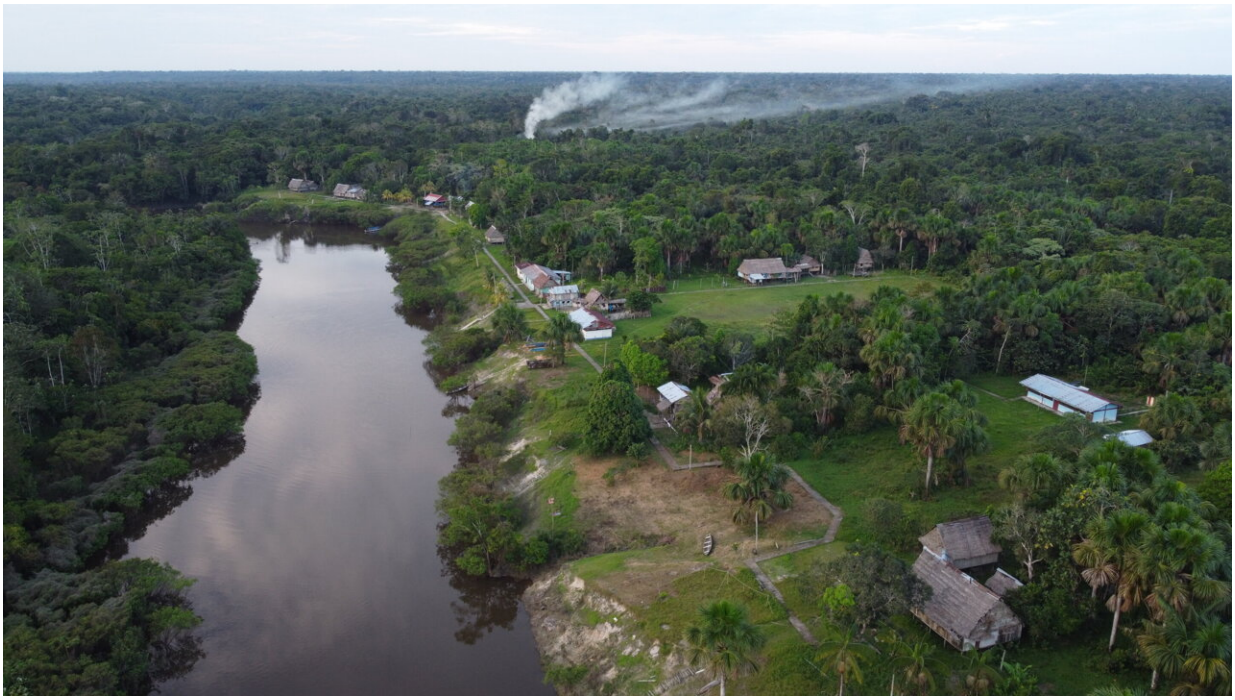
Newly discovered microbes in Amazon peatlands could affect global carbon balance

January 25 2025, by Richard Harth



An aerial view of a remote village in the Pastaza-Marañón Foreland Basin of the Amazon, where Hinsby Cadillo-Quiroz conducts fieldwork. This region, rich in biodiversity and cultural heritage, serves as a critical site for studying microbial life and its effects on climate change. Credit: Hinsby Cadillo-Quiroz

Complex organisms, thousands of times smaller than a grain of sand, can shape massive ecosystems and influence the fate of Earth's climate, according to a new study.

Researchers from Arizona State University, along with their colleagues from the National University of the Peruvian Amazon, have identified an unknown family of microbes uniquely adapted to the waterlogged, low-oxygen conditions of tropical peatlands in Peru's northwestern Amazonian rainforest.

The new research shows these microbes have a dual role in the carbon cycle and the potential to either moderate or intensify climate change. This process can either stabilize carbon for long-term storage or release it into the atmosphere as greenhouse gases, particularly CO_2 and methane.

Under stable conditions, these microbes enable peatlands to act as vast carbon reservoirs, sequestering carbon and reducing climate risks. However, environmental shifts, including drought and warming, can trigger their activity, accelerating global climate change.

And, continued human-caused disruption of the natural peatland ecosystem could release 500 million tons of carbon by the end of the century—roughly equivalent to 5% of the world's annual fossil fuel emissions.

