Microbiologists can now measure extremely slow life

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Lomstein when she took part in the Galathea 3 expedition. Here she and her colleague Alice Thoft Langerhuus examine a fresh mud core sample from the Bay of Aarhus on board Tyra, Aarhus University's research vessel. Credit: Jesper Rais/AU Communication

Microbiologists at Aarhus University (Denmark) have developed a new method for measuring the very slow metabolism of bacteria deep down in the seabed. The results can provide knowledge about the global carbon cycle and its long-term impact on the climate.

"Mud samples boiled in acid sounds like witchcraft," admits microbiologist Bente Lomstein from the Department of Bioscience when explaining how she and an international group of researchers achieved the outstanding results being published today in the journal *Nature*.

Bacteria are the only living organisms to produce D-amino acids that deposit a chemical signature in the mud in which they live. Researchers at the Department of Bioscience and the Danish National Research Foundation's Center for Geomicrobiology at Aarhus University have used this knowledge together with American researchers to develop a method to calculate the activity level of microorganisms in the deepest layers of the seabed.

Metabolism in slow motion

Why should we worry about the small organisms that live hidden below the seabed of the world's oceans? Because the slowly growing bacteria are important for the global storage of organic carbon and thereby for the oxygen content of the atmosphere.

"Seventy per cent of our planet is covered by ocean, which means that seventy per cent of the planet is made up of seabed consisting of sediments that store old organic matter. In some places the deposits are more than one hundred metres thick, and ten to thirty per cent of the total living biomass on Earth is actually found in the mud in the seabed. The bacteria in the seabed convert the carbon of organic matter to CO2, and if we add it all up, the metabolism down there plays a crucial role in the global carbon cycle, even if it happens very slowly," says Associate Professor Lomstein.

The researchers' results show that the metabolism of organic carbon takes place at a much slower rate in the deep seabed compared with all other known ecosystems. The mean generation time of bacterial cells down there is correspondingly long: 1000-3000 years. In comparison, many of the bacteria that have been studied in the laboratory or in nature reproduce in a number of hours.

Life in extreme environments

"Extremely high pressure, total darkness and very little nutrition – those are the conditions under which microorganisms live on the seabed. At the bottom of the deep oceans, the pressure reaches several hundred atmospheres," explains Alice Thoft Langerhuus, one of the researchers behind the results.

The researchers also have an idea about how the bacteria can survive under such extreme conditions. They actually succeeded for the first time in demonstrating that there are just as many dormant cells as there are active ones. To a great extent, the bacteria therefore choose to form endospores, which have a solid 'shell' to protect themselves against the harsh environment.

The researchers combined organic biogeochemistry with microbiological studies, and their interdisciplinary model can also provide information about life in other extreme ecosystems.

"Our knowledge can be used in ancient environments with extremely low biological activity, such as permafrost soil. The method is particularly useful for detecting life in the most inactive environments," says Bente Lomstein.

Provided by Aarhus University

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