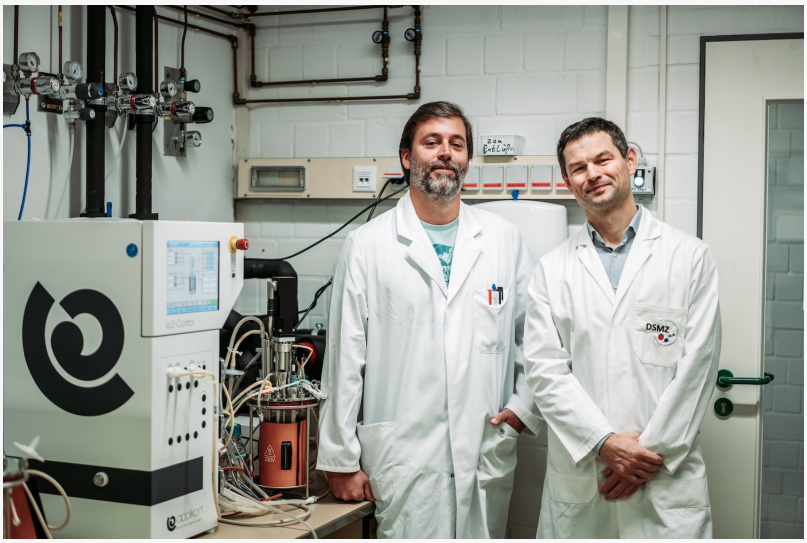
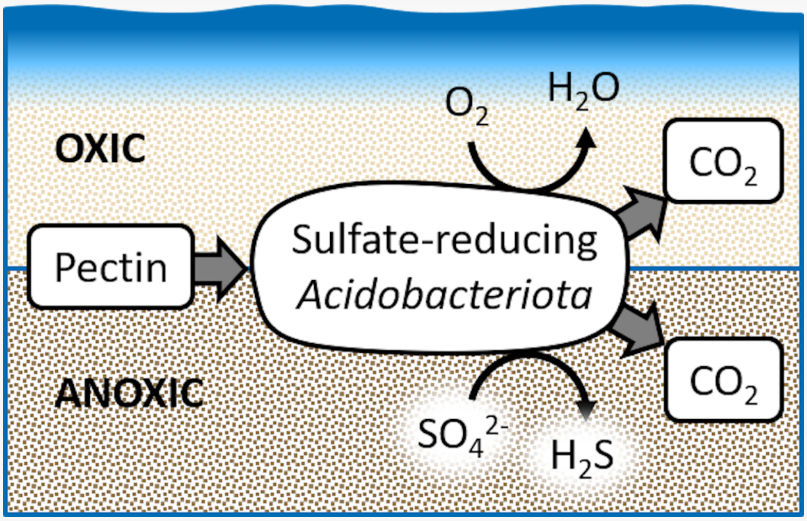
Textbook knowledge turned on its head: 3-in-1 microorganism discovered

Study on environmentally relevant microorganisms shows greater diversity than previously assumed



Dr. Stefan Dyskma (left) and Prof. Dr. Michael Pester next to a bioreactor at the DSMZ, in which novel "sulphate reducers" could be studied. Source: DSMZ



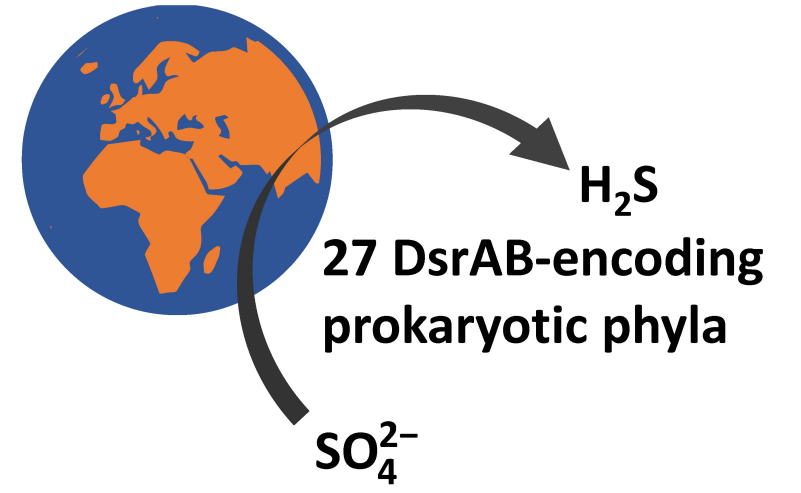
Schematic representation of the degradation of plant pectin – both by sulphate reduction and by respiration with oxygen in a newly discovered acidobacterium. Source: DSMZ

BRAUNSCHWEIG, NIEDERSACHSEN, GERMANY, November 7, 2023 /EINPresswire.com/ -- A team of researchers from the Leibniz Institute DSMZ- German Collection of Microorganisms and Cell Cultures GmbH and Technische Universität Braunschweig, in collaboration with the University of Vienna and the University of Wisconsin, USA, has now been able to show that there is an incredibly high biodiversity of environmentally relevant microorganisms in nature. This diversity is at least 4.5 times greater than previously known. The researchers recently published their findings in the prestigious journals Nature Communications and FEMS Microbiology Reviews.

