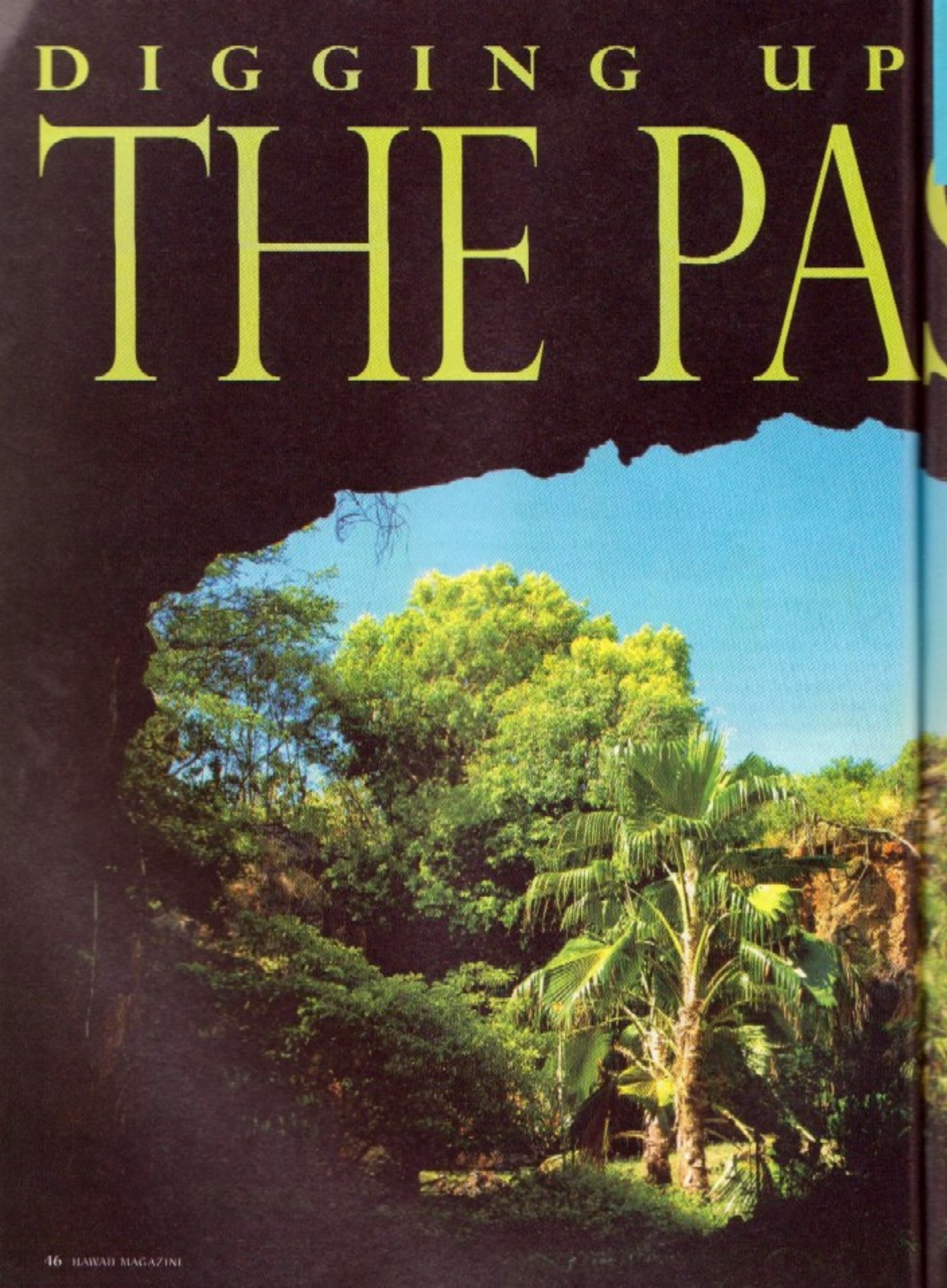
