Ancient packrat nests reveal how plants coped with past climate change

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(Phys.org) —Scientists are greatly concerned about the effects that rising carbon dioxide concentration and temperature will have on organisms in the future. Fortunately, scientists can gain a sense for how organisms may respond to future climate change by determining how they responded to climate change events in the past.

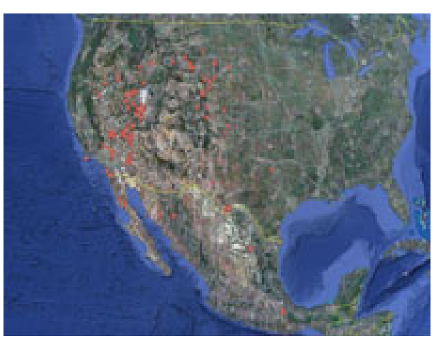
Researchers studying plant life at the University of Kansas are searching for answers to this question by looking at what happened during a time when massive ice sheets covered much of northern North America.

"We're especially interested in understanding how plants survived during the last glacial period, which peaked around 21,000 years ago," said Katie Becklin, a NIH IRACDA postdoctoral researcher in the lab of Joy Ward, a well-known plant biologist and associate professor of ecology and evolutionary biology at KU.

"During that time the Earth's climate was very different than it is today," Becklin said. "On average, the Earth was 14 degrees Fahrenheit cooler than it is today. Along with that, the concentration of carbon dioxide in the atmosphere was only 180 parts per million, which is less than half of what it is today. In fact, glacial carbon dioxide concentrations were among the lowest levels experienced during the evolution of land plants."

Because plants use carbon dioxide to make sugars during photosynthesis, many scientists think that low carbon dioxide levels during the last glacial period may have reduced plant growth, and this is referred to as carbon starvation.

"One of the questions that we have to consider is whether or not glacial plants were genetically adapted to low carbon dioxide concentrations," Becklin said. "If so, those adaptations could affect how plants function under current conditions, and how they may respond to future changes in carbon dioxide and climate."



To address this question, Becklin, Ward and their colleagues, including undergraduate researcher Kayla Sale, a KU University Scholar from Olathe, examined an intact community of ancient conifer plants that were preserved within the middens—or nests—of packrats that lived in Nevada's Snake Range during the last glacial period.

"Packrat middens are basically nests created by a type of rodent that is common throughout the western United States," Becklin said. "These rodents, or packrats, are the original hoarders. They create their nests using many different items such as sticks, leaves, seeds, thorns and bones from their local environment. Plant tissue is well-preserved in these middens, and we can use measurements of stable isotope ratios to better understand how these ancient plants functioned when they were alive."

The late Phillip Wells, a former faculty member in the Department of Ecology & Evolutionary Biology, put together a collection of almost 400 middens from locations across the western United States. The number and breadth of middens make this one of the finest collections of glacial plants in the world.

Nests in this collection range from 2,000 to 50,000 years old. The researchers dated their samples using radiocarbon dating, then measured physiological functioning of the plants over thousands of years using stable carbon isotope techniques. Their findings were recently published in *Ecology Letters*, which is the highest-ranked ecology journal in the world.

Becklin said their results show that most plant species altered their physiologies in response to changes in the environment since the last glacial period. "What's really interesting about these results is that plant species that are closely related—from the same plant family—showed very similar physiological responses," she said. "This suggested that plant lineage, or evolutionary history, is an important factor in driving plant responses to global change."

"The Bristlecone pine tree is an especially interesting species that we examined," Becklin said. This tree species is one of the longest living organisms on Earth, and individual trees can be more than 5,000 years old.

"During the last glacial period, Bristlecone pine trees were the most abundant conifer species in the Snake Range of Nevada where our study is located," she said. "Our results suggest that this species' physiology contributed to its ability to survive under glacial conditions. Unfortunately, this unique plant species has become less abundant over time, which is in part due to its inherent physiology and responses to climate change."

What do these findings mean for the future of the planet's vegetation as temperatures continue to rise and atmospheric carbon dioxide concentrations increase to levels that have not been seen for millions of years?

"Our results suggest that a plant species' evolutionary history is really important in determining how it will respond to global change," Becklin said. "In other words, plant species or families that have different evolutionary histories may respond differently to changes in their environment. Some species may be more likely to change their physiology than others, and for those that do respond, we may see differences in how quickly those species can adjust to new conditions. These differences can make it challenging to predict the effects of climate change since communities and ecosystems are made up of many different species that interact with each other."

According to Becklin, a more thorough understanding of plant responses to climate change is vital to making good choices about managing ecosystems and natural resources in the future.

"Plants are key indicators of climate change effects because plants form the foundation for the rest of the ecosystem," she said. "For example, many organisms rely on plants for food and shelter. Plants also play a key role in carbon storage and nutrient cycling, which are two important ecosystem processes. Consequently, changes in the plant community with climate conditions can impact the rest of the ecosystem."

Provided by University of Kansas

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