a pure, high-value end product, at less cost.'

Nichols says a more likely source of dietary PUFA could come in the form of genetically engineered crops. University of Tasmania PhD student Matthew Smith is characterising the PUFA genes from *Shewanella gelidimarina* and *Colwellia psychroerythraea*, with this end in mind.

'The better long-term application would be to apply these gene systems to cereal crops or other staple foods, to produce a functional food containing PUFA,' Nichols says.

PUFA factories may prove more useful in the aquaculture industry, which relies on fish and alga-derived oils to provide larvae with the DHA and EPA essential for growth and development.

Overfishing and the increased use of fish oils in aquaculture have depleted fish-oil reserves, with supplies expected to dry up in the next 10 years. Production of microalgae, on the other hand, is expensive. So the use of microbial PUFA – either as an extract, or as a feed for the tiny animals that are in turn fed to aquaculture larvae – is an expanding area of interest.

Experiments by the Antarctic CRC and the Tasmanian Department of Primary Industry and Fisheries, showed that rotifers (aquatic microinvertebrates) fed PUFA-producing microbes, became enriched with DHA and EPA. Once 'fattened', these tiny animals could potentially provide a rich source of fatty acids when fed to aquaculture larvae.

The extreme environment to which Antarctic bacteria have adapted has triggered the development of a third cellular product: cold-adapted enzymes.

These typically have maximum activity at temperatures below 40°C, and will provide new opportunities for industrial applications and products such as cleaning agents, leather processing, food processing, bioremediation in cold climates, and molecular biology.

'A high proportion of bacteria in Antarctica exhibit cold-active enzyme activity,' Nichols says. 'We're starting to screen our collection to identify the high performers and characterise those producing enzymes of commercial interest.'

The CRC for Antarctica and the Southern Ocean is a joint venture between the University of Tasmania, CSIRO Marine Research, the Australian Antarctic Division, Geosciences Australia and the Australian Bureau of Meteorology.

More about microorganisms

Nichols D Bowman J Sanderson K *et al* (1999) Developments with Antarctic microorganisms: culture collections, bioactivity screening, taxonomy, PUFA production and cold-adapted enzymes. *Current Opinion in Biotechnology*, 10:240–246.