We're on a ridge high above O'ahu's Kuli'ou'ou Valley. Extreme winds, driving rain, steep drops. "This is a little above my pay grade," I stammer to the slender woman guiding me up the unmarked trail. Ahead lies a fifty-foot stretch along a razor-thin ridge with calamitous drops on both sides. The mist-slick trail is maybe eighteen inches wide. The native forest growing on the highest ridges of the Ko'olau surrounds us. Ahead lie steep slopes full of magnificent 'ohi'a trees, including types not yet named, a biological treasure trove that might hold clues to the origin of the species. But first we have to get across this stretch.

My guide is patient but eager to get up the hill. Elizabeth Stacy is a lithe blond forest sprite with boundless energy. She's also a professor at the University of Hawai'i at Hilo and one of the world's foremost experts on the Metrosideros family of trees, locally known as 'ohi'a. She gamely offers to turn around rather than leave me here alone on the ridge while she forges on. "I think I can make it," I say. "Does it get worse?"

"I don't think so," she replies, "but I didn't remember it being this narrow, either." In a flash she's gone, over the ridge and clambering up the ropes dangling from the precipice on the far side. Stacy's fleet, but she's also fallen victim to her enthusiasm. The bump on her nose? From tumbling backward off a trail on Mount Ka'ala. Her limp? A broken foot from sliding off this same steep, unmarked trail. Her other limp? Tendonitis of the knee that flares when she climbs. "I know I should stop and let my body recover, but I just don't have any time," she says. "There is so much to do."

That's because Stacy is a woman on a mission: She's the 'Ohi'a Hunter of Hawai'i, and she is seeking answers to one of the great questions of biology: How do new species emerge?

In Hawaiian mythology the story of the 'ohi'a tree and its pompom-like lehua blossom goes something like this: 'Ohi'a and Lehua were young lovers. But Pele, the volcano goddess, fell for the striking 'Ohi'a. When she sought his affection, however, faithful 'Ohi'a rejected her. So Pele, in a jealous rage, turned him into a tree. Lehua cried and
cried over her lost lover. Out of pity the other Hawaiian gods transformed her into a beautiful, feathery blossom that hung on the branches of the ‘ohi’a tree, so the couple would be forever united. This myth is well known in the Islands; it’s frequently been told through hula kahiko (ancient hula). It’s often said even today that when one picks a red lehua blossom, rain will follow because the lovers have become separated.

What drew Stacy to the ‘ohi’a, though, had nothing to do with legends; she was amazed by its sheer ubiquity. “It is such a dominant species,” says Stacy. The trees thrive in barren lava deserts, where their gossamer-thin roots find buried moisture, and in highland bogs, where they grow in dwarf forms. For native birds, land snails and insects, ‘ohi’a are welcome but fastdisappearing shelter. While ‘ohi’a are not endangered or even threatened, most of the once-vast tracts where they were predominant have largely been displaced by invasive tree species. And genetically scientists consider ‘ohi’a to be a “messy” family, with numerous hybrids and species —a fascinating Gordian knot for an evolutionary biologist to try and untie.
Last year on the Wailuku River, which runs through the middle of Hilo town, Stacy and her team found an unusual group of 'ohi'a. Living among the rocks on steep banks, these trees survive submerged for long periods, unlike any other known 'ohi'a. What's more, it turns out they can't reproduce with other types of 'ohi'a, and they have different DNA—which means they could be an unknown species. Trees are thought to have arrived in Hawai'i no earlier than one hundred thousand years ago, an evolutionary blink of the eye. So the question is, How could a new species evolve in such a short time? Even more tantalizing, there could be a number of undocumented varieties, some poised to become new species in the near future.

This partly explains why studying 'ohi'a in Hawai'i is so interesting. Each island has slightly different 'ohi'a trees because the islands are different ages. That difference in ages creates more variety in landscapes and environmental conditions, which leads to greater diversity among plants within the same family. For example one 'ohi'a species, Metrosideros polymorpha (a.k.a. 'ohi'a lehua), can grow as straight, tall trees in dry forests, as small shrubs in cloud forest bogs or as enormous, sprawling “walking lehua” in rainforests. The stubby Metrosideros rugosa, or lehua papa, is endemic to O'ahu and has round, deeply furrowed leaves. Metrosideros waialeale, which grows only on Kaua'i, has longer leaves that do not gather into rosettes. Such differences, when considered along with the underlying genetic fingerprints, provide Stacy accurate time stamps for when different species could have evolved. That in turn makes it easier to track complex evolutionary processes.

