American Treetops Yielding Their Secrets

Continued From Page B5

pioneer. And there were other problems, notably the daunting nature of access.

Even for the few researchers who knew how to use them, rope-climbing techniques brought researchers only temporarily into the canopy, limiting their ability to assess canopy processes over the long term. Nor could they easily gain access to the canopy perimeter, where budding and branching and photosynthesis are most active.

Canopy research now appears to be entering a period of a resurgence, in part because of technological improvements that will help solve some of those problems. Rope-climbing techniques have been refined, and more researchers know how to use them safely. And more permanent research stations are being erected.

When Dr. Lowman, who had done extensive canopy work in Australia, was teaching at Williams College in Massachusetts in the early 1990's, she had a permanent walkway system built 70 feet high in the canopy of a nearby hardwood forest.

Building on the early research tradition, researchers last fall installed a platform system nearly 200 feet up in a 500-year-old Douglas fir in Andrews Experimental Forest. Although researchers still have to climb a rope to get there, the platform, attached to the tree with straps that can be expanded as the trunk grows, will provide a stable and permanent site for scientists and their instruments. Dr. Denison said it was also large enough to allow overnight stays, which would, for instance, allow a researcher with night vision equipment to observe nocturnal animals like flying squirrels.

R. Steve Foster

Canopy researchers in Andrews Experimental Forest in Oregon.

Immense Crane System

In an ambitious project in a forest on the Olympic Peninsula of Washington, researchers from the University of Washington hope by next autumn to have in place a giant construction crane and boom system of the sort normally used for building skyscrapers. That crane system "is going to give us an amazing new view of this forest," said Dr. David Shaw, who is managing the project.

"We'll attain access to all three dimensions," he said. "It will take us to the top of the canopy, to outer crowns, the places that are nearly impossible on rope systems."

The immense crane will include a counterbalanced horizontal boom, called a "jib," with a reach of 270 feet in any direction, which itself can be raised to nearly 300 feet. In all, according to Dr. Shaw, the system will give researchers access to some 5.3 acres of towering old growth Sitka spruce and western hemlock forest canopy. Because the canopy is three-dimensional, the added access provided by raising and lowering a gondola on cables through the canopy from the boom will actually amount to two million cubic yards of area.

Precisely what researchers will find when they reach these heights is unknown. But earlier research has yielded intriguing results.

Puzzle About Lichens

In the 1970's, for instance, Dr. Denison of Oregon State discovered that Lobaria organa, large lichens that had fallen to the forest floor, were fantastically rich in nitrogen. He wondered if significant amounts of nitrogen fixation, normally done by specialized bacteria in soils or certain root nodules, was occurring in the canopy as well. Early attempts to study the lichen specifically, or the canopy in general, were exercises in frustration, he said.

Typically, ecologists might begin by surveying a representative sample of an organism in an ecosystem and use data about the entire system to extrapolate from there. But he and his colleagues quickly found that no one had ever analyzed an old growth canopy in enough detail to catalogue even branches and needles. The Oregon scientists realized that before proceeding with their lichen studies, it would be necessary to do the more tedious basic work of characterizing canopy structure.

Dr. Denison recalled with a laugh an early attempt to gather such data. He visited a logging site in the Willamette National Forest where the Forest Service had offered the services of a "tree faller" to bring a fir crashing to earth for his inspection.

"The thing just exploded," he said. "There were pieces of branches and lichens and moss scattered everywhere. And no way to tell what had been where."

The breakthrough came when a young research assistant, Diane Tracy, who had rock-climbing experience offered to climb a tree. She then taught the technique to others. Just after his 65th birthday last autumn, Dr. Denison used the technique to ascend to the platform in the Andrews forest. Modifications of techniques she used are still used today for most ascents.

Nathan Poage, a graduate student at Oregon State, recently demonstrated the technique for a visitor by climbing into a 500-year-old Douglas fir whose first branch was some 150 feet off the ground. That distance is great enough, and the tree large enough, that Mr. Poage had become a relative speck by the time he vanished into its verdure.

The technique involves climbing a rope, not the tree itself, and is accomplished with climbing clamps called Jumars, a harness around the midsection and loops around the feet. The climb, as demonstrated by Mr. Poage, is a dolphin-like swimming motion: a sort of upward lunging kick to lift the body, an upward slide of the Jumars, a tuck and another kick. A novice, offered a chance to try the technique, found the motion to be more of an exhausting wallow, walrus-like.

