

A Snail's Tale: Can Rare Hawaiian Land Snails Be Saved From Extinction?

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In a remote area of the Wai'anae Mountains, some of the most imperiled land snails in the world are being rescued from the brink of extinction at undisclosed locations. This partnership working to protect the Islands' largely endemic snail population is made up of state, federal and nonprofit agencies placing Hawai'i at the leading edge of conservation. But will these efforts be enough to save the exquisite creatures that Hawaiians called "the voice of the forest"?

By Carlyn Tani

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Amastra spirizona.

Photos: Aaron K. Yoshino

On a bright, cloudless March morning, we caught a helicopter with two state naturalists visiting a protected patch of native forest deep in the Wai'anae Mountains. Once there, we picked our way across tangles of 'ie'ie and seed-laden sedge while 'ōhi'a lehua trees wove a lofty canopy overhead. The forest exuded a rich, loamy scent, and the chirps of 'apapane and 'elepaio floated through the air. David Sischo, coordinator of the Snail Extinction Prevention Program at the state's Department of Land and Natural Resources, led us to an area where a box made from wooden planks and wire mesh sat atop concrete blocks. The makeshift structure, no larger than a dog house, contained a remarkable sight. Inside, more than 100 *Amastra spirizona* were hidden among decayed māmaki leaves. Tucked into their dark brown, cone-shaped shells, which can reach an inch in length, the nocturnal snails were peacefully at rest.



It's a helicopter ride to the snail habitat in the Wai'anae mountains.

"These are some of the rarest animals in the world," Sischo said of *Amastridae*, one of 10 families of Hawaiian land snails, or pūpū kuahiwi. The lanky 33-year-old zoologist, a California native, recounted the history behind these tiny mollusks. *A. spirizona*, endemic to O'ahu, is a ground-dwelling species that previously lived throughout the Wai'anae mountain range. In 2015, Sischo helped collect the last 30 individuals and brought them to this site in a desperate attempt to halt their decline. Two years later, sheltered in what SEPP crew fondly call the "love shack," their population has more than tripled. Sischo was encouraged by the rebound, but the snails remain critically endangered because, he noted, gesturing to the box, "This is the only spot in the world where you can find them."

A. spirizona is far from unique. Before the arrival of humans, Hawai'i was home to more than 750 species of land snails, many of

them endemic to their island. Such diversity offers a stunning example of species radiation, considering that Hawai'i has 1/1,200th the land mass of the continental U.S. yet claims the same number of snail species. Within the past two centuries, however, snail populations have been decimated by a lethal convergence of factors: the destruction of native habitats, predation from introduced species and unbridled shell collection by humans. At least 200 species of land snails remain in isolated pockets across the Islands, but they all face overwhelming odds. "They're going extinct right now, right in front of our eyes," Sischo emphasizes. Conservation efforts normally take time; however, "We don't have time anymore. We expect that most of the larger snails will be extinct in five to 10 years—that's how dire it is." Despite those odds, Sischo is among a team of scientists that's working to protect the pūpū kuahiwi before they disappear forever.



Researcher Norine Yeung was studying to be an ornithologist when she fell in love with land snails. The diminutive 35-year-old speaks at a rapid-fire pace that mirrors the urgency of her work for UH Mānoa and the Bishop Museum. (She went on to earn a master's and doctoral degree in zoology with an ecology, evolution and conservation biology specialization.)

David Sischo, coordinator of the snail extinction prevention program.

At the museum, she oversees the world's most comprehensive collection of terrestrial snails from the Pacific, which range in size from a grain of sand to a slender ice-cream cone. A large poster of the 10 Hawaiian snail families hangs on the wall in front of her office. Pointing to *Amastriidae*, which originally comprised 325 species, or nearly half of the Islands' overall diversity, Yeung says, "They're the only extant endemic family of snails in Hawai'i, and there are only 18 species left."



ACHATINELLA MUSTELINA ON RIBBON.

