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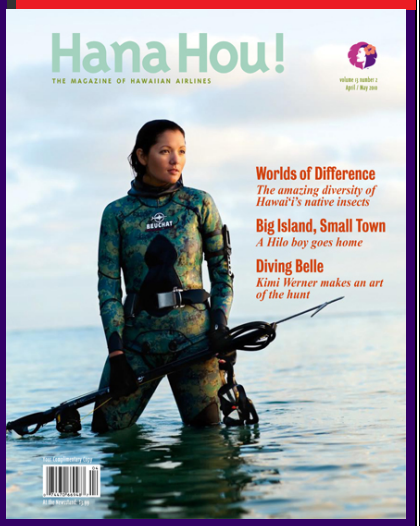

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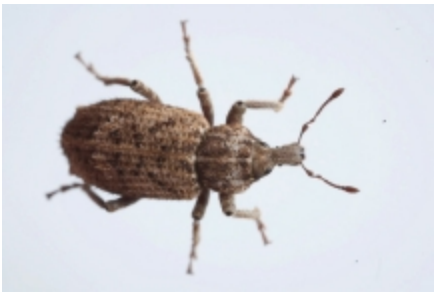
Hana Hou!
THE MAGAZINE OF HAWAIIAN AIRLINES

Life in the Microcosm

Story by Paul Wood
Photos by David Liitschwager



Like the native Hawaiian insects he loved so well, Hawai‘i’s greatest entomologist was not only strange, but also sensationally good at being strange. He was a shy, funny-looking little man with bright eyes and an astonishingly outsize nose, born in 1867 in the English village of Badminton. By family tradition he had been sent to Oxford to learn Greek and Latin classics. Midway through college, however, he rejected that course of study and succumbed to his boyhood love of insects—especially the order Hymenoptera (wasps, bees and ants). Just two years later he earned a degree in the natural sciences. A headstrong fellow, he rejected an excellent job offer from the British Museum simply because they wouldn’t promise him bug-related tasks. Instead he did something reckless—traveled halfway around the globe to collect specimens of indigenous insects and birds in the Hawaiian Islands.

When he arrived in Honolulu Harbor on the trans-Pacific steamship *Mariposa* in the spring of 1892, he was 25 years old and had never traveled farther than southern England. His name was RCL Perkins.

His one-man expedition was reckless for several reasons. Finances, for one. Although he had been sent to Hawai‘i by two esteemed British scientific societies—they planned to create a multivolume *Fauna Hawaiiensis*—these societies could provide Perkins only with travel expenses and a mere £100 for the work “as long as it will last.” It was madness for them to impose such a task on one paltry fellow—eight major islands, alpine volcanoes, vertical ravines, searing lava flats, impenetrable forests. … Perhaps those English academicians imagined that Perkins would spend his days netting grasshoppers in Honolulu back yards. They didn’t know about the true habitat of Hawai‘i’s indigenous insects, the wao akua—the forests of the gods, beyond the pale of civilization, higher than the last hut or footpath.

In fact, prior to sending Perkins, the societies had received a letter from the director of Bishop Museum declaring that “it was no use sending out an entomologist, as there were no native insects, but only a few American species.” So it might have seemed in the cultivated lowlands during the 1890s, where crops and pastures had replaced original habitats and where imported insects now ruled the micro-world. Big-headed ants, for example, with their caste of monstrous soldiers, and other species of militarized ants controlled the common areas. All ants were recent arrivals, as were cockroaches, mosquitoes, aphids. … Basically, anything that makes people say “ooh, ick” had come to Hawai‘i from the outside world within the century before Perkins’ arrival.

But RCL Perkins was fired by a holy fervor that simply intensified the

more he discovered about indigenous insects. Nine years he spent with them, alone, on foot and eventually—after he shredded his boots on sharp lava—barefoot. He spent days slogging through waist-deep swamps or cutting paths in primeval woods. He spent nights without food or sleep, collecting moths by lamplight and entertaining himself by reciting Greek poetry. He compromised his health in his enthusiasm.

What is the wonder of Hawai‘i’s insects that could drive a man to such extremes?

