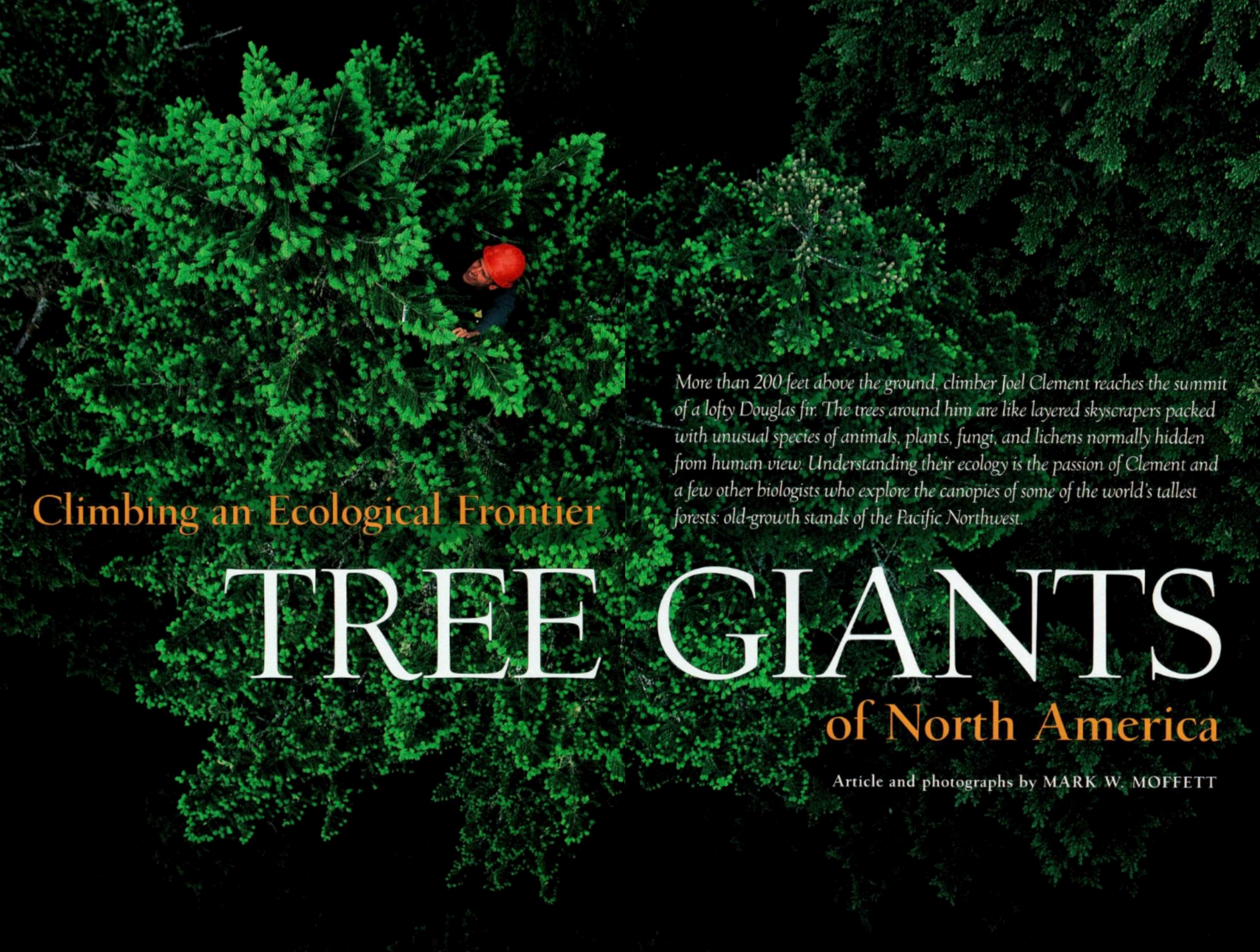


Climbing an Ecological Frontier

TREE GIANTS of North America

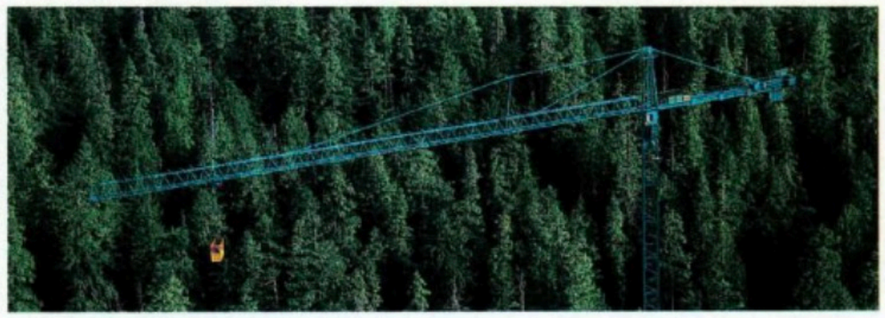
More than 200 feet above the ground, climber Joel Clement reaches the summit of a lofty Douglas fir. The trees around him are like layered skyscrapers packed with unusual species of animals, plants, fungi, and lichens normally hidden from human view. Understanding their ecology is the passion of Clement and a few other biologists who explore the canopies of some of the world's tallest forests: old-growth stands of the Pacific Northwest.

Article and photographs by MARK W. MOFFETT

A new world discovered

RIDING IN A GONDOLA 250 feet high in a forest of Douglas fir and western hemlock near Carson, Washington, any scientist who wishes can touch the crowns of 340 trees within the nearly six acres of the Wind River Canopy Crane's 280-foot horizontal reach (below). The crane was erected in April 1995 as a platform for tree canopy study. Despite all the controversy over the logging and preservation of old-growth forests of the Pacific Northwest, their canopies remained relatively unpublicized well into the 1990s, compared with much more remote tropical rain forests. (See the October 1990 and December 1991 issues of NATIONAL GEOGRAPHIC.)

Some studies of temperate rain forest canopies had been done in the 1970s by a handful of pioneering ecologists such as Oregon State University's Bill Denison—researchers with long climbing ropes and stomachs strong enough to operate at treetop heights equivalent to 35-story skyscrapers. When simply getting to the first branch of a giant tree can



