



ALEC BURNLEY

Looking to the past to restore
the future of a Hawaiian island

LESSONS OF A LIMESTONE

CAVE

By Sharon Levy

Paleoecologist David Burney was drawn to Kauai not by tropical sunshine but by a sinkhole at the mouth of a dank limestone cave. David, director of conservation at Kauai's National Tropical Botanical Garden, and his wife, Lida Piggott Burney, also a paleoecologist, began excavating the ancient Makauwahi Cave on the island's south coast in 1992. Their children, now grown, helped them sift bones and seeds thousands of years old from the mud of the cave floor. Over the years, the project has grown from a simple excavation into a pioneering effort to restore the vanished ecosystem of Kauai, using fossils as a guide.

"We don't own the cave," says David, "but the cave certainly owns us."

Standing at the start of the sandy trail that leads to Makauwahi, the Burneys reminisce. Both are in their late fifties, fit, and speak in a soft Carolina drawl. "We looked all over the world for a place like this one, with well-preserved fossils and human artifacts and the potential for community involvement," David says. During their shared career, the Burneys have worked at sites scattered from Africa to Puerto Rico to the farm fields of upper New York State, digging up bits of fossilized pollen, leaves, bones, and ash to reconstruct ancient ecosystems.

A short walk over dunes and stone outcrops brings us to the lip of the sinkhole. We stand on what remains of the

cave roof, which collapsed thousands of years ago, leaving a swath of ground encircled by rock but open to the tropical sun. Below us, Makauwahi blooms with dozens of indigenous flowers, shrubs, and trees planted by the Burneys, based on their finds deep beneath the floor of the sinkhole and its adjacent cave.

To reach the sinkhole, we crawl through a small opening in the side of the cave. We emerge inside a long tunnel that leads inland, toward the heart of the limestone mass perched atop a long-dead volcano, which lifted Kauai out of the sea. The cave's roof and walls are layered with miniature spires and curtains of stone that have formed from the dripping of muddy water over the course of tens of thousands of years. Deep in the tunnel, far beyond the reach of daylight,



ELLEN COULOMBE; GORDON SMITH (OPPOSITE)

The cave walls are nearly 400,000 years old; the graceful cones and ridges of flowstone that decorate them began to form at least 50,000 years ago.



Pages 44–45: Carrying a bucket of fossil-filled mud, paleoecologist David Burney climbs out of an excavated pit (opposite, an aerial view) in Makauwahi Cave on Kauai. The mud contains evidence of life forms that dwelt in the area for millennia, until humans arrived. In the total darkness of cave passages, a fragile ecosystem of blind invertebrates has evolved, including the carnivorous Kauai blind cave wolf spider (above).



ALEX BURNEY (2)

lie openings that hold ancient Hawaiian burials. The Burneys have taken care to leave these places undisturbed.