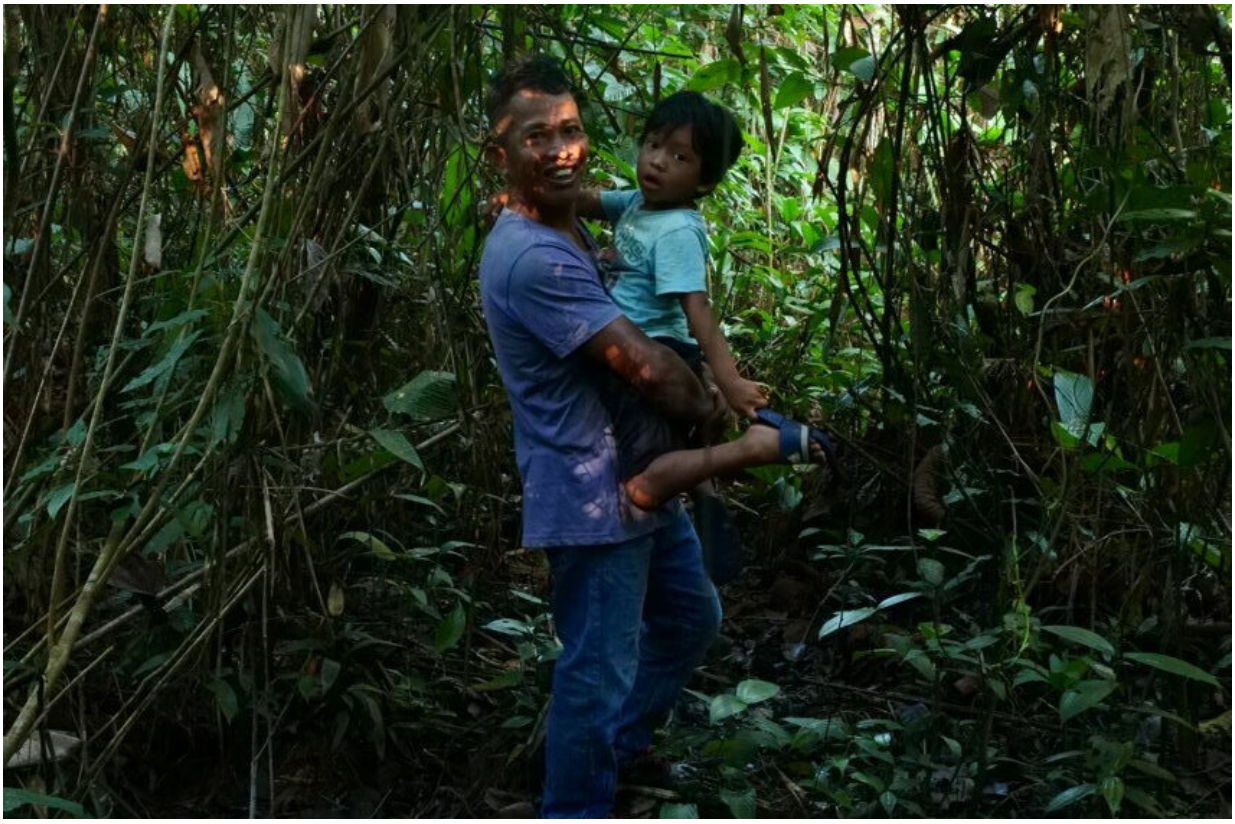
"The microbial universe of the Amazon peatlands is vast in space and time, has been hidden by their remote locations, and has been severely under-studied in their local and global contributions, but thanks to local partnerships, we can now visit and study these key ecosystems," says Hinsby Cadillo Quiroz, corresponding author of the new study and a researcher with the Biodesign Swette Center for Environmental Biotechnology at ASU.

"Our work is finding incredible organisms adapted to this environment, and several of them provide unique and important services—from carbon stabilization or recycling to carbon monoxide detoxification and

others."

Cadillo-Quiroz is also a researcher with the Biodesign Center for Fundamental and Applied Microbiomics and the ASU School of Life Sciences. ASU colleague Michael J. Pavia is the lead author of the investigation.

