Database shows effects of acid rain on microorganisms in Adirondack Lakes

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Prior to the federal Clean Air Act, unhindered industrial emissions were released into the air throughout the Midwestern and Eastern United States for decades. Many of those harmful chemicals came right back down to earth in the form of acid rain, a chemical concoction that includes nitric and sulfuric acid.

Researchers have long known that acid rain can severely decrease the diversity of plant and animal communities in fresh water lakes and ponds. However, little is known about how microscopic bacteria, which form the foundation of freshwater ecosystems, respond to acidification.

To address this knowledge gap, researchers at the Darrin Fresh Water Institute of Rensselaer Polytechnic Institute have developed one of the most comprehensive databases in existence on the impacts of acid rain at the foundation of the biological community.

The team found a general link between increased acidity and decreased bacterial diversity, but surprisingly, most of the dominant species of bacteria were not directly impacted by acidification. However, some rarer types of bacterial populations were significantly or strongly correlated to acidity, rising and falling with fluctuations in water pH. The findings could eventually allow scientists to use these bacteria as indicators of lake recovery, according to Sandra Nierzwicki-Bauer, director of the Darrin Fresh Water Institute and professor of biology.

The research is part of a much broader study on how Adirondack lakes

are recovering from the impacts of acidification. "Thanks in large part to the federal Clean Air Act and increased state focus on improving air quality here in New York, we are seeing a number of these lakes on a trajectory to recovery, but up until now we have had little understanding of the changing biodiversity of microbial communities within the impacted lakes as they recover," Nierzwicki-Bauer said. "I hope this study will help other scientists expand on the research and use this data to uncover additional information on how acid-impacted lakes and their ecosystems are recovering and how we can hasten that process."

The study was published in a recent edition of the journal *Applied and Environmental Microbiology* and was undertaken in partnership with the Skidaway Institute of Oceanography. The study is part of what has been a 12-year analysis on the recovery of Adirondack lakes from the effects of acid rain funded by the U.S. Environmental Protection Agency's Adirondack Effects Assessment Program (AEAP). The study included bacterial samples from 18 lakes, ponds, and reservoirs in various stages of recovery from acidification in the Adirondack mountain region of New York state.

For the current study, 31 physical and chemical parameters were examined for each water body, ranging from water clarity and temperature to aluminum and hydraulic retention time for a one-year period. Clone "libraries" representing the bacteria were developed from the lake samples and analyzed. The researchers found that the species diversity in acid-impacted Adirondack lakes were similar to bacterial communities in other, non-impacted freshwater systems

The impacts of acidity on most types of bacteria, including the freshwater classes of Actinobacteria and Betaproteobacteria, were found to be indirect, and population levels appeared more directly linked to a combination of acidity along with other environmental factors such as lake depth and carbon content. Several less abundant types of bacteria,

including a species known as Alphaproteobacteria, were strongly correlated to acidity and might someday be used as indicators of lake recovery from acidification, according to Nierzwicki-Bauer.

The researchers are in the process of expanding their study to include an additional 13 Adirondack lakes. They also plan to further investigate the role of specific types of bacteria in the ecosystem to better understand why certain bacteria are so directly impacted by acidity while others appear relatively unaffected.

Source: Rensselaer Polytechnic Institute