It is not, in any case, a project for those inclined either to vertigo or to motion sickness: the rope bounces and sways and ever so slowly spins its victim.

Theory Is Confirmed

By using rope techniques, Dr. Denison and his colleagues were able to confirm that lobaria indeed is a significant "fixer" of nitrogen for the forest, contributing, as lichens fall or rain leaches their nutrients out, 25 to 75 percent of the nitrogen added to soils in that forest each year. Forest soils in the region are typically rich in nitrogen. But since lobaria grows only on trees over a century old, "we may be living on our capital, without adding any interest to the account" if too many trees in already logged areas are cut again before they reach that age, Dr. Denison said.

Another early discovery, made by George Carroll, a biologist at the University of Oregon who was working with Dr. Denison, was that conifer needles were infected with endophytes. These specialized fungi, which cannot photosynthesize, live within the needle itself, consuming some of the carbohydrates the needle leaf makes through photosynthesis. But it appears that the fungi might symbiotically return the favor, by forming alkaloid compounds that drive away defoliating insects.

If so, Dr. Carroll said, this might answer a riddle that has long perplexed biologists: how can trees with a centuries-long life span maintain chemical defenses against short-lived insects that can quickly evolve adaptations to those defenses? The answer might be that the trees do not. It is, instead, the short-lived endophytes that do.

"Since insects can adapt to any defense so quickly, ecologists like to ask the question: why are there any trees left at all in the world?" Dr. Carroll said. "But with these fungi inhabiting trees, you can allow the possibility of a changing chemistry."

Tarzans of Science

"Canopy work has been viewed almost as a Tarzan semi-science, in the same way that scuba divers were viewed at first by marine biologists," said Dr. Nalini Nadkarni, an ecologist at Evergreen State University in Washington. "A lot of the work done so far is viewed as kind of exciting, but not scientifically rigorous enough."

Much of the work for the near future, she said, needs to be of a more mundane sort: gathering base-line data, standardizing procedures and developing statistical approaches to characterize ecosystems that operate in three dimensions.

Very few studies have been duplicated, said Dr. Nadkarni, because of the rigor of access. "It's easy enough to go out and measure the diameters of 100 pines on the ground, or measure the distribution of plants. But working 200 feet off the ground and trying to work in three dimensions is far more complex and time-consuming."

But, she said, scientists are increasingly convinced that the effort is worthwhile. "If you're interested in a process in the canopy, you have to get up where its happening," she said. "It's like studying elephants in the wilds of Africa instead of in a zoo."

Treetops Yield Their Secrets

By JON R. LUOMA

One of the least explored ecosystems on earth is at last yielding its secrets as a small cadre of adventurous researchers refine their climbing techniques and broach the upper regions of North America's old growth forests.

Although canopy research in tropical rain forests has been widely hailed as important science, similar work in the temperate zone has been sporadic. Yet the limited research that has been done suggests that the canopy, especially in old trees, is virtually an ecosystem in itself.

Some scientists have compared it to a coral reef: replete with virtually self-contained ecological webs of animals, insects, plants and fungi that depend on the tree's structure for habitat. And these canopy systems promise to be treasure troves of new biological information, experts say.

"The canopy represents one of the last frontiers of unknown science on the planet," said Dr. Margaret Lowman, a canopy specialist who is director of research at the Selby Botanical Garden in Sarasota, Fla. "Like the ocean bottom, the tops of trees are areas where very few people have ventured and very few people have made observations. There's an opportunity to describe new species and make new observations and discover new processes that could be extremely important for the way forest ecosystems function."

Canopy research enjoyed an early burst of activity in the woods of Oregon in the 1970's and early 1980's. There in the Andrews Experimental Forest, which is part of the Willamette National Forest, scientists using techniques borrowed from rock climbers first found ways to hoist themselves to dizzying heights in trees. These techniques were later transferred to the tropics.

That early exploration allowed scientists, for the first time, to count and characterize the branching structure of an old growth canopy and yielded other intriguing results. But in the 1980's, the research fell into a decadelong lull.

Financial support from foundations and universities was virtually nonexistent, said Bill Denison, a botanist at Oregon State University who is a canopy

Continued on Page B9