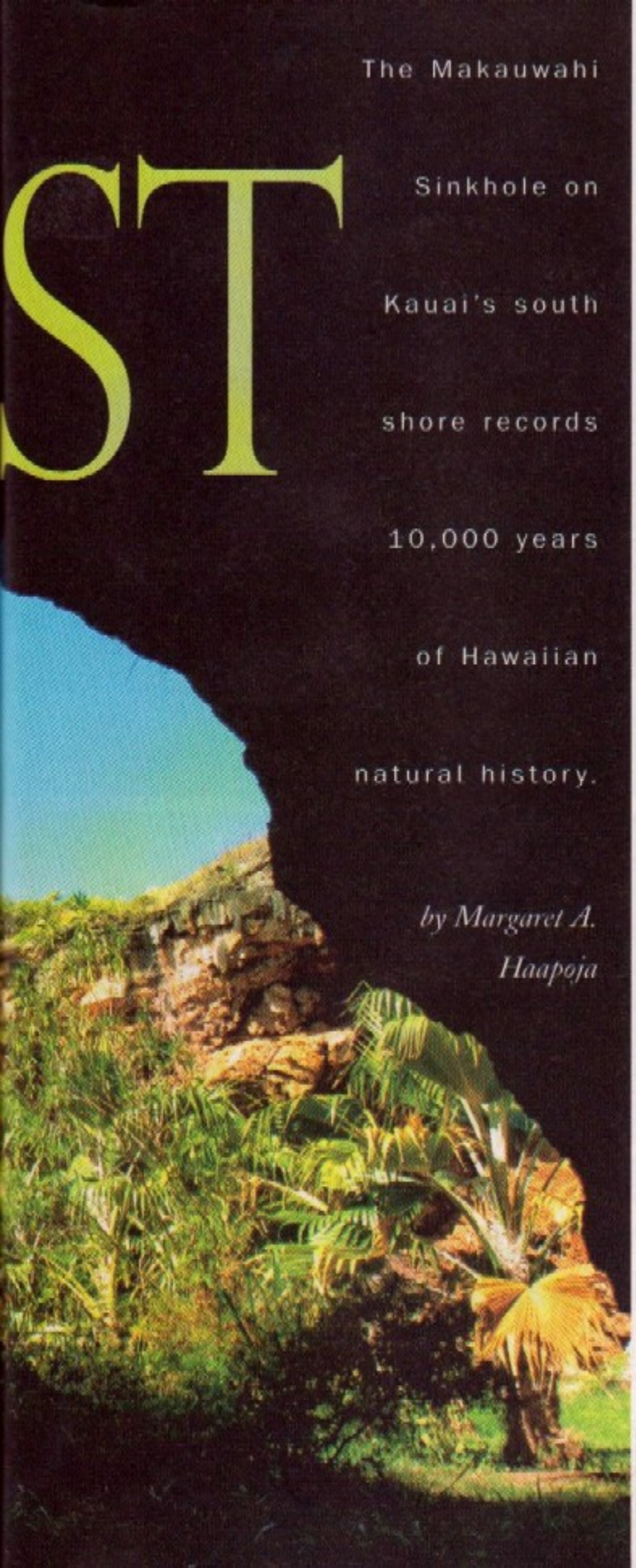
DIGGING UP THE PA