The study, appearing in the American Society for Microbiology journal *Microbiology Spectrum*, emphasizes the importance of protecting tropical peatlands to stabilize one of the planet's most significant carbon storage systems and underscores the subtle interplay between microbial life and global climate regulation.



Local residents in the dense Amazon rainforest, near the Pastaza-Marañón Foreland Basin. Their deep connection to the land offers valuable insights for

researchers like Hinsby, whose work depends on understanding both the ecosystem and the communities living within it. Credit: Hinsby Cadillo-Quiroz

Why peatlands are crucial for climate stability

The Amazonian peatlands are among the planet's largest carbon vaults, storing an estimated 3.1 billion tons of carbon in their dense, saturated soils—roughly twice the carbon stored in all the world's forests. Peatlands are critical for global carbon storage because their waterlogged conditions slow decomposition, allowing organic material to accumulate over thousands of years. These ecosystems play a crucial role in regulating greenhouse gas emissions and influencing global climate patterns.

Building on earlier research, the current study describes newly identified microbes—part of the ancient Bathyarchaeia group that forms a complex network essential to the functioning of this ecosystem. The study highlights the remarkable abilities of these microorganisms to regulate carbon cycling in peatlands. Unlike most organisms, these microbes can thrive in extreme conditions, including environments with little to no oxygen, thanks to their metabolic flexibility.

The microbes are found in the Pastaza-Marañón Foreland Basin—a vital peatland in the northwestern Amazon rainforest of Peru. Encompassing approximately 100,000 square kilometers, the basin includes vast tracts of flooded rainforest and swamps underlain by ancient peat.

These peatland microbes consume carbon monoxide—metabolizing a gas toxic to many organisms—and convert it into energy, simultaneously reducing carbon toxicity in the environment. By breaking down carbon compounds, they produce hydrogen and CO_2 that other microbes use to

generate methane. Their ability to survive both oxygen-rich and oxygen-poor conditions makes them well suited to Amazonian environments, where water levels and oxygen availability fluctuate throughout the year.

However, shifts in rainfall, temperature and human activities, including deforestation and mining, are disrupting this delicate balance, causing peatlands to release greenhouse gases like carbon dioxide and methane.

Climate connection

While tropical peatlands currently act as carbon sinks, absorbing more carbon than they release, they are increasingly vulnerable to climate change. Rising temperatures and altered rainfall patterns could dry out these peatlands, turning them into carbon sources.

Study author Hinsby Cadillo-Quiroz collects soil samples in the lush rainforest of the Pastaza-Marañón Foreland Basin. Fieldwork like this is vital for understanding the complex ecosystems of the Amazon and their role in global environmental processes. Credit: Hinsby Cadillo-Quiroz

The release of billions of tons of carbon dioxide and methane from peatlands would significantly amplify global warming. The findings emphasize the urgent need to protect tropical peatlands from human activities and climate-induced stress.

The researchers advocate for sustainable land management, including reducing deforestation, drainage and mining activities in peatlands to prevent disruptions. Further investigation of microbial communities is needed to better understand their roles in carbon and nutrient cycling.

Tracking changes in temperature, rainfall and ecosystem dynamics is also necessary to predict future impacts on peatlands.

New directions

The discovery of highly adaptable peatland microbes advances our understanding of microbial diversity and underscores the resilience of life in extreme environments. These microbes represent a key piece of the puzzle in addressing global climate challenges, showing how the tiniest organisms can have an outsized impact on Earth's systems.

This research, supported by the National Science Foundation, marks a significant step forward in understanding the critical role of tropical peatlands and their microbial inhabitants in global carbon cycling. As climate change continues to reshape our planet, these hidden ecosystems

hold lessons that may help safeguard our future.

Cadillo-Quiroz and his team plan to use this microbial and ecological knowledge for tropical peatlands management and restoration in their future work, which can be followed here.

"Working to understand microbes and ecosystems in the lush and magnificent Amazon rainforest is the honor of my life, which I aim to use in the protection of this region in the fight against climate change," Cadillo-Quiroz says.

More information: Michael J. Pavia et al, Functional insights of novel Bathyarchaeia reveal metabolic versatility in their role in peatlands of the Peruvian Amazon, *Microbiology Spectrum* (2024). DOI: 10.1128/spectrum.00387-24

Provided by Arizona State University