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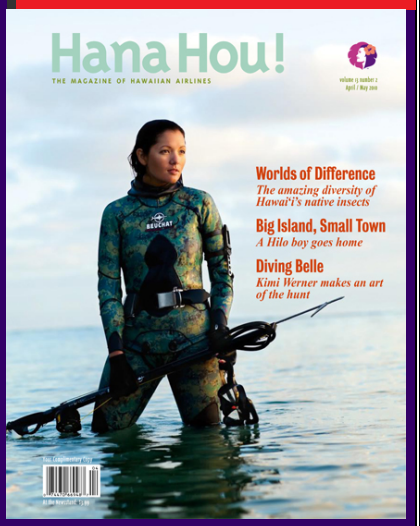

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All biology students know the common fruit fly, *Drosophila melanogaster*, a dippy, harmless little thing that has lent itself to countless experiments in genetic recombination.

There is a relation of this fly living only in Hawai‘i that has engaged in its own evolutionary experiments and produced amazing results. This so-called picture-winged drosophila grows three times the size of its cousin in the lab. It’s long and sleek, its transparent wings patterned with patches of brown. It lives in deep gulches and remote, damp forests, feeding on the lightest mush, the little pockets of organic dampness so common in such places. Its courtship rituals involve complex patterns of dance and musical buzzing. What gives this creature significance beyond entomology itself is that it has evolved over time into some six hundred species, each one of these having developed independently from the same common ancestor.

Something similar happened with moths, specifically the tiny ones we tend to flick away with the back of the hand—the one batting around your own kitchen light, for example. Chances are good (one in three) that it will be in the genus *Hyposmocoma*. Hawai‘i has at least 350 distinct species of these micro-moths, all of them descended over time from a single forebear. In fact, the true number of these *Hyposmocoma* moths may be far higher because entomologists are still discovering them. Last November two scientists from the University of Hawai‘i, having explored parts of the Northwest Hawaiian chain, announced that they had discovered eight more such species. These scientists were pursuing an idea: that native insects have been island-hopping and exploring new habitats since long before the present eight main islands were ever formed.

That last comment requires a bit of explanation. The key point, though, is that the Hawaiian Islands and their homegrown insects constitute the greatest natural laboratory for the study of genetics and evolution in the known universe. How could a scientist ever set up a lab with one fruit fly, six hundred different habitats and time enough to watch that fly morph into as many different forms?

No need. Already done.

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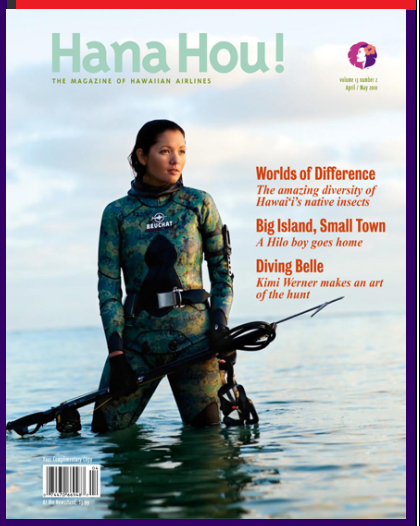

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In speaking of insects, we are talking of creatures with external skeletons and three body parts. The middle part (thorax) bears three pairs of legs and, in the adults of many species, two pairs of wings (or just one pair in the order *Diptera*, the flies). These wings are not modified forelimbs, as is the case with birds. They are additional to the basic body plan, in the manner of Pegasus, the mythical winged horse. They are an elegant invention matched to the most adaptable body design in the entire animal kingdom. For insects, unlike us, gravity is an insignificant force. They are surfers of thin air.

And yet no surfer has ever ridden a wave from Asia to Hawai‘i. This fact touches on the mystery of our native insects. How did they get here, across some three thousand miles of salt water?

We don’t know the “how,” but entomologists are pretty clear about the “how many.” Calculating backward from the number of living species that clearly evolved from a common ancestor, biologists have decided that the number of successful “colonizations” is no more than four hundred. Considering that the archipelago is about seventy million years old, the calculation adds up to one colonizer every 175,000 years. More or less.