LOST

The Makauwahi Sinkhole on Kauai's south shore records 10,000 years of Hawaiian natural history.

by Margaret A. Haapoja



BRODIE MACKAY

Peeling back time like the layers of an onion, paleoecologists Dr. David Burney and Dr. Lida Pigott Burney and dozens of volunteers are digging up astonishing secrets of Kauai's past at the Makauwahi Sinkhole, a record of Hawaiian history that dates back 10,000 years. The project has changed the current understanding of what Hawaii looked like before humans arrived. In partnership with the late Dr. Bill Pila Kikuchi, who did archaeological research on the island beginning in 1958, the Burneys began working at the site 14 years ago. Kikuchi worked with the Burneys at the sinkhole from 1992 until he died in 2003.

David Burney, a Fordham University professor and director of conservation at the National Tropical Botanical Garden on Kauai, calls the site "the La Brea Tar Pits of Hawaii." The sinkhole, which is on land leased to the researchers by Grove Farm Co., is located on the scenic Mahaulepu coastline not far from busy Poipu Beach.

"This is Kauai's real *Lost World*," Burney says in reference to the 1997 movie filmed on the island. "We could dig here forever."

DIG SITE

The Makauwahi Sinkhole is the largest limestone cave complex, the richest fossil site and the oldest dated ecological site in the Hawaiian Islands. About 400,000 years ago, the sea level at Mahaulepu was rising, and the area was a giant sand dune, according to Lida.

Over time, the sand hardened into natural concrete (sandy limestone) atop a base layer of basalt. The high water table caused streams to hollow out the rock, creating a gigantic complex of caves. About 7,000 years ago, the roof of one large section of the caves collapsed, forming the sinkhole. Once a freshwater lake, the area is about 100 yards from the entry to the most distant known cave and as much as 40 yards wide.

"One of the good things about this site, other than the excellent stratification (layering), is the preservation of perishable materials," says David, who has researched caves all over the world. "This is like a giant pickling jar. Leaves, whole tree trunks, extinct land snail shells, bird bones, seeds, fish with scales still

PHOTOS BY ROXANNE MCCRAW

Dr. Lida Pigott Burney sifts through mud and debris (above) at the Makauwahi Sinkhole (top) on Kaua'i's south shore in hopes of finding fossil remains such as bird bones, water creatures and Polynesian artifacts to help further understand the island's past.

on — they're all remarkably preserved."

Layers of sediment reflect the age of the fossils found. The first layer produced pop tops, Styrofoam, cellophane and other materials generated by modern society. Below that, the diggers found iron nails, some bent into fishhooks.

The next layer represented an era approximately 400 years ago and tells the story of a huge *tsunami* that dislodged large

deposit were human artifacts — pieces of outrigger canoes, paddles and smashed gourds. This Hawaiian period also contained remnants of rope and string, some of it from the fibers of a plant called *akaana*, revealing the kind of braid those earlier residents used and the knots they tied.

Below that a huge layer of peat was found that held the most amazing fossils — bones of extinct birds and snails, and

The Burneys took their first core samples in 1992.

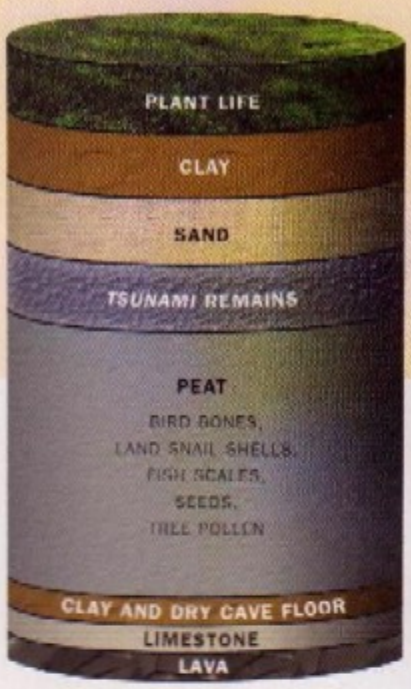
"We took a test core at what we call the North Cave, and we came up with the skull of the endemic coot (sea bird) in that 2-inch diameter core," Lida says. "We thought, 'This is either a once-in-a-billion happening, or this is a really good site!'"

Persuaded that the project was worth while, the Burneys convinced the National

5 STEPS TO TAKING A SAMPLE

To take a core sample, the following steps must be taken.