require the combined skills of an archer, ship rigger, mountaineer, and gymnast, the pursuit of science is fueled by a significant boost of adrenaline. Compensations include tucking into a hammock at night high in the canopy and listening to the haunting call of a spotted owl.

Not all scientists can take that route, and the crane's reach brings old-growth studies into the mainstream. "But the crane covers only a very small area," says Steve Sillett of Humboldt State University in Arcata, California, who still traverses from tree to tree (right) and climbs straight up them. "There's always going to be the need for us lone guys and gals to be out there with our ropes."

A frequent contributor to the magazine, biologist MARK W. MOFFETT is the author of *The High Frontier: Exploring the Tropical Rainforest Canopy.*

Hard day's height

"A surreal candelabra jungle gym" is what Joel Clement, foreground, a Seattle-based canopy ecologist, calls a 2,000-year-old sequoia that he and I climbed with Steve Sillett for research. Their working day includes collecting some of the tree's lichen-laden reproductive cones, which grow on outer branches.

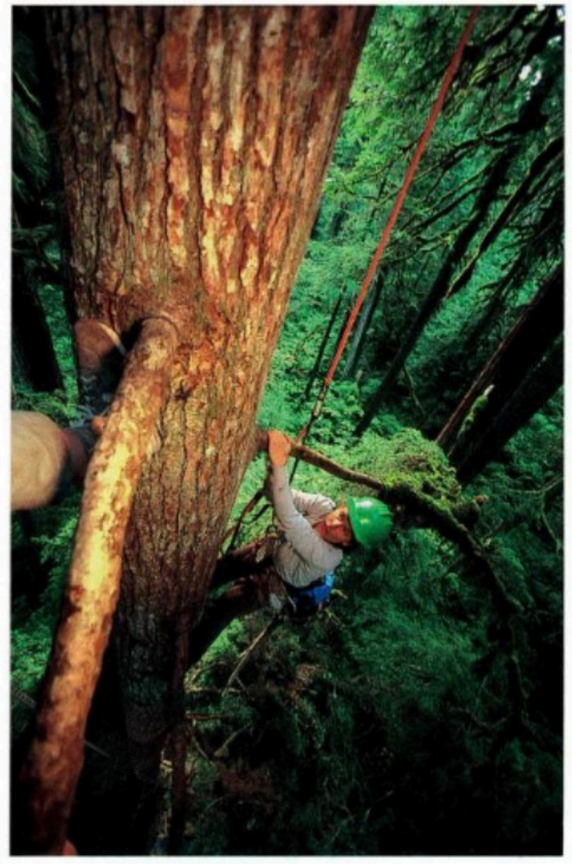
Partly because sequoias slough off their bark, lichens and canopy plants do not have a stable substrate to grow on. Dead limbs and cones are exceptions. For reasons not yet understood, sequoia cones remain on the tree for as long as two decades, allowing a community of lichens to develop.