On the average each such colonizer gave rise to twenty-five new species of insects that evolved and now live only in Hawai‘i. But certain species gave rise to many, many more than that. And some to far fewer. For example, Hawai‘i has hundreds and hundreds of species of tiny moths but only two species of (relatively large) butterflies. Considering that moths and butterflies are members of the same order, *Lepidoptera*, with similar body plans and feeding habits, one has to wonder why. What’s the difference? The answer could possibly be this: microclimates.

From an insect’s viewpoint, Hawai‘i is not one place. It is thousands. A single canyon can amount to the entire extent of an insect’s known universe. A certain peak. A certain islet. A certain cave. A steady drip of water next to a pool somewhere might attract a new generation of experiments. A different pool in the next canyon over will attract a slightly different generation. These generations will quickly develop their own unique characteristics.

A strong-flying, large insect can traverse ridges and cross channels, mingling and mating on every island. This fact might explain why our Kamehameha butterfly (*Vanessa tameamea*), a large, robust beauty whose red-and-black wings are rimmed and dotted white, remains consistent throughout the Islands. The same is true with our giant blue dragonfly *Anax strenuus*. With its half-foot-long wingspan, it is the largest of all native insects, a champion flyer with a range throughout the Islands and beyond.

For the littler critters, though, cruising from (say) O‘ahu to Moloka‘i would be unlikely and rare, another kind of colonization. Therefore, for the small insects, each Hawaiian island is as distinct as a continent. Even a single high ridge can effectively separate insect populations. And as evolutionary biology has shown, separate populations over time naturally become distinct species.
This explains the crickets. Hawai‘i, with its many pockets and niches, has developed twice as many species of crickets as can be found across the entirety of North America. They call this phenomenon “adaptive radiation”—the evolution of new species to fill unoccupied ecological niches. Hence the picture-winged *drosophila*.

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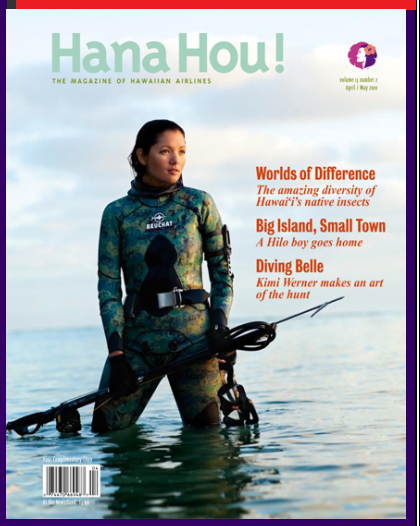

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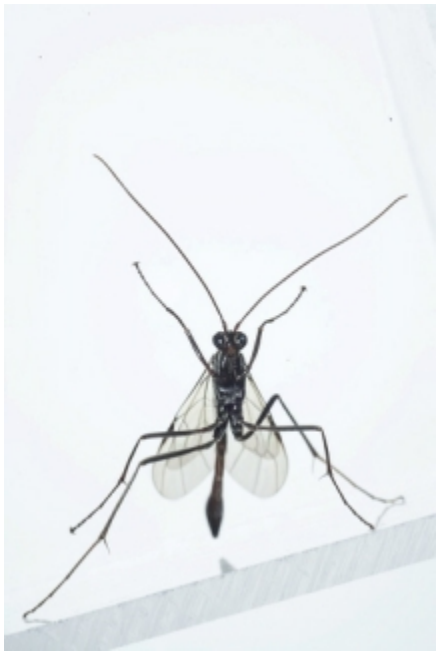

Because the Islands have offered lucky six-legged colonizers so many diverse and extreme life-niches, Hawaiian entomology is filled with evolutionary oddities. Take the *wekiu* bug (*Nysius wekiucola*), for example. (A “bug,” by the way, is not a general synonym for the word “insect.” To an entomologist it means something specific—a member of the order *Heteroptera*. True bugs have wings that are opaque [like a beetle’s] near the head and transparent [like a fly’s] to the rear, and they have hypodermic-like mouthparts that can suck the juice from a plant or from an animal. The wekiu bug fits into that latter type.)

Insects naturally “hilltop”—that is, drift upward as the ground rises and then, not wanting to leave the earth altogether, congregate on peaks and ridgelines. When insects hilltop on Mauna Kea, though, rising up to the snow line, they perish in the cold. Wekiu bugs, which have antifreeze for blood, have adapted to this extreme environment in order to feast on the frozen insects falling out of the snow-melt. A comparable species, *Nysius aa*, fills the same niche on Mauna Loa.
Incidentally, these wekiu bugs do not develop fully formed wings. What would be the point of flying around in such a howling, turbulent atmosphere when your natural food delivers itself? Evolution is conservative. If a creature can’t use a trait or skill, it will lose it.

In fact, one curious quality we see a lot in Hawai‘i’s natural order is a trend toward flightlessness. We know now that pre-human Hawai‘i included many flightless birds. The same effect is widespread among its insects. So Hawai‘i has, of all things, flightless flies. Crane flies, for example, are gauzy, frail things, practically weightless. Species that live on any one of Hawai‘i’s *pali* (cliffs) are constantly subject to pounding winds that could fling them into the sea. In such conditions, wings are a liability.

Similar environmental pressures in Hawai‘i have produced flightless grasshoppers, crickets, beetles and lacewings. A wingless lacewing? How about a wingless moth? We have them. A big brawny beetle without its wing-covers looks strangely naked. Welcome to the Islands.

Only half of Earth’s major insect orders established a place in Hawai‘i

(before human interference, that is). Here are some major insect designs that never got to the Islands on their own: scarab beetles, swallowtail butterflies, termites, cockroaches, short-horned grasshoppers, honeybees, bumblebees, horseflies and ants. Late-arriving ants have been especially disruptive of the six-legged world, and they keep coming. During the 1930s the Argentine ant, unable to conquer the firmly established big-headed ant, moved into landscapes higher in the mountains. Just this year in Waihe‘e, Maui, a nasty insect called the little fire ant established a colony on a half-acre farm site. Luckily the state Department of Agriculture jumped on it.

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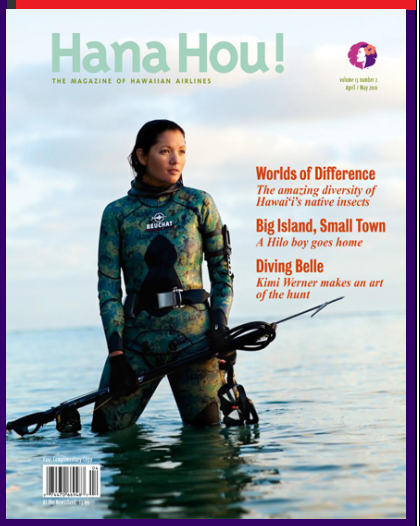

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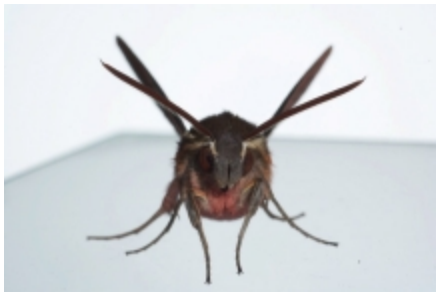

There's a stout, stubby-looking wasp that got into the Islands during the mid-'70s, probably brought in with a shipment of Christmas trees. Western yellow jacket they call it, *Vespula pensylvanica*. It cruises the mountain slopes of aHaleakala and Hawai'i Volcanoes National Park looking for meat. Any insect it finds, this wasp simply bites off its legs and wings and flies the helpless carcass back to the nest. In its native habitat, this wasp dies out each winter as freezing temperatures deliver a cruel payback in the creature's underground nests. But in Hawai'i those nests won't stop growing. Last October *Harper*'s magazine listed this announcement in its "Findings" feature: "Invasive wasps were eating pheasants in Hawai'i. 'You see them flying with their little balls of meat,' said an entomologist of the wasps. 'If you have something that can fight back, like a honeybee, then they go straight for the head.'"

These Western yellow jackets have been eating a lot of picture-winged drosophila. Populations are down and eight species are now endangered. That's what Steve Montgomery told me as we sat recently at an outdoor cafe table, where the cool canyon walls of 'Iao Valley rose on either side of us. "Used to be the Health Department would come out in sting-proof suits," he said. "We can control *Vespula*. It just takes proper management."

