Solving Everest's wildlife mysteries with eDNA

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Tracie Seimon of WCS's Zoological Health Program collecting eDNA sample. Credit: Anton Seimon/National Geographic

A team of scientists led by the Wildlife Conservation Society (WCS) and Appalachian State University used environmental DNA (eDNA) to document the breadth of high-alpine biodiversity present on Earth's highest mountain, 29,032-foot Mt. Everest (8,849 m). This critical work is part of the 2019 National Geographic and Rolex Perpetual Planet Everest Expedition, the most comprehensive single scientific expedition to the mountain in history.

Describing their findings in the journal *iScience*, the team collected eDNA from water samples over a four-week period in ten ponds and streams between 14,763 feet (4,500 meters) and 18,044 feet (5,500 meters). The sites included areas of the alpine zone that exist above the tree line and contain an array of flowering plants and shrub species, along with the aeolian zone that reaches beyond the range of flowering plants and shrubs at the uppermost reaches of the biosphere. From just 20 liters of water, they identified organisms belonging to 187 taxonomic orders, which corresponds to 16.3 percent, or one sixth, of the total known orders across the tree of life—a family tree of Earth's biodiversity.

eDNA searches for trace amounts of genetic material left behind by organisms and wildlife and offers a more accessible, rapid, and comprehensive approach to increasing survey capacity for assessing biodiversity in aquatic environments. Samples are collected using a sealed cartridge containing a filter that captures genetic material that is later analyzed at a lab using DNA metabarcoding and other sequencing methodologies. WCS has been using eDNA for detection of rare and threatened species from humpback whales to Swinhoe's softshell turtle, one of the rarest species on the planet.

Although the Everest study focused on identification at the order level, the team was able to identify many organisms to the genus or species level.

For example, the team identified both rotifers and tardigrades, two tiny animal organisms that are known to occur in the harshest and most extreme environments and are considered to be among the most resilient animals known on Earth. In addition, they identified Tibetan snow cock, which are found in Sagarmatha National Park, and were surprised to find species such as domestic dog and chicken, representing how human activities are influencing the landscape.

They also identified pine trees, which only are found far downhill from where they sampled, demonstrating how wind-blown pollen can make its way high up into these watersheds. Another organism they identified from several sites were mayflies, which are known indicator species for environmental change.

The eDNA inventory will aid future high-Himalayan biomonitoring and retrospective molecular studies to assess changes over time as climate-driven warming, glacial melt, and human-caused influences reshape this rapidly transforming world-renowned ecosystem.

Dr. Tracie Seimon of WCS's Zoological Health Program, co-lead of the Everest biology field team and lead of the study, says that "high-alpine and aeolian environments, which have often been thought of as barren and mostly devoid of life, in fact have abundant biodiversity. High mountain environments including Mount Everest should be recognized as a target for sustained long-term biodiversity monitoring of high-alpine taxa to complement bioclimatic monitoring and climate change impact assessments."

Dr. Marisa Lim of the Wildlife Conservation Society says that they "went in search for life on the roof of the world. This is what we found. However, the story does not end here. There is more to be discovered and we hope our findings help to inform future exploration."

Dr. Anton Seimon, co-lead of the field study, National Geographic Explorer, and Research Assistant Professor at Appalachian State University says that "a century ago, when asked, 'Why go to Mt Everest?', the British mountaineer George Mallory famously replied 'Because it's there'. Our 2019 team had a rather different perspective: we went to Mt Everest because it is informative, it can teach us things about the world we live in."

By providing this open-source dataset to the research community, the authors hope to contribute towards the continued efforts to build up molecular resources to study and track the shifts in biodiversity of Earth's highest mountain.

More information: Marisa C.W. Lim et al, Estimating biodiversity across the tree of life on Mount Everest's southern flank with environmental DNA, *iScience* (2022). DOI: 10.1016/j.isci.2022.104848

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