Pūpū kuahiwi first arrived in Hawai'i some 5 million years ago, borne by strong winds, sea currents or oceangoing birds. Seabirds once nested from the sea to the mountaintops, and scientists believe the snails fastened onto the legs or feathers of nesting birds and were flown into remote mountain valleys and ridges. Hawai'i's diverse habitats and ecosystems, which Yeung calls "a living laboratory of evolution and ecology," offered fertile ground for growth. Land snails typically feed on leaf fungus and mold or on dead leaves, leaving new shoots unharmed. "They're our decomposers—they put nutrients like nitrogen back into the soil," she explains. "And because Hawai'i is nutrient-poor, we need them to create a healthy watershed."

Early Hawaiians celebrated pūpū kuahiwi in oli, mele and mo'olelo. The variety of names by which they were known, including *pūpū kani oe* (whistling sounds of the snail) and *kani ka nahele* (sounds of the forest), attest to their status and to the belief that snails had voices. "There are all kinds of chants and stories that talk about snails singing, and it's usually in combination with forest birds," explains Samuel M. 'Ohukani'ōhi'a Gon III, a senior scientist for The Nature Conservancy of Hawai'i and kumu oli. "Ke Kaa o Laieikawai" by S.N. Hale'ole, a classic tale about the romance of a high-ranking chiefess, features a beautiful passage on the calls of forest birds that climaxes with the auspicious singing of the snails.



ACHATINELLA CONCAVOSPIRA.

Biologically, snails lack vocal chords, but some speculate that crickets, which inhabit the same ecosystems, caused Hawaiians to mistakenly attribute their nocturnal chirpings to snails. Others have a more nuanced view. “If something has a voice, you accept it,” says Aimee Sato, who wrote her thesis at UH Mānoa on snails in Hawaiian literature. “We’re not sure what the forest sounded like centuries ago, because there were more species then, so snails may have had not a literal but figurative voice.” Intriguingly, she noted, when Hawaiians first heard the piano, they compared its sound to that of the singing snails.

The most famous snails are the tree-dwelling *achatinellines*, or kāhuli, whose brightly colored shells made them prized as adornments. Hawaiians strung the shells into necklaces, bracelets and other ornaments. In its private collection, Bishop Museum has a rare necklace that belonged to Queen Lili’uokalani, which was made from several species of *Achatinella*. “Anything collected from the uplands was connected to the realm of the gods, or *wao akua*,” Gon explains. “So the tree snails were considered to represent that realm.” Kamehameha III’s summer home in upper Nu’uanu valley was named *Kaniakapūpū* (sounds of the snail) for the creatures that once thrived there.



SNAIL LEI.

PHOTO: BISHOP MUSEUM

The beauty of their shells also hastened the snails' demise. In 1789, English captain George Dixon, who had served on Cook's third voyage, wrote of sailing around O'ahu two years earlier and acquiring a mysterious shell lei. He described the seven-spined shells as having "a black-brown color, except the tip, which is pale yellow," prompting him to name the species *apexfulva*, or yellow tip. Dixon's journal was the first mention of Hawaiian land snails in Western scientific literature, but, as more reports circulated about Hawai'i's unique flora and fauna, the demand for specimens grew. In 1850, English biologist Charles Darwin wrote: "Of all the places in the world I would like to see a good flora of the Sandwich islands. I would subscribe 50 pounds to any

collector to go there and work at these islands.” The Victorian-era fascination with natural history coincidentally fueled a mania for collecting exotic species.

In Hawai‘i, kama‘āina took up snail collecting as a hobby. Boys at Punahou School in Mānoa trekked into the nearby mountains to collect the then-abundant kāhuli. In 1853, the *Punahou Gazette* chronicled a weekend outing where “over (2000) two thousand specimens were brought back alive by the hardy adventurers, comprising about fourteen species of the genus *Achatinella*.” One youthful collector, John T. Gulick, later studied *Achatinella* in the Ko‘olau Mountains and showed how adjacent populations living under similar conditions evolved into different species, leading him to identify geographical isolation as a key factor in evolution. Gulick’s ideas, first published in 1873, were dismissed by Darwinian advocates of natural selection, but eventually became a pillar of evolutionary theory.



