Small but speedy: Short plants live in the evolutionary fast lane

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Biologists have known for a long time that some creatures evolve more quickly than others. Exactly why isn't well understood, particularly for plants. But it may be that height plays a role, says Robert Lanfear of Australian National University and the U. S. National Evolutionary Synthesis Center.

In a study to be published 21 May in the journal *Nature Communications*, Lanfear and colleagues report that shorter plants have faster-changing genomes.

Drawing from a database of global patterns in plant height for more than 20,000 species, the researchers estimated average maximum height for nearly 140 plant families worldwide—ranging from a group of tropical plants called the Burmanniaceae, whose average height tops out at two inches (5 cm), to a family called the Tetramelaceae, which can tower above 140 feet (45 m).

For each family, the researchers also estimated how much their DNA sequences—the strings of As, Cs, Ts and Gs that make up their genetic code—changed over time.

When they plotted evolutionary rates against plant height, the researchers were surprised to find that shorter plants evolved as much as five times faster than taller ones.

The pattern held up for both the nuclear and the chloroplast genomes,

even after the researchers accounted for factors shown in previous studies to correlate with evolutionary speed—such as species richness, latitude, temperature, and levels of UV radiation. The results also held up when the researchers looked just within trees and shrubs, which are typically tall, or just herbs, which tend to be short.

What puts short plants in the evolutionary fast lane? The researchers suspect the difference may be driven by genetic changes that accumulate in the actively-dividing cells in the tip of the plant shoot as it grows. Cells don't copy their DNA perfectly each time they divide. In animals, most DNA copy mistakes that occur in the cells of the animal's body can't be inherited—they're evolutionary dead ends. But this isn't the case for plants, where genetic changes in any part of the plant could potentially get passed on if those cells eventually form flowers or other reproductive organs

"Genetic changes that occur during cell division in plant shoots could potentially get passed on to future generations," Lanfear explained.

Importantly, growth slows as plants increase in size, he added. This means that over the long term, the rate of cell division and genome copying in taller plants eventually slows down, and changes in DNA—the raw material for evolution—accumulates less quickly.

"Our study also answers a question that was posed [in a paper] in Nature in 1986:" the researchers write. "Do plants evolve differently? The answer is 'yes.'"

More information: Lanfear, R., et al. (2013). "Taller plants have lower rates of molecular evolution: the rate of mitosis hypothesis." *Nature Communications*.

All data, code and scripts used in this study are available in the Dryad