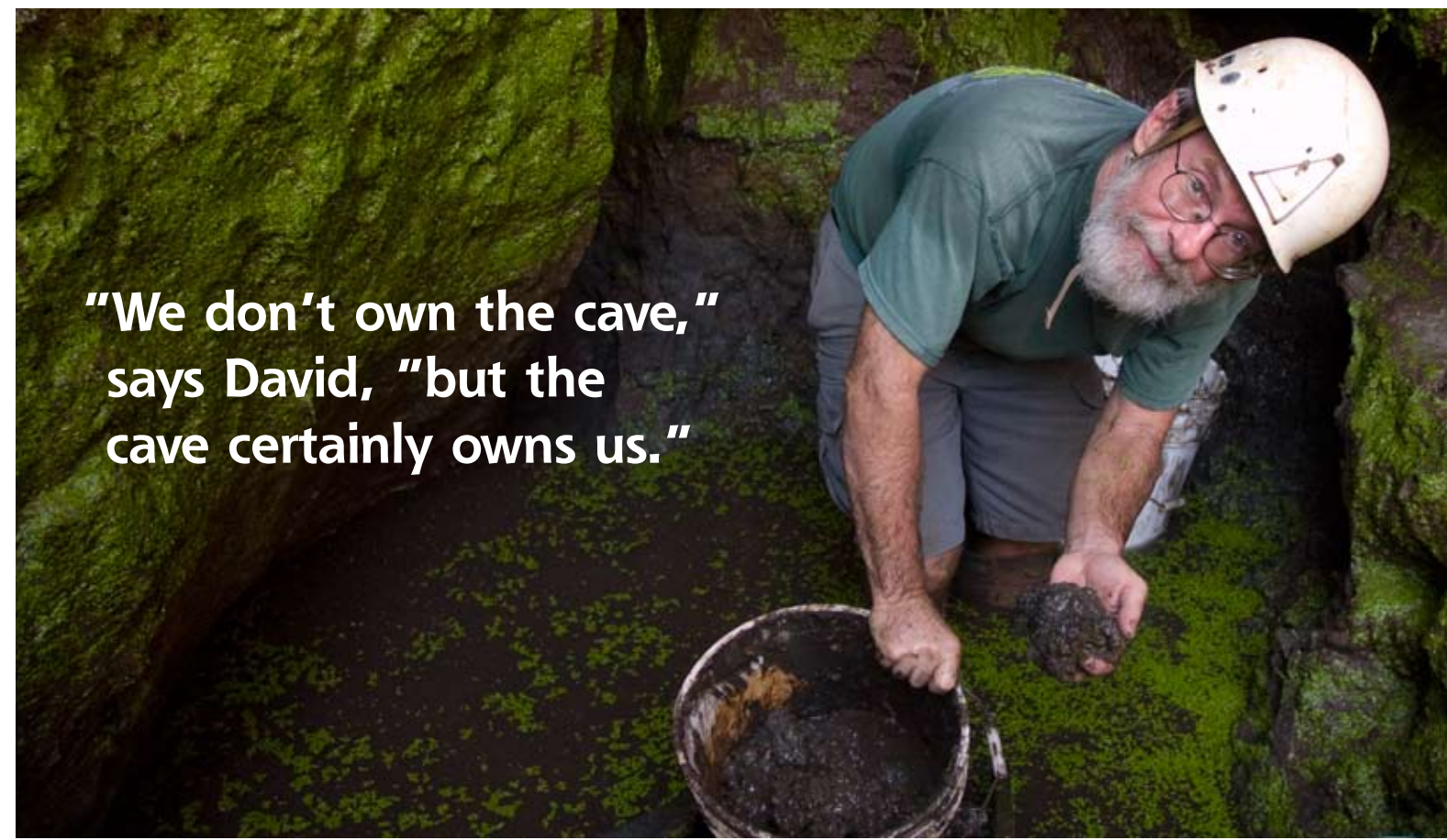
Out in the bright sunshine, palms sway in a gentle breeze. The trees look as if they've always stood here, as eternal as the tide rushing in on the nearby beach. In fact, these 20-foot-tall plants are only four years old, bearing flowers and fruit for the first time. They constitute a miracle: a native species returning to life after a close brush with extinction.

"This is one of the rarest palms in the world," explains David. "There are only two trees of this species, *Pritchardia aylmer-robinsonii*, alive in the wild. We chose to plant this species here because it has distinctive, spherical seeds that match about 95 percent of the fossil palm seeds we've found at this site." The *Pritchardia* palms are surrounded by thriving native shrubs and flowers. The successful restoration of many of these native plants here on the coast defies conventional wisdom, which long held that these species could grow only high on remote mountains and cliff faces.

Like the other main islands in the Hawaiian archipelago, Kauai is so overrun with introduced species that native plants and animals have become precious rarities. Many of the survivors exist solely in Kauai's highlands—rugged terrain that in some cases can be reached only with helicopters and climbing ropes. The impact of introduced cats, rats, and pigs, along with deadly avian diseases carried by introduced mosquitoes, have driven the dwindling number of native forest birds to a few high-elevation refuges.