1. Core samples are taken by drilling into soft mud and other materials with a special sampling device.
2. The mud is usually collected in meter-long sections of plastic or metal pipe.
3. Scientists slice off a cubic centimeter at a time and analyze it for pollen, charcoal and diatoms.
4. If they find nothing, they take a slightly larger section and look for macrofossils, such as a piece of grass or wood.
5. When they find such material, they can send it to a radiocarbon lab for dating.



Smithsonian Institution, Fordham University, the U.S. Department of Agriculture and the National Geographic Society to provide funding.

SIFTING SANDS

Archaeological digs like this one involve a painstaking process of sifting and screening huge quantities of sediment. So far, the Burneys and their team have sorted through 250 cubic meters of earth and obtained thousands of specimens.

Working very slowly, volunteers "wet-screen," scooping gobs of mud into nested 1x2-foot boxes covered with fine mesh and straining the mud through a sieve with water. Pumps run constantly to keep the excavation from refilling with water. Sometimes it comes down to luck; once, a woman touring the site unearthed the jaw of an extinct honeycreeper, an artifact that happens to be the best specimen of that tiny native bird's jaw ever found.

"Sifting doesn't require patience," Lida says, "because it's like panning for gold. For whatever reason, just before you give up, you always find something really exciting. Then you want to work on and on. The patience comes when you get back to the lab, where it takes weeks and weeks of processing to make microscope slides, identify the pollen, count charcoal and classify."

AMAZING DISCOVERIES

Fossil bones of a diverse group of land snails have turned up at the site, as have 45 species of birds, half or more of them extinct. Avian paleontologists at the Smithsonian are currently studying the bones of seven or eight strange birds previously unnamed to science. Artists have made drawings of their conceptions of these unusual birds. One is a tiny night-feeding duck with eyes far back on its head, resembling the kiwi. Another is a turtle-jawed *moa nalo* (lost fowl). The scientists also found the remains of turkey-sized flightless birds that grazed like goats, a long-legged owl that probably fed on other birds, a new species of bat, a gull and several forest birds, now all extinct.

According to Lida, one of the most fascinating discoveries is a stone mirror. The ancient Hawaiians would take a piece of basalt, polish it until it was totally smooth, put a drop of water on it and hold it perfectly flat in their hands to get a reflection.

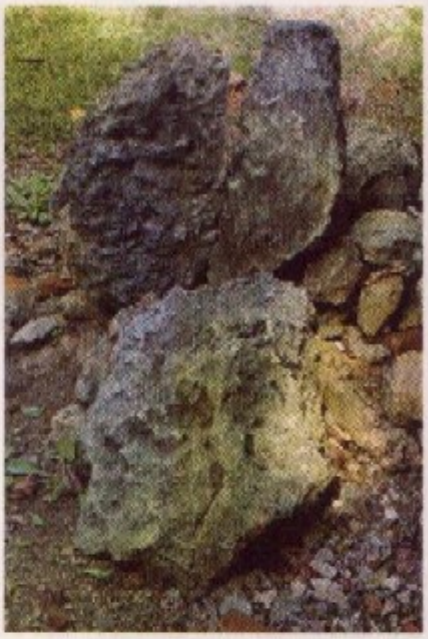
"This is an incredibly unique site," Lida says. "In most places where you work, you either get bird bones or you get pollen; you don't get both. With the limestone buffering this place, you have a neutral pH, so the bird bones that like alkaline conditions are happy because it's neutral, and the pollen that wants it acidic is also happy because it's neutral."

The diggers found seeds and pollen of trees like *koa* and *hala* that were always considered "canoe plants" introduced by the Polynesians when they first arrived in the islands more than 1,500 years ago. The scientists discovered seed pods and pollen from *kanaloa*, a small tree whose two known surviving specimens cling to cliffs on the uninhabited island of Kahoolawe in Maui County.

