New insights to past ecosystems are now available based on pollen and plant traits

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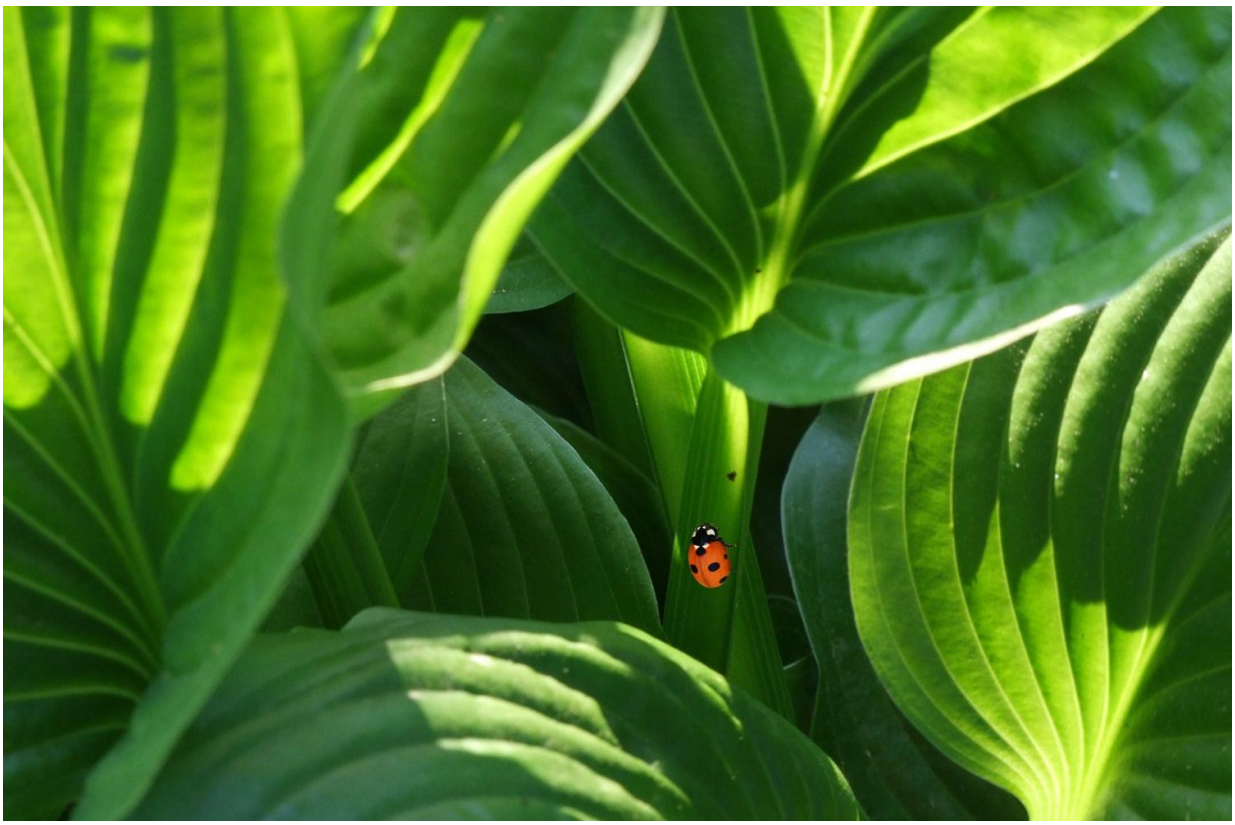

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Researchers have mined and combined information from two databases to link pollen and key plant traits to generate confidence in the ability to reconstruct past ecosystem services.

The approach provides a new tool to that can be used to understand how plants performed different benefits useful for humans over the past 21,000 years, and how these services responded to human and climate disturbances, including droughts and fires, said Thomas Brussel, a postdoctoral researcher in the University of Oregon's Department of Geography.

The approach is detailed in a paper published online Jan. 13 in the journal *Frontiers in Ecology and Evolution*.

Ultimately, Brussel said, the combined information could enhance decisions about conservation to allow regional ecosystem managers to continue to provide goods and services, such as having plants that protect hillsides from erosion or help purify water, based on their relationship with climate changes in the past.

For example, he said, an ecosystem's history may indicate that plants have previously withstood similar disruptions and could continue to thrive through preservation techniques.

Pollen cores have long helped scientists study environmental and ecological changes in a given location that have occurred because of climate changes and wildfires over recent geologic time. Combining pollen records to plant traits provides a picture of how well ecosystems have functioned under different scenarios, Brussel said.

"The biggest finding in this study is that researchers can now be confident that transforming pollen into the processes that ecosystems undergo works," he said. "With this information, we can now explore new questions that were previously unanswerable and provide positive guidance on how we can conserve and manage landscapes and biodiversity."

Brussel began pursuing the approach as a doctoral student at the University of Utah in the emerging field of functional paleoecology. Initial reception to the approach, when presented at conferences, drew interest but also calls for proof that the idea is possible, Brussel said. The paper, co-authored with his Utah mentor Simon Christopher Brewer, provides a proof-of-concept that his approach works.

For the study, Brussel and Brewer merged publicly available records for surface pollen samples found in the Neotoma Paleoecology Database and plant traits, specifically leaf area, plant height and seed mass, from the Botanical Information and Ecology Network.

They then restricted their results to only plants native to ecosystems from Mexico to Canada by combing through the U.S. Department of Agriculture's PLANTS Database and a compilation of all native plants in Mexico.

The resulting data for North America covers some 1,300 individual sites and includes 9.5 million plant height measurements for 2,146 species, 13,103 leaf area details from 1,016 species, and 16,621 seed mass data from 3,580 species.

The information, Brussel said, provides extensive details on the fitness of ecosystems that should help researchers study the mechanisms of changes in carbon or water cycling related to climate change.

"Our work is extremely relevant to modern climate change," he said. "The past houses all these natural experiments. The data are there. We can use that data as parallels for what may happen in the future. Using trait-based information through this approach, we can gain new insight, with confidence, that we haven't been able to get at before now."

At the UO, Brussel is working with Melissa Lucash, a research assistant

professor who studies large, forested landscapes with a focus on the impacts of climate change and wildfires. Brussel is part of Lucash's research on potential climate changes being faced by Siberia's boreal forests and tundra.

He also is applying his approach to potential conservation and management strategies for some of the world's biodiversity hotspots, which are seeing a decline in plant species and wildlife as a result of global change.

"Using the newly validated approach, my idea is to assess the severity of the biodiversity degradation that has been occurring in these regions over recent millennia," Brussel said. "My end goal is to create a list of regions that can be prioritized for hotspot conservation, based on how severe an ecosystem's services have declined over time."

More information: Thomas Brussel et al, Functional Paleoecology and the Pollen-Plant Functional Trait Linkage, *Frontiers in Ecology and Evolution* (2021). DOI: 10.3389/fevo.2020.564609

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