Botanists working on the island had assumed that the many rare plants found only in the mountains are adapted to higher altitudes and had never grown in the

Lida Pigott Burney (left) sifts cave mud from an excavation deep below the water table. The fossil-rich sediment has yielded bones of large extinct birds, as seen here, as well as shells of extinct land snails, seeds and wood of rare plants, and artifacts of the earliest Polynesian people on Kauai. Opposite: David Burney gathers another bucket of mud for sifting.



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lowlands along the coast. But ancient seeds, leaves, bones, and shells preserved in the layers of sediment at Makauwahi have revolutionized the Burneys' ideas about Kauai before human arrival and have led them to a new way of restoring the island's plundered ecosystems. To find the path forward, they now believe, ecologists must study the distant past.

Before the first Polynesian settlers set foot on Kauai, Hawaii was a strange Eden, empty of mammals, reptiles, and amphibians, because none had ever made it across the vastness of the Pacific to these remote islands. An array of native birds that had evolved in splendid isolation filled every kind of niche. Among the bones discovered at Makauwahi were those of one lumbering flightless duck with a heavy bill designed to graze like a tortoise on short, tough grass and vegetation from rocks. The bones of another duck showed that it probably browsed on ferns and the leaves of shrubs, filling the ecological role of a goat.

Bones of the endangered Hawaiian hawk and Laysan duck have also been discovered at the sinkhole. Today, these two species survive on single islands distant from Kauai, but the fossil discoveries suggest they were once more widespread throughout Hawaii, and that populations could be restored on Kauai.

More than 40 species of extinct native bird fossils have been excavated from Makauwahi, including an odd long-

legged owl, which specialized in hunting small forest birds, and a nocturnal duck with shrunken eyes. Hold the bones of these strange beasts in your hand, and it's easy to become lost in contemplation of their vanished world. But the Burneys' work at the sinkhole is not just about dead things from the past. "We need to look at what's still alive, but could be lost if we don't take action," says David. At the National Tropical Botanical Garden, he focuses on rescuing the island's vanishing native plants. His team of botanists and volunteers gathers seeds from the last wild survivors in order to raise new sprouts in the garden's greenhouse and replant them in their natural habitats.

Keeping native plants alive can be crucial for green sea turtles and other wildlife. The invasion of exotic beach grasses at Lawai Kai, a strand of beach once heavily used by nesting green sea turtles, caused the turtles to abandon the area. David's excavation work on the beach has given him a 6,000-year record of the plant life, an invaluable guide to restoring the pre-human, turtle-friendly vegetation.

With the help of a group of dedicated volunteers, the Burneys have been working to remove introduced plant species from the Makauwahi Cave and the surrounding lands, and to grow native species, some of which may not have sprouted here for hundreds of years. A crucial first step was gaining a lease on the property, which is owned by Grove

Farm Company. Keeping jeeps and trucks off the sand was also imperative. “Once we got the vehicles off, some native plants started to come back on their own and others were easy to reestablish,” remembers Lida. She points out a native Hawaiian relative of the cotton plant, its stems bright with yellow blossoms, and a native morning glory with pale lavender flowers. “If you clear an area of invasives, there seem to be plenty of seeds in the ground.”

For other plants, like the *Pritchardia* palms thriving inside the sinkhole, seeds had to be collected from a few wild survivors. The palms were probably among the first native plants to disappear after Polynesians arrived, victims of rats that had stowed away in the settlers’ ocean-going canoes. “As soon as we start to see rat bones in the sediments—about a thousand years ago, at the same time we find the first evidence of human occupation—*Pritchardia* seeds vanish,” says David.

He adds that the *Pritchardia* palms growing at the botanical garden are a favorite target of hungry rats. The rodents climb the trees to reach the nutritious, fat-rich seeds before they can mature and drop to the ground. “We think that rats neutered the palms, stopped them from reproducing. And people probably overused the palms as well, because they harvested the leaves for thatch, so they cut the tops out of the trees. If you do that too much, the trees can’t reproduce, they’ll disappear,” he explains.