SUCCINEA.

Shell collection was just one of many threats unleashed by man. The arrival of hooved animals—pigs, goats, deer and cattle—overturned the delicate balance of native environments. Large-scale agriculture, cattle ranching and logging further demolished the snails’ habitats, while the introduction of rats, Jackson’s chameleons and carnivorous mollusks wiped out entire populations. An especially deadly foe, the rosy wolfsnail, *Euglandina rosea*, was brought to Hawai‘i in 1955 to combat the giant African snail, which had been released illegally two decades before.

Pūpū kuahiwi had evolved largely in the absence of predators, and adopted a leisurely life cycle. Individuals take about five years to reach maturity, whereupon they produce one to seven live offspring a year. (Land snails are hermaphroditic but typically require a mate to reproduce.) They also tend to live on or beneath a single tree, heightening their vulnerability to predation and habitat change. The rosy wolfsnail, in contrast, which feeds exclusively on other mollusks, reaches maturity in one year, lays 25 to 45 eggs annually, and is highly mobile, thereby vastly outstripping the reproductive rate and range of its Hawaiian prey.



BIOLOGIST JENNY PRIOR CHECKING FOR THE INVASIVE PREDATORY SNAIL *EUGLANDINA ROSEA*.

But there are glimmers of hope. The state's Snail Extinction Prevention Program, one of the only invertebrate programs of its kind in the U.S., coordinates with the state's Department of Land and Natural Resources, U.S. Fish and Wildlife Service, the O'ahu Army Natural Resources Program, UH Mānoa and Bishop Museum to prevent the snail's extinction. It oversees a captive-breeding laboratory and co-manages five predator-free environments on O'ahu.

You're getting a 360-degree view inside the Hawaii DLNR (Department of Land and Natural Resources) Snail Lab. Researchers are working hard to clean the homes of endangered Hawaiian land snails.

Video: Diane Lee and Aaron Yoshino

On the morning of Aug. 18, 2016, after 20 years of captive breeding, 100 *Achatinella lila* were released into the Ko'olau Mountains for the first time. Atop the rain-swept summit, the multicolored kähuli emerged from their shells and latched onto the leaves of nearby 'ōhi'a lehua. "The snails began crawling and awakening," recalls Gon, who had offered an oli for their homecoming. "If they're up and moving they will move onto new plants, so it was a joy to see." The snails came from the state's captive-breeding laboratory, founded in 1986 by marine biologist Michael G. Hadfield of UH Mānoa. The lab currently houses 500 snails, predominantly from the genus *Achatinella*.

The kähuli were released into a fenced, quarter-acre site that protects them from their main predators. The metal, 4.5-foot-tall fence is strung with electric wires that zap rosy wolfsnails and topped by a rolled lip that prevents rats and chameleons from vaulting inside. Since 1998, four exclosures have been built in the Wai'anae Mountains and one in the Ko'olau. The fences, which are imported from New Zealand, can cost upward of \$100,000 to erect but their benefits are indisputable. In the areas where exclosures have been built, Sicho says, "The snails inside have survived and thrived, while the snails outside are all gone."



PRIOR INSPECTS RAT TRAPS THAT HELP PROTECT THE SNAILS.

Meanwhile, new research has highlighted the urgent need for expanded conservation efforts. In 2011, Yeung and her husband, Kenneth Hayes, an invertebrate biologist at Howard University, received a \$650,000 grant from the National Science Foundation to conduct field surveys throughout Hawai'i to confirm how many snail species remain. Using detailed field notes from the early

1900s by Charles M. Cooke, the museum's founding malacologist, they targeted areas that once hosted thriving populations. Many of the species had not been studied for a century or more, so experts assumed that 90 percent of all Hawaiian land snails were extinct. Yeung and Hayes' research proved that assumption wrong.