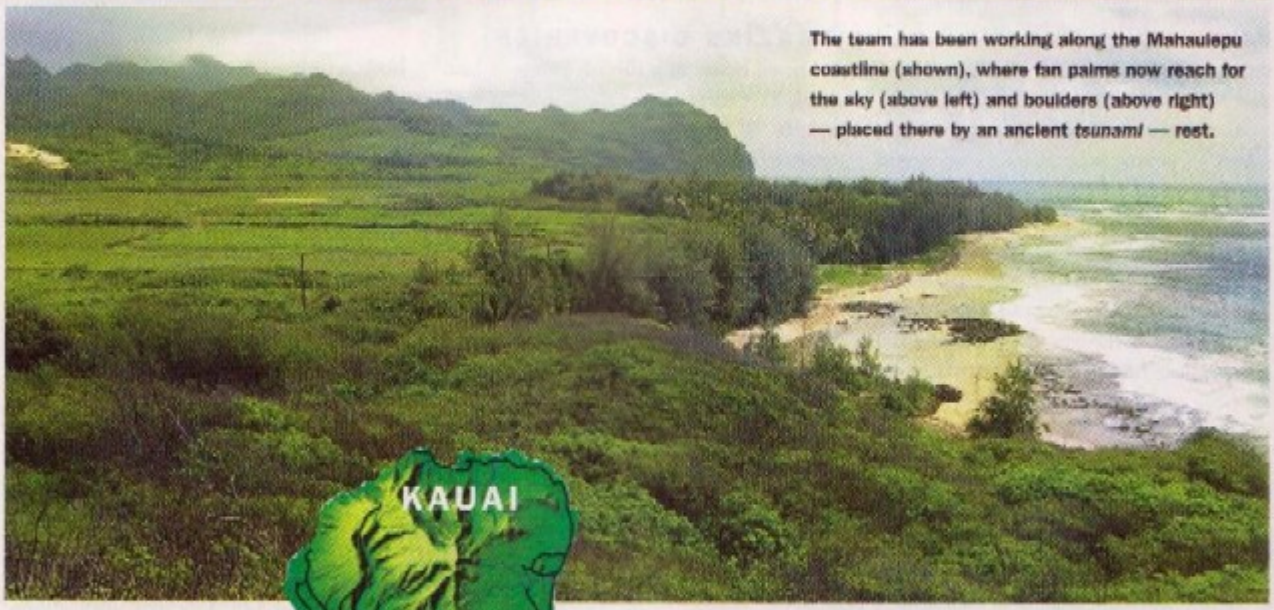
"One of the things that was surprising about this," David says, "is that many plant species that today are rare and often thought endangered on Kauai and throughout the Hawaiian Islands, and that today are

Photo © BPBM

Paleoecologist David Burney searches for clues to Hawaii's past in the mud and muck of the Makauwahi Sinkhole, which holds some 7,000 years of island history.



The team has been working along the Mahaulepu coastline (shown), where fan palms now reach for the sky (above left) and boulders (above right) — placed there by an ancient *tsunami* — rest.



only seen in high, cold, wet areas of the interior — the most remote part of the island — were growing right down there at sea level on the dry leeward coast of Kauai. Many species that today seem restricted ecologically actually had much broader niches before humans arrived."

Such insights inspired the Burneys to begin a pilot restoration project near the sinkhole.

LESSONS LEARNED

As paleoecologists, the Burneys hope this work will allow for a better understanding of the evolution of Hawaii, its flora, fauna and people.

"In recent years, archaeologists have sort of revisited their research on when humans first set foot in Hawaii," David says.

He describes the changes in Hawaii's ecosystem over the years represented in the sinkhole dig as a three-tiered extinction. The first stage occurred immediately after humans arrived, caused by the introduction of rats and hunting of large flightless birds. The second stage was a slow attrition as humans cleared forests, burned the landscape, ate some species preferentially and introduced other species to supplant them.

