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TRILOBITES

How Woody Vines Do the Twist

Slowly, scientists are learning how lianas quickly climb.

By Devi Lockwood

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Wood is typically thought of as stiff and rigid, but some wood, in the race upward to access the best sunlight, twists. Lianas, or woody vines, are concentrated in tropical forests; they possess a narrow stem that lets them climb to the top of the canopy, more than 100 feet above the ground, as quickly as possible by twisting their way around tree trunks. Basking in the sun at the top, these vines flower, fruit and lay out new leaves as they photosynthesize.

But the number of lianas is increasing in tropical forests relative to trees, and their overabundance can hamper a forest's ability to store carbon, so botanists are eager to learn as much about these plants as they can.

"We understand a lot about their ecology, but we don't understand how these diverse and strange wood forms evolved," said Joyce Chery, a botanist at Cornell, and the lead author of a study published earlier this year in the journal Current Biology.

In early 2017, as a graduate student, Dr. Chery visited the Smithsonian Tropical Research Institute in Panama, where she collected cross-section samples of various species of Paullinia, a lineage of liana. Those samples are now part of the herbaria at the University of California, Berkeley, and the University of Panama.

Dr. Chery extracted DNA from the leaves and analyzed the molecular sequence of each sample, and of similar samples stored at herbaria at the University of Panama, Universidad Nacional Autónoma de México and the Smithsonian Institution. She also studied the configuration of cells in 148 samples of cross-sections of the stems.

The Smithsonian Tropical Research Institute in Gamboa, Panama. Luis Acosta/Agence France-Presse — Getty Images

From this analysis, Dr. Chery and the co-authors on the recent paper identified five patterns of stem growth, ranging from circular to lobed, to star-shaped cross-sections.

The driving force behind each of these patterns is a bundle of cells behind the bark called the vascular cambium. To survive, a woody vine must be both strong and flexible — variant shapes allow woody vines to make the twists and turns they need to be successful in the tropics. Their sugar- and water-conducting cells are positioned in irregular ways, far different than they would be in run-of-the-mill trees or shrubs.

“Whereas trees all tend to be the same shape, lianas are all over the place,” said Stefan Schnitzer, a botanist at Marquette University who was not involved in the study.

These strange stem variations give the vines an advantage. “Being asymmetrical helps you to anchor in the trees you’re growing on,” said Marcelo Rodrigo Pace, a botanist at Universidad Nacional Autónoma de México and a co-author of the study. “These lianas also have tendrils that let them grab pieces of stems and leaves and start growing.”

This adaptation is “purely mechanical, architectural,” he said. “It’s better than being slippery and cylindrical.”

The study considered two scales of time: an individual plant's life, and a longer, evolutionary breadth. Dr. Chery and her colleagues found that in a single plant's early development, when the liana is leafy, green and small, woody vines already have an unusual tissue formation. The stem is star-shaped rather than circular; the vascular bundles are scattered in the lobes of the star-shaped body and absent in the arcs. At later stages, this lobed structure can lead to more unusual growth patterns.

Over evolutionary time, vines of different groups developed various mechanisms to contort their stems. The paper's authors found that the five different atypical forms found in mature liana stems trace their evolutionary history back to a common disturbance to the young plant's development: the lobed stem.

"This is exciting because it's one step away from saying that this leads in perfectly to understanding how lianas do what they do," Dr. Schnitzer said. While lianas share most characteristics with trees, like producing wood and thriving in similar environmental conditions, the two plant types invest differently in certain parts of their composition. Lianas have more cells related to being flexible, whereas trees prioritize being stiff and tough. Both have cells responsible for stiffness and flexibility in differing ratios.

"They have the same ingredients, but the proportion of those ingredients is distributed differently," Dr. Chery said.

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