Stacy, who is in her late 30s, has spent most of her professional career unraveling the secrets of trees. A Bostonian who grew up loving nature, she studied pre-veterinary medicine at Penn State University. After graduating she volunteered with a forest research team headed for the Amazon, where she fell in love with tropical rainforests, trees in particular.

Shortly after arriving in Hilo in 2004, Stacy noticed that 'ohi'a were ubiquitous on the Big Island. In fact, Stacy discovered, 'ohi'a are often the only native tree in some places. “Rarely do you find such dominance by a single species of trees among native flora,” she says. “It was just amazing. I started asking questions and found that very little research had been done on the genetics and evolution of the Metrosideros. It's a messy family: There are so many hybrids, so many varieties, and the speciation was really unclear. We had the five known species, but there could have been many others. … We just didn’t know.” When Stacy investigated why there wasn’t more research on 'ohi’a, a colleague told her that they were complex and scary, meaning there was no obvious path to an amazing discovery. It was a career risk for a scientist. But not for Stacy: “I thought, ‘Cool! That’s a great opportunity.’ I like messes, you see.”

Slowly, one foot at a time, I cross the ridge and then climb the rope. My hands slip, and I have a moment of terror before gaining a toehold. Just above the top of the rope is a patch of Metrosideros rugosa, the aforementioned stubby species that lives only high in the mountains and prefers wickedly windy conditions. Next to the rugosa sits a different 'ohi'a. The leaves are a slightly lighter green and more oblong. Stacy rubs the underside of the leaves to see how easily the soft fuzz comes off. “This one … I have no idea. It’s a wild hybrid of some sort. Probably a loser.” A reproductive loser, that is. Stacy hopes to sort the losers from the winners to determine why some hybrid trees become full-blown species capable of reproducing and others don’t.

Occasionally we pass 'ohi'a blossoms wrapped in tiny mesh bags — places where Stacy and her UH Hilo students have hand-pollinated a blossom to ensure that it gets fertilized by a specific male. By mating hybrid and non-hybrid trees in different combinations, Stacy can both identify new species and gain insight into how trees evolve. “Hawai'i is a blank slate upon which organisms can colonize, differentiate and speciate,” she says. “Hawai'i Island is the youngest, so we can look at what’s going on there and contrast it with what we see on the older islands of O'ahu and Kaua'i to look for patterns that develop over time.”

There’s a lot of effort to this sort of science: Stacy and her assistants keep tabs on 'ohi'a populations on O'ahu, Kaua'i and the Big Island, which involves painstaking record keeping, computerized bioinformatics and genetic analysis and complex GPS location tracking. But perhaps the hardest part, she says, is hand-pollination, especially in conditions like this. “If it's windy or it's wet or anything, getting those tiny little bits of pollen into the blossoms is darn near impossible. One time we were up here and the bees were out,” she recalls. “And we were literally racing the bees, because once they land on a blossom, we can’t use it. They carry too much pollen. So we had to pollinate then bag blossoms as fast as we could. We were exhausted.”
Truthfully it’s hard to imagine Elizabeth Stacy ever being exhausted. Her enthusiasm for her research is among the reasons Stacy received a prestigious, five-year National Science Foundation CAREER grant. She’s also a popular lecturer and works with K-12 students on the Big Island to spread the gospel of science. Stacy uses a demonstration garden to show students how two plants of the same species can turn out differently depending on the conditions.

In the field her tools are rudimentary and catch-as-catch-can. But in the lab Stacy is riding at the forefront of evolutionary genetics. “We search for divergences in the so-called ‘microsatellite DNA’ of related plants.” Her team has identified striking differences, for example, in microsatellite DNA between the Wailuku River ‘ohi’a and other ‘ohi’a from Hawai’i Island—meaning that she could be tantalizingly close to discovering a new ‘ohi’a species. To be certain that it’s new will require more study. It’s possible that it might not be a new species, but rather an old one that fared poorly in the modern world. “Few places in Hawai’i remain totally undisturbed,” she says. “Things that are considered rare today maybe were common at one time but are now dealing with lost habitat or competition by invasive weeds.”

The rain has slackened. The sun is out, and the colors of the forest come alive. We stop at a healthy ‘ohi’a, a tree that Stacy and her team have used for several pollinations. It’s still blossoming even though the flowering season for most ‘ohi’a is over. “I never really know exactly when they’ll flower and when they won’t. There’s just so much variation that it’s impossible to make blanket statements,” she says. “They always surprise me, and that’s one of the reasons I find them so fascinating.”

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On the web: