Temperate Treetops

Canopy research reaches new latitudes

By ELIZABETH PENNISI

In the "eco-romance" *Medicine Man,* an eccentric biologist played by Sean Connery "discovers" a cancer cure high in the treetops of the Amazon rain forest. Like many real-life biological prospectors (SN: 7/18/92, p.40), he had been following folk-medicine leads – in this case, uncovering why a local Amazonian tribe never suffered from cancer. He tracked the prophylactic to a bromeliad, or so he thought. An extract from this plant made tumors disappear overnight, with no side effects. But Connery faced one problem: None of the additional samples he collected showed any antitumor activity. Only in the final scenes, with road builders hours from knocking down that piece of forest, does he realize that the ants living in these plants – and hiding in his sugar bowl – are the drug's source.

He should have had Margaret D. Lowman along.

Early in her career as a botanist, Lowman learned to pay heed not only to plants but to the insects that eat, inhabit, and in other ways use those plants. First in Australia, then in Panama, and now in western Massachusetts and southern Florida, she has honed an expertise studying canopies – forest ecosystems typically out of reach and beyond view of most ground-bound scientists.

Now based at the Selby Botanical Gardens in Sarasota, Fla., Lowman is part of a research movement begun a decade ago by entomologist Terry L. Erwin of the Smithsonian Institution's National Museum of Natural History in Washington, D.C. Erwin found almost 1,000 species of beetles in the canopy of one species of tropical tree and from that calculated there could be 30 million tropical arthropods. Since then, canopy science has become one of the hottest areas in forest research, says Bruce H. Rinker, a high school biology teacher who has studied canopies in Africa.

Lowman didn't climb many trees growing up or even when she first started studying forest biology. But she has more than made up for those missed arboreal opportunities. In her fieldwork in Australia during the early 1980s, she used a slingshot to shoot fishing line over the branches of her study site and with that line hoisted climbing ropes. Then, like a mountaineer, she would haul herself to specific heights and hang suspended in the air while she measured leaves.

Unlike the pleasant canopy-swinging scenes in *Medicine Man,* Lowman's time on ropes is not always a joyride. Wind, rain, leeches, and cold weather can make the work difficult and somewhat treacherous.

Only later did she discover her first walkway, a platform built near a guest house in a subtropical forest in an Australian national park. It afforded a steadier viewing stand for work that spanned a decade.

During her tenure at the University of Sydney in Australia, she marked and inventoried more than 5,000 leaves, returning year after year to assess how they changed. She observed that a leaf's placement on a tree greatly affects its fate. "The leaves at the top of the forest are not like leaves at the bottom," she notes. Six lower canopy leaves have lasted more than a decade, while most upper leaves disappear within two or three years, she found.

Also, Lowman began to notice that, over time, insects tend to cluster in the lower parts of the canopy. They seek a "middle" ground with just the right amount of light and protection from potential predators. For these and other forest denizens, the canopy represents a complex environment, one scientists are just beginning to fathom.

Lowman's Australian experiences shaped her research interests. Like many of her colleagues, and in some sense the whole of ecology, her focus began to broaden to include not just a single species but an entire ecosystem – in this case, the canopy. She realized it was not enough to study a tree's leaves. She needed also to pay attention to the insects that nibble on this green stuff, the light that warms and energizes the leaves, and the birds that flit among the branches.

This approach to studying biological diversity challenges researchers in new ways. "[Canopies] require different kinds of monitoring devices," Lowman explains. "We're in an air medium."

Photos: Lowman

With others, she is helping to develop techniques that will make it possible for more scientists to work in the treetops. Eventually, they hope to compare results from disparate places so they can develop a fuller sense of the importance of these upper reaches to the overall ecology of forests. "Understanding canopies will lead us to understand how to restore forests," she contends. The work has taken Lowman around the world, to temperate as well as tropical canopies.

In Cameroon, she worked with a French team that launched a balloon-borne raft that floated along the tops of the forest. From this perch, scientists could reach out with their nets, traps, and sensors to assess the upper canopy. At the same time, they could use sweep nets and trays to sample insects, says Lowman. With the balloon, the raft moves "in a similar fashion to a speedboat pulling a skier across the water," she explains. Thus she could collect from each tree in its path.

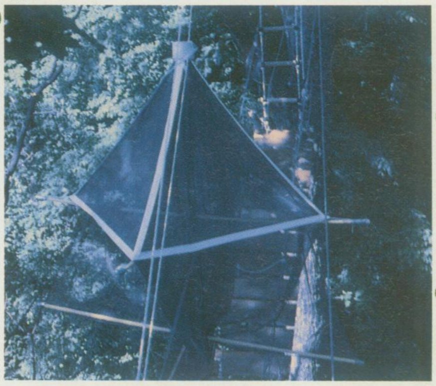
"For the first time, we were able to get [a] relative abundance [of species] at the same point in time," she adds. The team discovered that some trees had many different kinds of insects; others sported very few. "Perhaps diversity is very patchy," she says.

Still, much more work lies ahead before Lowman and others can say for sure what the data from canopy studies mean. "If we can set up certain standard kinds of measurements, we can come up with comparative answers," says Lowman.

In the meantime, she now knows that one need not be a movie stunt person, or even a Ph.D. scientist, to appreciate the appeal of the treetops.

In 1990, Lowman returned from Australia to teach ecology to undergraduate students at Williams College in Williamstown, Mass., and decided she wanted them to experience the joy — and tedium — of canopy work. She obtained a small grant — $2,200 from the college's Miller Fund — and with the help of a tree surgeon built two 70-foot-high platforms connected by a 40-foot-long walkway. It lies smack in the middle of a century-old red oak forest that is peppered with smaller sugar maples, beeches, and birches. It was possibly the first walkway of its kind in the United States, and the students loved it.

Canopy work requires that researchers (left) and insect traps (below) become airborne.



"It's sort of like being on a mast of a ship, almost 100 feet up," recalls Peter Taylor, a former Williams student. "Once you get your sea legs, it's kind of fun. You can mix adventure with data collection."

"The most exciting thing is it puts you in the third dimension," adds David M. Scholle, a senior at Williams. "You have up and down and every direction to look at. It's like a tree house, like finding your childhood again."

They and other students helped Lowman expand her studies from tropical canopies to canopies in colder climates. Already, their efforts have taught her that temperate treetops undergo many underappreciated changes and support a different kind of biological diversity.

For example, from this bird's-eye view, they could see that the uppermost, sun-privileged leaves were pockmarked with yellow spots — scars of acid rain, Lowman concluded. Then too, Taylor got a new perspective on a much-studied oak-tree pest, the gypsy moth. "It's obvious [from the literature] that very few people who've studied the gypsy moth have looked at it higher than six feet off the ground," says Lowman. That had been true for Taylor, who had been assessing predators of immature moths with ground-based experiments until the walkway became available.

"It expanded what [research] we could do," says Taylor, who could now include study sites up in the trees. "It taught me that the way most researchers see the [forest] ecosystem is going to be very different from the way researchers who have access to canopies are going to see it. Where you put your traps is going to have a huge effect on what you get."

Taylor, like Williams students Alexandra H. Smith and Nadine Block before him, trapped small mammals at ground level, at 2 meters, and at 20 meters up, elevating some traps with a pulley system. They set the traps overnight — using bacon, peanut-butter, and oats as bait — then surveyed their catches the next morning before releasing the animals. The tree-borne traps revealed a thriving population of flying squirrels, previously considered rare in that forest. Also contrary to current thinking, the white-footed mouse sometimes ranges as high as 20 meters. Both mammals feast on gypsy moth pupae.

The results showed that, as in the tropics, different mammals tend to live at specific heights, Taylor says. Squirrels prefer to be high, where they can easily launch into an effective escape glide, whereas the mice, overall, hung out at lower levels — closer to ground cover. Often the same animal reappeared in a given trap, Smith and Block report, indicating that individuals develop favorite foraging spots.

Other Williams students have investigated forest insects. During the summer of 1992, they set traps weekly to monitor nighttime visitors. With pulleys, they set up an ultraviolet "black light" (run off a car battery) and a trap high in the canopy. Then they placed a second light and trap at ground level. The lights attracted insects, luring them into the traps.

