**////Title: Exploring How Microbes Can Shed Light on Ancient Climate Conditions**

**////Standfirst:**

To study the climate of the ancient past, researchers look for its fingerprints in deep marine and lake sediments. Within these geological records are large and active microbial communities that may hold other clues about past environmental conditions and transitions. Tor Einar Møller [Tore Ee-naar Moe-lerr], a doctoral candidate at the University of Bergen, Norway, examined the link between contemporary microbe composition and the ancient climate. In a recent paper, he demonstrates that current microbe communities found within sediment cores capture elements of past environments.

**////Main text:**

Palaeoclimatology, the study of Earth’s climate in the ancient past, relies on sediment cores that preserve evidence of past climatic conditions. Like counting the rings of a tree to determine its age, evaluating cores for certain types of climate proxies can yield tell-tale signs of dramatic shifts in environmental conditions. Among these features are grain size measurements, organic matter composition, and biological signatures such as plant spores and fat molecules.

Complex, active microbial communities are also found within sediment cores. These microbes were deposited on the sediment surface and buried over time. Significant research had linked sedimentary microbes to the prevailing conditions when the sediment was initially deposited on the lake floor. However, since parts of these microbial populations are still active and have been inevitably influenced by current climate conditions, it is challenging to use microbe community composition to glean information about significant climate events in the distant past.

In a unique study, Tor Einar Møller at the University of Bergen in Norway investigated the link between environmental conditions and microbial structure in two sediment cores from a glacier-fed lake in southeast Greenland. Using established proxies to profile the past climate, he linked physical and geochemical shifts in the lake to microbial variation. Published in the journal *Frontiers in Microbiology* in 2020, his research strongly highlights the potential to use of molecular microbiological data to refine existing past climate classifications.

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Some of Møller’s colleagues travelled to Greenland to sample a local lake that comprises two basins separated by a shallow zone. In the summer of 2014, they took sediment cores from each basin and used them to identify regional climate variability during the Holocene – our current epoch of time, which started around 11,500 years ago when the last ice-age ended. Using conventional analysis focusing on climate proxies such as grain size and mineral deposits, other researchers subdivided the cores into four time periods with unique climate conditions.

The team sampled each core to characterise the microbes inhabiting the sediment. They also tested the water surrounding the grains of the sediment, called the ‘pore water’. By combining pore water composition and properties of the sediment related to past climate change in statistical analysis, the researchers were able to compare their relative influence on the contemporary microbial community. By analysing the pore water, they could infer the level of oxygen depletion, which offers an indication of microbial respiration in the sediment, and reveals how fast the microbes are turning organic material in the sediment into inorganic material.

Thus, the researchers used pore water analysis to determine that the microbes were active and in what way. Significant climate transitions should change microbial activity, affecting variables sensitive to microbial activity, such as dissolved iron and pH. If microbial activity is linked with past climate conditions, pore water analysis should constrain the microbial activity to past climate and align variables such as iron and pH to specific periods.

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Møller and his colleagues were able to successfully reclassify the four climate units already described. They also found that microbial community profile was primarily grouped according to the previously inferred four climate variables and thus aligned with past environmental transitions.  
  
When assessing which physical factors explain the link between climate and microbe community, the scientists found that the variables best describing differences in microbial composition are products of microbial activity. Thus, microbial communities are strongly connected to variables associated with their activity, but nonetheless contain a quantifiable link to conditions associated with past climatic changes.

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Even though the two sampled areas were only 200 meters apart, their microbial communities and specific physical parameters were different. This implies that, despite experiencing the same climatic conditions, site-specific factors affected the physical and geochemical signatures in the deposited sediments.

Although both sites experienced identical climates, Møller and his colleagues believe that local conditions likely constrained climatic effects on the microbial communities. When investigating these differences, the researchers found that the distinct communities were correlated with minerals and organic carbon. It is also likely that the initial microbial communities established in the surface sediments differed between the two sites.

These data suggest that the link between climate conditions and microbial communities can be further affected by local settings, which work in conjunction with the regional climate to drive microbial variability.

Since these microbial communities are still active, they perform essential functions such as dividing elements across the sediment-water interface. This strongly implies that the past climate continues to indirectly influence the lake’s water chemistry today through its impacts on contemporary microbial populations.

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The team’s study highlights the value of collecting molecular microbiological data alongside existing methods to refine classifications of past climate events. Using an interdisciplinary approach combining geochemistry, microbiology and palaeoclimatology, Møller and his colleagues have expanded our understanding of the link between paleoclimate and microbial structure.

Although much remains to be learned about the specific feedback mechanisms between climate events and sedimentary microbes, characterising and assessing the microbial communities within sediments can add biological context to already established paleoclimate knowledge. Møller’s study also strongly implies that the past environmental conditions still influence microbial activity today. Given the diverse functions of microbial species, additional research is sure to find that Earth’s ancient climate continues to influence our environment today.

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This SciPod is a summary of the paper ‘Microbial Community Structure in Arctic Lake Sediments Reflect Variations in Holocene Climate Conditions’, in *Frontiers in Microbiology*. <https://doi.org/10.3389/fmicb.2020.01520>

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