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Mangroves in the Margin

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Against the azure backdrop of the Caribbean sky, Dr. Candy Feller perches in the canopy of a mangrove tree nearly 20 feet off the ground unaffected by the sweltering heat and oppressive smell of sulfur wafting from the swamp. Painstakingly, she plucks select leaves and insects from the highest branches, inspects them one by one and then tucks them carefully away for later.

An insect and plant ecologist, Feller will spend many hours a day for two to three weeks at a stretch engaged in this tedious ritual at her field site in Belize. She will repeat the process, as she has for many years, in mangrove forests in Panama, Brazil, Australia, New Zealand and Florida. Her goal is to understand the impact of changes in available nutrients on the structure and function of mangrove ecosystems. “All kinds of things such as growth, decomposition, nutrient cycling and herbivory respond in different ways to different nutrient inputs,” she says. “These differences can have major effects on the function of the mangrove.”

Between Two Worlds

Once considered unpleasant and expendable coastal hinterlands, mangroves are now recognized as necessary to the health of both the terrestrial and aquatic worlds they straddle. As buffers, they trap sediment, pollutants and nutrients running off the land. As breakwaters, they protect the shore from erosion and storm damage. They also serve as nursery grounds for marine organisms, such as reef and ocean fish, and shore birds.

Like the salt marshes of the temperate zone, mangrove trees are supremely adapted to living in the extreme environment where land and sea intertwine. Every day they are alternately inundated with salty ocean tides and desiccated under the sun. They are intermittently drenched in fresh rainwater and battered by storms.

To survive their harsh environment, they have developed a variety of adaptive characteristics. Prop roots emerge from the trunks of some species to cascade downward through the air in a tangled thicket. On island fringes, these prop roots hang suspended in the water and provide a sturdy brace against the tireless sea breeze and relentless waves. In other species, specialized roots shoot skyward out of the sodden ground, their pores opening to an extensive system of airways that transports oxygen to the belowground root system. In yet another elegant adaptation to their briny surroundings, mangrove trees are able to extract fresh water from the sea or exclude saltwater from their tissues.

Losing Ground

But despite their adaptive nature and hardy resilience, mangroves are losing ground to the demands of the modern world. In 2006, the United Nations Environmental Program reported that more than a third of the world’s mangroves are now gone. Cleared to make way for housing developments, resorts and aquaculture, they are disappearing faster than tropical rainforests.

In Belize, on the islands adjacent to Feller’s study site, large tracts of mangroves are being cleared for luxury homes, resorts and shrimp farms. Although Belize has set regulations to restrict clearing, enforcement is rare, and pressure to capitalize on the demand from the developed world is, in most cases, irresistible. But the consequences of clearing have already proven disastrous in

other parts of the world. Large tropical storms have destroyed villages along coastlines that have been depleted of their mangrove buffers, while adjacent villages that remained protected by intact mangroves have suffered very little damage.

Furthermore, like big sponges, mangroves absorb human waste and sediment washing off the land. For fragile coral reefs, they are the first line of defense against the assaults of land side development. What those assaults do to the mangroves, however, is largely unknown. Feller hopes to help change that. For 15 years, she has been carefully fertilizing patches of mangrove trees and monitoring the effects on plant growth and herbivory.

At Twin Cays in Belize and at comparative sites in Florida, Feller has found that the type of fertilizer she uses and which trees she fertilizes can have very different impacts on the ecosystem. Her studies have shown that nitrogen, such as that introduced by fertilizer and waste, spurs the growth of mangroves along inland shorelines. The addition of phosphorous, a nutrient that washes into the water when land is cleared, increases the growth of trees in mangrove islands offshore.

Gaining Insight

To Feller, understanding which mangroves grow in response to which land-based activities is only the first step. The next step has been to figure out how shifts in mangrove populations and changes in the nutrients available to each plant affect the things that feed on them. Herbivores play a major role in controlling the amount and distribution of biomass in a forest, so it's important to understand how human activity on land will affect their food source. An increase in herbivores in the mangroves could decrease plant size or yield, and the results could vary depending upon which plants are affected. Over time, these sorts of interactions can influence the structure and function of the entire mangrove ecosystem. Predicting how such changes will unfold is nearly impossible at the moment, because so much remains to be learned.

Sitting among the gnarled thicket of her experimental mangrove trees, Feller has collected dozens of insects previously unknown to science (including one she describes as "a gorgeous long-horned beetle" that was named after her). In a recent study investigating the impact of nutrient inputs to herbivory at Twin Cays, Feller determined that the two dominant herbivores are previously undescribed psyllids. A type of sap-sucking plant lice, the psyllids varied their eating patterns and their location on the island depending on the nutrient added. While they don't leave holes in the plants or eat the leaves, the psyllids do stunt and deform them, resulting in a loss of yield to the plant. "It's subtle, often overlooked as a significant form of herbivory," Feller says. "Quantifying it is the tricky part."

Indeed, it requires many laborious hours of counting, measuring, weighing, and comparing the leaves and insects from affected and unaffected plants. It's slow and monotonous, but for Feller, who feels perfectly at home perched high in a tree gathering insects and twigs, it's a satisfying way to begin assembling the big picture. "I'm trying to figure out basically what happens in the system," she says, and the system is revealing itself to her one leaf at a time.