The third wave of extinction came when the area was rediscovered by Europeans, starting with British Capt. James Cook's arrival in 1778. Biological invasion occured on a large scale with the introduction of many species for agricultural purposes. Rapid use of the forests and other resources caused erosion and sedimentation in the lowlands.

"The lesson from analyses of fossil pollen and seeds should be clear for conservation biologists," David says. "Many rare species may be barely surviving today in suboptimal environments, often very steep, that bear little resemblance to their typical habitat at first human contact. The human onslaughts of deforestation, introduced herbivores and diseases usually do their work rapidly and thoroughly in coastal lowlands. With the right kinds of protection, many rare plant species could be reintroduced to

Dr. Lida Pigott Burney and Dr. David Burney (above) hope to bring back indigenous plants to Kauai, such as flowering *Hibiscus waimeae* and *Pritchardia aylmer-robinsonii* fan palms (both pictured right).

TAKE A TOUR

For more information about group tours or volunteer opportunities with the Makauwahi Cave Reserve, contact Dr. Lida Pigott Burney. Tours are available from 9 to 11 a.m. on Sundays. Please call ahead. (808) 482-1059; makauwahi @gmail.com

National Tropical Botanical Garden: www.ntbg.org

converted or degraded lowland habitats of Hawaii where none are found today."

RESUSCITATING FOSSILS

The Burneys' goal is to use the knowledge gained from the dig to recreate a landscape that the Polynesians saw when they first arrived in Hawaii. They believe that some ecological damage caused by humans can be reversed, that whatever grew along the Mahaulepu coastline for millennia once again could thrive there if buffered against human disturbances and biological invasions that caused them to disappear from that area. Consequently, they have attempted two coastal restoration projects — one in the Lawai Kai coastal zone in National Tropical Botanical Garden's Allerton Garden and the other in the vicinity of the sinkhole itself.

"The Makauwahi Sinkhole project is an invaluable resource for Hawaii," says Chipper Wichman, director and CEO of NTBG. "It is the premier site in the islands for giving us a look back in time to see what kinds of plants and animals actually existed in this area. For NTBG, this is critical information because it greatly expands our understanding of the natural ranges of plants that we don't find in the coastal plant communities of south Kauai. This in turn has allowed us to enhance our restoration projects to better represent what these plant communities were like 2,000 years ago."

At NTBG's Lawai Kai, workers have removed a thick mat of alien grass from the beach strand to enable sea turtles to nest and planted several at-risk species on the 3-acre site, including *ohai* (*Sesbania tomentosa*), false *ohe* (*Munroidendron racemosum*), *Hau kuahiwi* (*Hibiscadelphus distans*) and *Pritchardia aylmer-robinsonii*, a subspecies of *loulu*, a fan palm native to the island of Niihau, where it is believed only two specimens remain.

In the sinkhole, more tall *Pritchardia aylmer-robinsonii* now reach for the sky, Kauai tree cotton (*Kokia kauaiensis*) grows in its shadow, and Kauai white hibiscus flowers (*Hibiscus waimeae*). Closer to the shoreline in a former sugar cane field *kou*, *hala*, *naio* (false sandalwood), Kauai tree cotton, *koaia*, *maiapilo*, *wiliwili* and more natives are making a comeback. "What we're trying to do here," Lida says, "is see if we can grow these plants on a large scale on abandoned cane land to prove that farmers actually could make money growing them."

The money would come from producing nursery stock for native plant landscaping, a growing trend aided by a new state law requiring hotels and other commerical developments to use 60 percent native plants in new construction.

"There is a supreme irony in this turn of events," David says. "In order to provide some plants with a future, we must look to the past. In the long term, the thing that humans do that is changing the world most profoundly is changing the course of evolution. So if we can, after careful deliberation, bring a species back from the brink through translocation, this is a positive and important thing that we can do to alleviate some of the damage we've caused." ◆

Master gardener Margaret A. Haapoja splits her time between Kauai and Minnesota.