Which genes are crucial for the energy metabolism of Archaea?

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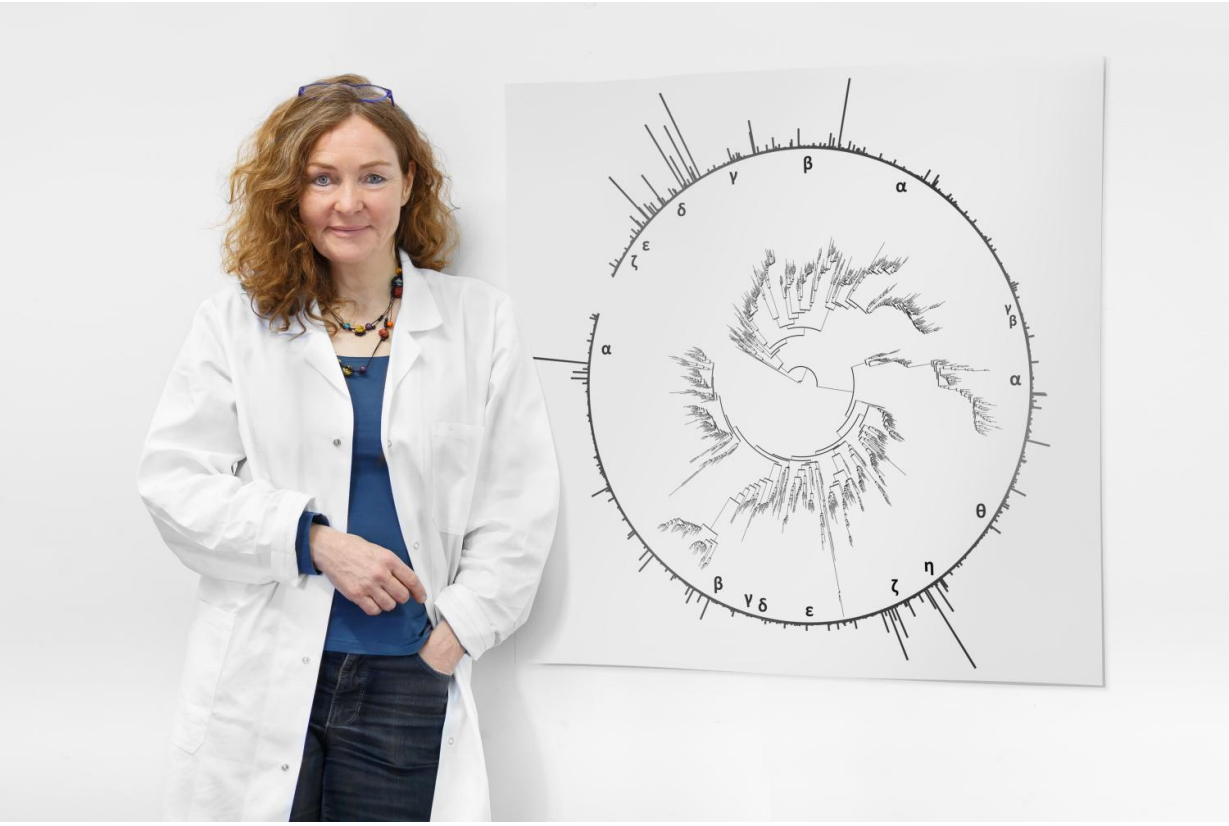


Schleper's research focuses on ecology, molecular biology and evolution of archaea, virus-host interactions and the investigation of non-cultivable microorganisms using metagenomics. Credit: University of Vienna

A research team led by Christa Schleper from the University of Vienna

succeeded in isolating the first ammonia-oxidizing archaeon from soil: Nitrososphaera viennensis—the 'spherical ammonia oxidizer from Vienna.' In the current issue of the journal *PNAS*, the scientists present new results: they were able to detect all proteins that are active during ammonia oxidation—another important piece of the puzzle for the elucidation of the energy metabolism of Archaea.

