Woody plants adapted to past climate change more slowly than herbs

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If evolutionary history repeats itself, woody plants may have a harder time than herbaceous plants keeping pace with global warming. Credit: Yoshikazu Hara, Wikimedia Commons

Can we predict which species will be most vulnerable to climate change by studying how they responded in the past? A new study of flowering plants provides a clue. An analysis of more than 5000 plant species reveals that woody plants — such as trees and shrubs — adapted to past climate change much more slowly than herbaceous plants did. If the past is any indicator of the future, woody plants may have a harder time than other plants keeping pace with global warming, researchers say.

In a new study, biologists at the National Evolutionary Synthesis Center and Yale University teamed up to find out how flowering plants adapted

to new climates over the course of their evolution. By integrating previously published genealogies for several plant groups with temperature and rainfall data for each species, they were able to measure how fast each lineage filled new climate niches over time.

When they compared woody and herbaceous groups, they found that woody plants adapted to new climates 2 to 10 times slower than herbs. "Woody plants eventually evolved to occupy about the same range of climates that herbaceous plants did, but woody plants took a lot longer to get there," said lead author Stephen Smith, a postdoctoral researcher at the National Evolutionary Synthesis Center in Durham, NC.

The researchers trace the disparity to differences in generation time between the two groups. Longer-lived plants like trees and shrubs typically take longer to reach reproductive age than fast-growing herbaceous plants, they explained. "Some woody plants take many years to produce their first flower, whereas for herbs it could take just a couple months," said co-author Jeremy Beaulieu, a graduate student at Yale University.

Because woody plants have longer reproductive cycles, they also tend to accumulate genetic changes at slower rates, prior research shows. "If genetic mutations build up every generation, then in 1000 years you would expect plants with longer generation times to accumulate fewer mutations per unit time," said Smith. This could explain why woody plants were slower to adapt to new environments. If genetic mutations provide the raw material for evolution, then woody plants simply didn't accumulate mutations fast enough to keep up. "If woody and herbaceous plants were running a race, the herbs would be the hares and the woody plants would be the tortoises," said Beaulieu.

By understanding how plants responded to climate change in the past, scientists may be better able to predict which groups will be hardest hit

by global warming in the future. Unlike the tortoise and the hare, however, in this case slow and steady may not win the race. "Woody groups are obviously at a disadvantage as the climate changes," Beaulieu explained.

Does this mean that ecosystems dominated by trees — such as rainforests — will be more likely to disappear? Possibly. "If we look to the past for our clues, chances are trees will continue to respond much slower than herbs — as much as 10 times slower," Smith said. "But if the rate of climate change is 100 times faster, then they could all be in trouble. The kind of change we're experiencing now is so unprecedented," he added. While this study focused on long-term change over the last 100 million years, most climate models predict significant warming in the next century, the researchers explained. "That time frame may be too quick for any plant," Beaulieu said.

More information: Smith, S. A. and J. M. Beaulieu. (2009). " Life-history influences rates of climatic niche evolution in flowering plants." Proceedings of the Royal Society B doi: 10.1098/rspb.2009.1176

Source: National Evolutionary Synthesis Center