Throughout the Hawaiian Islands, rats remain a serious problem for many native plants and birds, whose eggs and nestlings they prey on. Within the sinkhole, the Burneys have been able to control the rat population through trapping.

Other native plants were able to survive centuries of settlement by the first Hawaiians, but vanished after European contact. The arrival of Captain Cook’s expedition in 1778 is clearly marked in the sediments of Makauwahi. In addition to traditional bone fish hooks, the first iron hooks—fashioned from nails used on the tall ships—appear. So do the remains of goats, the first of a wave of European livestock that would devastate native plants.

“Many of the species that only grow up on cliffs or in the mountains today are up there because that’s the only place they haven’t gone extinct yet,” says Burney. “It’s not that they’re particularly adapted to cliffs, that’s just the only place where goats won’t get them.”

The fossil record and historical documents show that within a few decades of Cook’s arrival in Hawaii, the beach near Makauwahi had been denuded of most native plants. An 1824 sketch from a missionary’s notebook shows 34 houses standing in the area, but only a single tree. Native Kauaians continued to farm the sandy soil as they had for generations: One of the finds at the sinkhole is a 300-year-old yam, intact except for a few insect holes.

Now, in a series of fields just inland of Makauwahi, Lida is carrying on that farming tradition in a new way, tending a mixture of the commonplace and the extremely rare. One of the native plants growing here was recently discovered on

Mount Haupu, which towers above the Maha’ulepu Valley, where the cave lies. Ken Wood, a botanist working with the National Tropical Botanical Garden, was climbing a sheer cliff face when he realized he was looking at a plant he’d never seen before, so he collected a few seeds. By the time he confirmed that he’d discovered a new species, the last of the wild plants had disappeared. The flowering plant, still unnamed, now exists only in the garden’s greenhouse and gardens and in Lida’s restoration plots, where rare natives are interspersed with ordinary plants like squash and tomatoes. “I want to demonstrate that subsistence farming and native plant restoration can be compatible,” she explains. “Since we grow the native plants without using toxic chemicals, food can be produced on the same land.”

The Burneys’ work is changing the way ecologists under-

stand Kauai’s past. But for the Burneys, the most compelling mission is to change the way local people see the future of their island. They’ve begun a program that teaches middle school and high school students about the fossil finds at Makauwahi, then brings them out to work on restoration projects. Every high school on Kauai hosts one of these Junior Restoration teams, and more than 600 kids have come to study and work at the cave. “They’ll plant something and come back at the end of the school year and see how much it’s grown,” says David. “They name their plants, draw pictures of them. They get a sense of how long it takes to make a new forest.”

David stands in the dark recesses of Makauwahi Cave. “This place can give people a true sense of the immensity of time,” he says. The cave walls are nearly 400,000 years

old; the graceful cones and ridges of flowstone that decorate them began to form at least 50,000 years ago. The sediments beneath his feet have revealed the changing story of life on Kauai long before the first human walked its beaches. In the topmost layer, David has found artifacts from his own lifetime. “I have found Bakelite plastic that looks just like the stuff I saw in my grandmother’s kitchen when I was a child,” he muses.

After a long career spent studying the ecology of the past, David now focuses on what lies ahead. “The most interesting part of the story,” he says, “is all about the future.”

Freelance writer Sharon Levy lives in northern California and often dreams of Kauai. She wrote about the island’s Newell’s shearwaters in the October 2007 issue.

Right: Volunteer guide Mel Gabel shows visitors interpretive signage that depicts the geology, research findings, and volunteer activities at Makauwahi Cave Reserve. Groups of volunteers from local high schools are working hard to uproot alien plant species around the cave and replace them with seedlings of native species, including kou and hala, two trees that botanists had previously believed were brought to the island by Polynesian settlers. Finds in the cave sediments make it clear that these plants were abundant on Kauai long before the first human settlers arrived. The trees thrived in a forest far more diverse than any of the coastal plant communities surviving there today.