Steve is a Hawai'i entomologist who has earned a place on the limited arc of names that stretches back through RCL Perkins. With his gnomelike abundance of hair and beard and his imperturbable demeanor, he is perhaps what RCL would have become had the Englishman refused to go home. He has had enough time not only to see how the insect environment is shifting, but also to learn more about the life cycles of the very species that Perkins collected.

For example, Perkins was on Moloka'i in May 1893 and wrote in his journal about collecting moths under daunting conditions. "Heavy rain last night and still raining hard this morning. Mountains above here all hidden in dense fog." That morning he got doused and returned to camp "about 1 p.m. starved with cold." But a break in the weather gave him a successful experience, tersely recorded: "collected Geometers on tree trunks. Found a large *Eupethicia* quite new to me."

"Geometers" are universally known for their immature forms, caterpillars called inchworms. These caterpillars travel by inching their way forward, reaching with their front legs, then catching up with the hind. On that day in 1893, RCL collected the winged adults, but the extreme weather conditions caused him to miss the best story in all of

Hawaiian entomology: the world's only ambush-style carnivorous caterpillar.

The inchworms of the genus *Eupethicia* do much more than inch. They wait on leaf edges and on slight twigs trying their best to look like part of the plant. When an insect walks over them, they flick around in one-twentieth of a second, seize it and suck the life out of it.

This biological phenomenon was first discovered in 1972 by Steve Montgomery. Since then eighteen species of these carnivorous inchworms have been identified. Steve's find had startling implications: that the great discovery period for Hawaiian entomology is far from over. In fact, only about sixty percent of the indigenous species have been described so far, and none is fully known, not really.

While we sat at the ʻIao Valley table, Steve occasionally interrupted himself to look over my shoulder—a curious beetle cruising past, a flash of color he hoped would be a Kamehameha butterfly. (No such luck. Just a Gulf fritillary.) Several times, a handsome little fly landed on the tabletop next to my hand. It had clean lines, cellophane wings and high legs like bent wires. "That's a Nereid fly," he said, "a newcomer. It's competing now with the picture-wing *drosophila*. Picture-wing *drosophila* species live on specific stuff—decaying koa, decaying *myoporum*, decaying *ʻieʻie*. But this fly will lay its eggs on anything."

Just a few years ago a wasp the size of a pencil dot got into the Islands and started killing popular landscape trees of the genus *Erythrina*, which are storybook-looking trees with lush dark canopies and brilliant red-orange floral displays. This invader was a gall wasp, a kind of wasp whose toxic sting causes the growing tips of plants to curdle into cancerous lumps. Back where they evolved and normally live, the wasps are not common. In Hawaiʻi, though, they went unchecked, destroying every limb they wanted. By year's end crews were chain-sawing deformed tree carcasses at airports and college campuses, and biologists were frightened about the future for Hawaiʻi's one wonderful endemic species of Erythrina, the *wiliwili*.

And so scientists tested and released into the Islands yet another new species of alien insect, this one a parasite of the Erythrina gall wasp—a minute enemy of the enemy. This deliberate introduction was an act of bio-control, a risky move. Would the new bug cause unpredicted troubles? I asked Steve about the situation, and he said, "It appears to be working." He favors bio-control and feels that authorities are too worried about "inadvertently becoming Typhoid Marys." He wants the state to release an insect parasite of strawberry guava trees, which are "evicting the native trees" in Hawaiʻi's forests. Not that these strawberry guava trees themselves are killing insects outright, but they are destroying habitats. An indigenous Hawaiian insect is not separable from its host plant, its dewy gulch, its unspoiled high ridge, the wild place where it has learned to live.

The future of Hawaiʻi's ten thousand-plus species of native insects is now a great unknown. After millions of years of sanctuary, they have been pummeled by the changes of the last two centuries. Without help what stands to be lost is, any biologist will tell you, the most exciting and important natural laboratory on Earth. Hawaiʻi is home to an extraordinary micro-world, to millions of small dramas taking place right now. The future for these insects will ultimately depend upon the power of the human imagination to travel into their universe, which is

hidden right before our eyes.

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