Like mammals, arthropods tend to space themselves, the data indicated. But in oak trees, the distribution was different from what researchers had found in more extensively studied tropical trees. "The patterns of vertical stratification of temperate forest organisms appear to be reversed from tropical forests, where the majority of insects are located in the canopy," says Lowman. In Massachusetts, "the insects in the understory were found to vastly outnumber insects in the canopy."

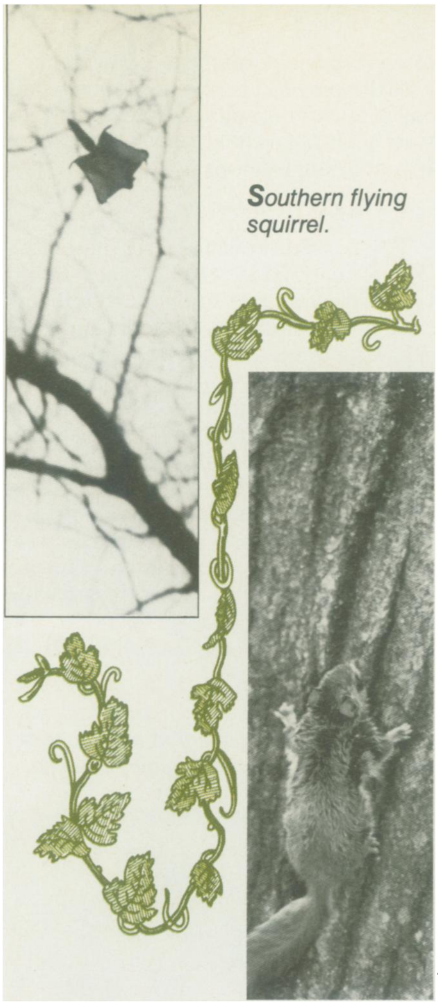
Even temperate ants behaved differently than their tropical counterparts. On some occasions, the students put sardine bits along the forest floor and up an oak trunk, then checked this bait every four hours for a day. In this way they trapped about 50 ants on the ground. But only four ants showed up at the bait on the trees. In contrast, ants wander quite high up the trunks of tropical trees, Lowman notes.

Because the number and types of insects found varied according to the time of year, temperature, and phase of the moon, Lowman suspects that the seasons influence where insects reside and how many species exist.

Temperate arthropods, especially insects, may hang out closer to the ground than their tropical counterparts because temperate trees lose their leaves each season, forcing them to seek terrestrial refuges over winter or to lay eggs that hatch the following spring. It's at that point that warming causes the young to mature and migrate.

In contrast, insect abundance in the tropics seems most closely tied to rain — and the vegetation it supports in wet versus dry seasons.

Also, the makeup of the trees exerts an effect. In the tropics, flowers and fruits attract bugs and bees to upper branches, while newly emergent leaves appeal to leaf eaters, including caterpillars. But in temperate forests, the upper reaches tend to be more uniform, says Lowman. Northern trees support fewer epiphytes — plants that grow among tree branches — and therefore offer fewer niches that can be exploited by different kinds of organisms, she adds.



Southern flying squirrel.

Photos: Taylor

Other researchers think the complexity and thrills of canopy work should be available to people even younger than college age. Rinker, who worked with Lowman in Cameroon, hopes to introduce canopy science into the small private high school where he teaches. "It's a natural for young people," says Rinker, who heads the science department at Millbrook (N.Y.) School. With all the ropes, climbing, and hanging the work entails, "it's a real 'Wow!' experience for them," he adds.

An arboreal walkway on Millbrook School's grounds would add a new dimension to ongoing research carried out by the school's science students since the 1950s — and for only a moderate cost, he notes. The school is the site of a National Oceanic and Atmospheric Administration weather station and annual bird banding efforts coordinated by the U.S. Fish and Wildlife Service, and so has already gathered long-term data.

"Now, I'd like to collect long-term microclimatic data at the canopy and at the bottom," says Rinker. "I don't think anybody is doing that." He also expects that netting birds high in the trees might reveal trends no one else has uncovered.

That, too, appeals to teenagers. "They realize that they are on the cutting edge and that they are right there, absolutely exploring new areas," says Rinker. "It's a new frontier in research and in science education." □