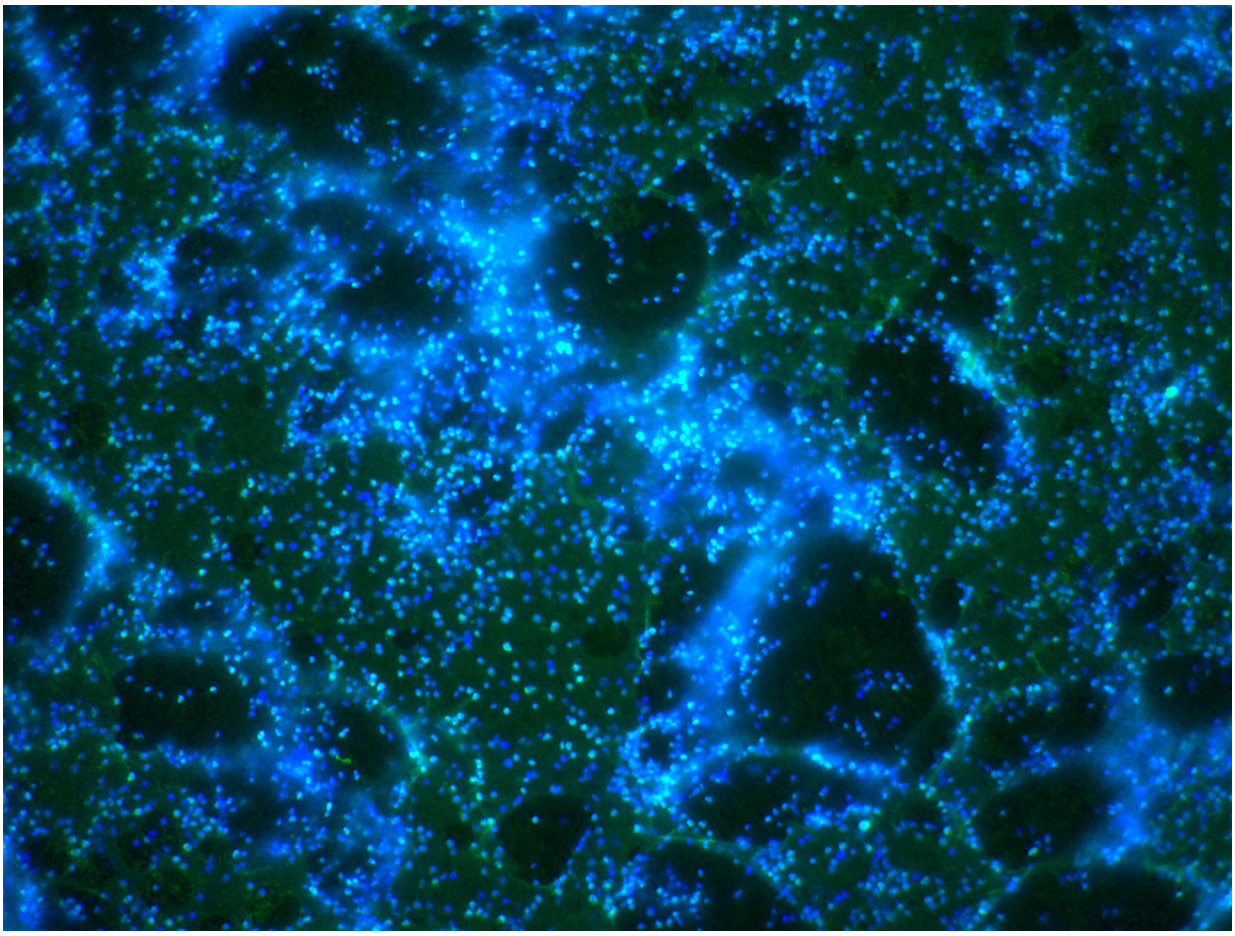
Microorganisms are still often perceived only as disease promoters, although the vast majority of them plays an important ecological role in the global geochemical cycles: without the metabolic activities of the smallest of all living organisms, bacteria and archaea, life on Earth would not be possible. These microorganisms play a central role in the large geochemical cycles by decomposing organic matter and returning the resulting building blocks to the atmosphere or making them available for new life. It is now also known from microbiome research that our gut bacteria affect not only our general health, but even our psyche.

But what about Archaea? For a long time, this second group of microorganisms, which beside bacteria belong to the prokaryotes, has only been found in hot springs and other extreme locations. Only ten years ago the so-called Thaumarchaea were discovered in great numbers in the sea water of all oceans, but also in soils and lakes. These archaea oxidize ammonia to nitrite and due to their global abundance are obviously involved in this important step of the nitrogen cycle.

The first officially described strain of such an archaeon is *Nitrososphaera viennensis*. It stems from the garden of the university center Althanstraße in the 9th district of Vienna, and because of its form and origin is called "Nitrososphaera viennensis", the "spherical ammonia oxidizer from Vienna". A single cell has a diameter of only 0.8 micrometres, thus 0.8 millionth of a meter.

This scientific breakthrough in 2011 was the prerequisite for Christa

Schleper and her team to investigate not only the individual genes, but also the proteins of an ammonia-oxidizing archaeon from soil. "As the organism grows only to very low cell densities, we had to run large fermenters to obtain enough biomass," explains Christa Schleper. The scientists have now been able to investigate which of the genes of this model organism are present in all thaumarchaeota and which are active during ammonia oxidation.



Biofilm *Nitrososphaera viennensis*: The cells fluoresce in blue (DAPI dye) and the "glues" of the biofilm glow in green (FITC dye for staining N-acetylglucosamine and / or N-acetylneuraminic acid). Credit: Copyright: Melina Kerou

"Our study allows hypotheses to be developed about the process of ammonia oxidation which can now be verified experimentally: Because until today the energy metabolism of these archaea, which belong to the most frequent microorganisms on our planet, has not yet been elucidated," said the microbiologist.

Furthermore, the new study provides for the first time clues for special adaptations of the Archaea from soil. These include their ability to form biofilms and to interact with other microorganisms. "A better understanding of the archaea living in the soil is of great ecological importance. Since Archaea produce less greenhouse gases than Bacteria during the oxidation of ammonia, it is important to learn under which conditions they can be propagated preferentially in agricultural soils," explains Christa Schleper. In the future, exploration of *Nitrososphaera viennensis* could also gain medical relevance, since closely related strains are found on the human skin.

Christa Schleper in her laboratory in the University of Vienna. Credit: Copyright: University of Vienna

More information: Proteomics and comparative genomics of Nitrososphaera viennensis reveal the core genome and adaptations of terrestrial archaeal ammonia oxidizers, *PNAS*, www.pnas.org/cgi/doi/10.1073/pnas.1601212113

Provided by University of Vienna