The hidden world of microorganisms is often overlooked, even though many climate-relevant processes are influenced by microorganisms, often associated with an incredible diversity of species within the groups of bacteria and archaea (“primitive bacteria”). For example, sulphate-reducing microorganisms convert a third of the organic carbon in marine sediments into carbon dioxide. This produces toxic hydrogen sulphide.

On the positive side, sulphur-oxidising microorganisms quickly use this as an energy source and render it harmless.

“These processes also play an important role in lakes, bogs and even in the human gut to keep nature and health in balance,” says Dr. Michael Pester, Head of the Department of Microorganisms at the Leibniz Institute DSMZ and Professor at the Institute of Microbiology at Technische Universität Braunschweig. A study examined the metabolism of one of these novel microorganisms in more detail, revealing a multifunctionality that was previously unattainable.



Extremely high species diversity of sulphate-reducing microorganisms discovered. Sulfate reducers are now found in a total of 27 phyla within the bacteria and archaea instead of the six previously known. Source: DSMZ

Microorganisms stabilise ecosystems

The sulphur cycle is one of the most important and oldest biogeochemical cycles on our planet. At the same time, it is closely linked to the carbon and nitrogen cycles, underlining its importance. It is mainly driven by sulphate-reducing and sulphur-oxidising microorganisms. On a global scale, sulphate reducers convert about a third of the organic carbon that reaches the seafloor each year. In return, sulphur oxidisers consume about a quarter of the oxygen in marine sediments.

When these ecosystems become unbalanced, the activities of these microorganisms can rapidly lead to oxygen depletion and the accumulation of toxic hydrogen sulphide. This leads to the formation of ‘dead zones’ where animals and plants can no longer survive. This not only causes economic damage, for example to fisheries, but also social damage through the destruction of important local recreational areas. It is therefore important to understand which microorganisms keep the sulphur cycle in balance and how they do this.

The published results show that the species diversity of sulphate-reducing microorganisms includes at least 27 phyla (strains). Previously, only six phyla were known. By comparison, 40 phyla are currently known in the animal kingdom, with vertebrates belonging to only one phylum, the Chordata.

Newly discovered multifunctional bacterial species

The researchers were able to assign one of these novel “sulphate reducers” to the little researched phylum of acidobacteriota and to study it in a bioreactor.

Using cutting-edge methods from environmental microbiology, they were able to show that

these bacteria can obtain energy from both sulphate reduction and oxygen respiration. These two pathways are normally mutually exclusive in all known microorganisms. At the same time, the researchers were able to show that the sulphate-reducing acidobacteriota can break down complex plant carbohydrates such as pectin – another previously unknown property of “sulphate reducers”. The researchers have thus turned textbook knowledge on its head. They show that complex plant compounds can be degraded under oxygen exclusion not only by the coordinated interaction of different microorganisms, as previously thought, but also by a single bacterial species via a shortcut.

Another new finding is that these bacteria can use both sulphate and oxygen for this purpose. Researchers at the DSMZ and Technische Universität Braunschweig are currently investigating how the new findings affect the interplay of the carbon and sulphur cycles and how they are linked to climate-relevant processes.

Publications

Dyksma S, Pester M.: Oxygen respiration and polysaccharide degradation by a sulfate-reducing acidobacterium. Nature Communications 2023;14: 6337

Diao M, Dyksma S, Koeksoy E, Ngugi DK, Anantharaman A, Loy A. Pester M.: Global diversity and inferred ecophysiology of microorganisms with the potential for dissimilatory sulfate/sulfite reduction. FEMS Microbiology Reviews 2023, DOI 10.1093/femsre/fuad058

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About the Leibniz Institute DSMZ

The Leibniz Institute DSMZ-German Collection of Microorganisms and Cell Cultures is the world's most di-verse collection of biological resources (bacteria, archaea, protists, yeasts, fungi, bacteriophages, plant vi-ruses, genomic bacterial DNA as well as human and animal cell lines). Microorganisms and cell cultures are collected, investigated and archived at the DSMZ. As an institution of the Leibniz Association, the DSMZ with its extensive scientific services and biological resources has been a global partner for research, science and industry since 1969. The DSMZ was the first registered collection in Europe (Regulation (EU) No. 511/2014) and is certified according to the quality standard ISO 9001:2015. As a patent depository, it offers the only possibility in Germany to deposit biological material in accordance with the requirements of the Budapest Treaty. In addition to scientific services, research is the second pillar of the DSMZ. The institute, located on the Science Campus Braunschweig-Süd, accommodates more than 85,000 cultures and bio-materials and has around 220 employees. www.dsmz.de

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