Over five years, they teamed up with conservationists to survey 900 sites across the Islands, including areas that had never been studied. It was the most comprehensive survey of land snails conducted in Hawai'i's history. And it yielded startling results. "We found at least 30 and possibly upward of 100 new species," says Yeung, who notes that they are still sifting through the data. On O'ahu, researchers found two new species; on Maui and Kaua'i, where *Amastridae* were long believed extinct, they discovered several surviving populations. "The most important message that's come out of our research is that 90 percent of land snails are *not* extinct in Hawai'i," Hayes emphasized. He hopes their findings will not only ignite greater interest in Hawaiian land snails, but shift research, conservation and funding to species beyond the large and colorful *Achatinella*. Of the smaller, less eye-catching mollusks, Yeung says, "Just because they're small doesn't mean they don't matter. Because having lots of different species is what makes our ecosystems stable."



THE LOVE SHACK.

Sischo was quick to agree. After consulting with Yeung and Hayes, he's expanded the priority list for the captive-breeding program. "We have 50 species on our list, so as soon as our new chambers come in, we're going to rush out and grab a whole

bunch,” he says. In the meantime, he’s building up the lab’s populations for release (snails can live up to 10 years in captivity but survive twice that long in the wild, adding urgency to their return). Nevertheless, there’s one captive that will never see the wild. In the lab, a single *Achatinella apexfulva* sports a dark-brown-and-white conical shell with a thick, grizzled lip. This kāhuli is likely the last of its kind. Centuries ago, Dixon gave the snail its Latin name, but the species has not been seen on O’ahu for two decades and is presumed extinct. For now, the snail lives alone in its tank, unable to reproduce. “We have hope that we’ll come across a population in some remote valley,” Sischo says, before adding, “But that’s the reason we’re doing all this—so we don’t have another situation where there’s only one left.” There are other encouraging developments on the horizon: Lāna’i and Maui are erecting their first enclosures this year, and the Honolulu Zoo is planning to mount a captive-breeding exhibit that features Hawaiian land snails.

What would be lost if the pūpū kuahiwi disappeared? Experts offered up a range of answers, from the scientific (“They recycle organic matter, they’re foundational to our watershed ecosystems”) to the cultural (“They’re part of the living context of ancient times”) to the ecological (“When snails start disappearing, that’s a warning that things are awry”). Yet they also shared a profound sense of wonder that these exquisite creatures had evolved over millions of years to give life to the Hawaiian forests. Now it’s our turn to ensure that children will always be able to experience the sights, sounds and smells of a Hawaiian forest thriving with native snails. If that happens, then it’s not hard to imagine the pūpū kani oe will once again sing.

Scroll down to meet more snails!



But What About Rat Lungworm Disease?

Hawai’i residents and visitors have been on high alert because of rat lungworm disease, an incurable condition caused by a parasitic worm, *Angiostrongylus cantonesis*. It primarily affects rats, but can be transmitted to humans by snails, slugs and other animals (freshwater shrimp, land crabs and frogs).

Should we worry that endemic Hawaiian snails are spreading rat lungworm? Not so much. According to a 2014 research paper by Kim, Hayes, Yeung and Cowie, the parasite was found in nearly one-third of non-native snail species but only two native species. An invasive semislug, *Parmarion martensi*, is the main culprit in transmitting the disease to humans. While the study acknowledges that most native snails live in elevated areas that preclude high levels of human contact, it also cautions that “almost any terrestrial or freshwater gastropod may have the potential to carry and transmit the parasite”

SEE ALSO: [6 Things You Need to Know About Rat Lungworm Disease Before You Eat a Salad](#)

Find out more about snails at dlnr.hawaii.gov/sepp