Molecular Genealogy in the Arctic Sediment

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Molecular biologists on the move: An unusual place to find heat-loving microorganisms. How they found their way to Spitsbergen is the subject of research by an international team supported by the FWF.

(PhysOrg.com) -- Heat-loving bacteria found in the Arctic seabed have their origins in oil springs and the depths of the Earth's crust. This is the finding of a project supported by the Austrian Science Fund FWF, which used molecular biology to study "misplaced" bacteria such as these. The possibility that molecular biology could also help track down oil fields gives the project an interesting economic twist.

They were discovered over 50 years ago but their origins have remained a mystery. Living in the sediment of the Arctic seabed around Spitsbergen are bacteria that only really thrive in temperatures above 50 degrees Celsius. In fact, the term "living" can only be applied in the loosest of terms, as the bacteria found here exhibit little in the way of metabolic activity and spend their existence as dormant spores. But it is their metabolism that is of most interest, since some of them are "sulphate-reducing microorganisms" (SRMs) and as such are capable of breaking down organic material in the absence of oxygen and the presence of sulphate. It is precisely this capability that gave the first indications of where these microbial migrants could originate from.

From the Depths

"While we would describe conditions in certain parts of our planet as inhospitable, others feel right at home there. Thermophilic SRMs love environments where temperatures exceed 50 degrees Celsius and where there is a distinct lack of oxygen. In conditions such as these, these microorganisms are able to break down organic material," explains Project Leader Dr. Alexander Loy from the Department of Microbial Ecology at the University of Vienna, adding: "Underwater oil springs and ecosystems deep in the Earth's crust offer just such conditions and were our first thought when trying to pin down the origins of thermophilic SRMs in Arctic sediment."

To test out this hypothesis, Dr. Loy and his team first used appropriate molecular biological methods to determine the relationships of the thermophilic bacteria. This work, which was supported by the Austrian Science Fund FWF, focused on 16S rRNA, a component of bacterial "protein factories". Due to the essential nature of 16S rRNA for all living beings, it has changed relatively little over the course of evolution. And these few changes enable scientists to draw conclusions about relationships between bacteria. If two species have some of these changes in common, it can be assumed that they are closely related.

Relationships in Percentages

The work quickly yielded results and, in September 2009, initial findings from Dr. Loy's team and data from colleagues at the Max Planck Institute for Marine Microbiology in Bremen (Germany), and the Universities of North Carolina (USA) and Aarhus (Denmark) were published in SCIENCE. Dr. Loy on the results of this "family history" research: "The closest relatives of the thermophilic bacteria in the Arctic come from oil fields in the North Sea. Up to 96 percent of the 16S rRNA in these species is identical to that of the species found in Arctic sediment." These results provided the first indications of where the bacteria could come from.

Further evidence came from an analysis of the number of endospores present in the Arctic seabed, which was conducted by Dr. Loy's international colleagues. Based on the numbers detected, it has been calculated that 100 million bacterial spores are deposited for each square metre, each year. This was the second key indication of the origin of these bacteria. It is evident that a big enough population must exist to ensure a continuous supply. Only oil fields and ecosystems in the Earth's crust, where high temperatures provide ideal conditions for heat-loving bacteria, could be responsible for such numbers.

If the thermophilic SRMs in Arctic waters do originate from underwater oil springs, the methods used could also have applications in oil exploration. Although this particular aspect was not a focal point of Dr. Loy's FWF project, it could have a very practical side effect.

More information: "A Constant Flux of Diverse Thermophilic Bacteria into the Cold Arctic Seabed" C. Hubert, A. Loy, M. Nickel, C. Arnosti, C. Baranyi, V. Brüchert, T. Ferdelman, K. Finster, F. M. Christensen, J. R. de Rezende, V. Vandieken, and B. B. Jørgensen. Science, 18th September 2009, VOL 325, doi:10.1126/science.1174012

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