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Guam's most endangered tree species reveals universal biological concept

Newly published research carried out at the University of Guam has used a critically endangered species to show how trees modify leaf function to best exploit prevailing light conditions. The findings revealed numerous leaf traits that change depending on the light levels during leaf construction.

"The list of ways a leaf can modify its shape and structure is lengthy, and past research has not adequately looked at that entire list," said Benjamin Deloso, lead author of the study.

The results appear in the October issue of the journal *Biology* (doi:10.3390/biology9100333).

Terrestrial plants are unable to move after they find their permanent home, so they employ methods to maximize their growth potential under prevailing conditions by modifying their structure and behavior. The environmental factor that has been most studied in this line of botany research is the availability of light, as many trees begin their life in deep shade but eventually grow tall to position their leaves in full sun when they are old. These changes in prevailing light require the tree to modify the manner in which their leaves are constructed to capitalize on the light that is available at the time of leaf construction.

"One size does not fit all," Deloso said. "A leaf designed to perform in deep shade would try to use every bit of the limited light energy, but a leaf grown under full sun needs to refrain from being damaged by excessive energy."

The research team used Guam's critically endangered *Serianthes nelsonii* tree as the model species because of the complexity of its leaf design. This tree's leaf is classified as a bi-pinnate compound leaf, a designation that means a single leaf is comprised of many smaller leaflets that are arranged on linear structures that have a stem-like appearance. The primary outcome of the work was to show that this type of leaf modifies many whole-leaf traits in response to prevailing light conditions. Most literature on this subject has not completely considered many of these whole-leaf traits, and may have under-estimated the diversity of skills that compound leaves can benefit from while achieving the greatest growth potential.

This study provides an example of how plant species that are federally listed as endangered can be exploited for non-destructive research, helping to highlight the value of conserving the world's threatened biodiversity while demonstrating a universal concept.

The study was a continuation of several years of research at the University of Guam designed to understand the ecology of the species. The research program has identified recruitment as the greatest limitation of species survival. Recruitment is what botanists use to describe the transition of seedlings into larger juvenile plants that are better able to remain viable. Considerable seed germination and seedling establishment occur in Guam's habitat, but 100% of the seedlings die. Extreme shade is one of the possible stress factors that generate the seedling mortality. Testing this possibility by providing outplanted seedlings with a greater range of sunlight transmission than the 6% recorded in this study may provide answers to the extreme shade stress hypothesis.

The latest results have augmented the team's earlier research that demonstrated how a specialized leaf gland enables rapid leaflet movement when the light energy is excessive. This skill of being able to change the leaflet's orientation is an instantaneous behavior that mitigates the damage that may result from excessive sunlight exposure.

"Just because the tree can't move itself, that doesn't mean it can't move its leaves to avoid stress," Deloso said.

Serianthes nelsonii was listed on the Endangered Species Act in 1987. A formal plan to recover the species was published in 1994 and called for research to more fully understand the factors that limit success of the species. This latest publication adds to the expanding knowledge that the University of Guam is generating to inform conservation decisions into the future.

Further Reading:

Deloso, B.E. and T.E. Marler. 2020. Bi-pinnate compound *Serianthes nelsonii* leaf-level plasticity magnifies leaflet-level plasticity. Biology 9: 333; doi:10.3390/biology9100333.

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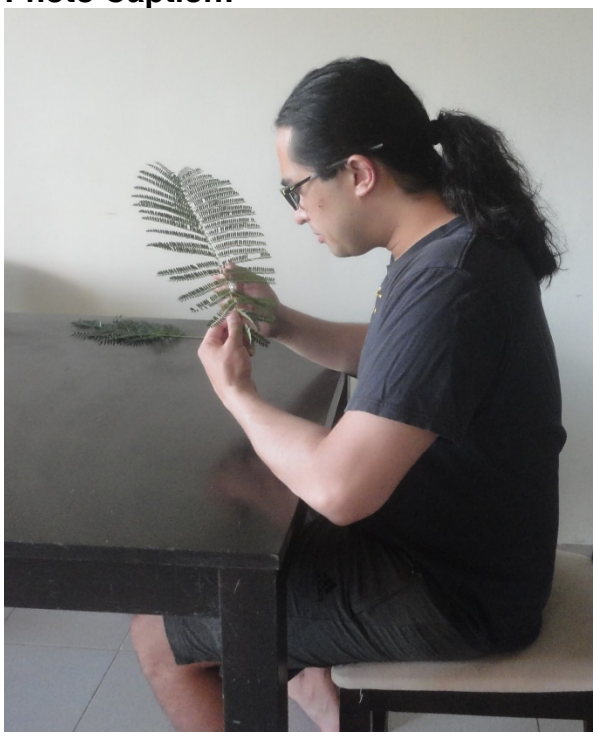
Photo Caption:



University of Guam Research Associate Benjamin Deloso examines a bi-pinnately compound leaf of Guam's flame tree. The endangered *Serianthes nelsonii* tree makes a leaf that uses this same design.
Photo courtesy of University of Guam