Research with care

Checking a mist collector on a tower in Seattle's Cedar River watershed, John Rombold (left), a student of University of Washington forestry professor Tom Hinckley, holds on as rain begins to fall. Such collectors use hundreds of filament strands to rake moisture out of the air and deposit it in suspended cones. These and other measurements help Hinckley investigate hydrologic dynamics of the watershed.

Piloting the Wind River Canopy Crane, Mark "Sky King" Creighton (above) eases the gondola along the boom so that David Shaw, director of the crane facility, can observe bird behavior.

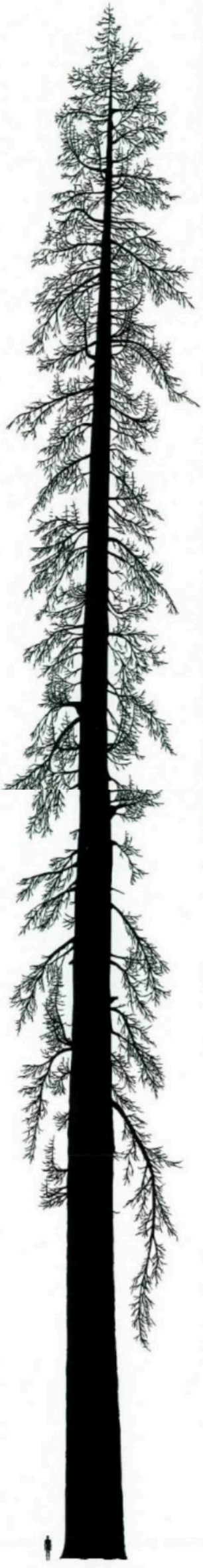
When making an ascent with arborist Donna Attewell in Mount Rainier National Park, I saw evidence that direct climbing can leave lasting wounds. Just by my foot (right) a dark ring shows scarring from a rope burn, and mosses and lichens had been scuffed from the branch. This hemlock was known to have been climbed only four times before—by a responsible professional. The rise in popularity of sport tree climbing now complicates canopy preservation. To protect forest health, Attewell and her colleagues are examining the methods and ethics of climbing.



Giant of giants

Discovered in 1963 by naturalist Paul A. Zahl, the National Geographic Society Tree (a coast redwood in Redwood National Park) has for several years topped the list of the world's tallest living trees. On March 24, 1995, Steve Sillett and I led an expedition to climb, map, and study the tree, and we established its exact height as 365 feet, 6 inches. Its status has recently been challenged by other coast redwoods in the region, although no official measurements have been announced.

Its striking features were drawn by artist R. Steve Foster in this silhouette view. Near its summit, massive, upturned branches produce mini-crowns of their own, some extending 60 feet above their junction with the trunk. Below, some branches sweep downward in great arcs, one approaching 50 feet. While large dead branches were a hazard during our ascent, even live branches can break free, plummet, and spear the earth. Some are thought to have sprouted new growth, exciting researchers with the possibility of an entirely new form of reproduction.



Treetop world of rare surprises

MARK W. MOFFETT WITH S. KIM NELSON, OREGON STATE UNIVERSITY

A visit to the canopy puts familiar subjects in new perspectives and adds a few surprises. The top of one Douglas fir (above) has the look of a Ferris wheel ornamented with tinsel, in this case lichens, mosses, and liverworts. Such canopy plants, called epiphytes, form communities so dense in places that their mass equals a ton of plant material for every two acres of trees.

Prime examples are the big-leaf maples in Olympic National Park, where mosses reach a foot thick and contain more green leafy material than the trees themselves. Nalini Nadkarni (left) of Evergreen State College in Olympia, Washington, has been climbing big-leaf maples since she was a graduate student in the 1980s. Folding back the mosses like a luxuriant shag carpet, Nadkarni reveals a soil layer beneath. Treetop soil is created primarily from the decaying remains of leaves and epiphytes and, in the case of conifers, from needles shed by the tree.

Leached by heavy rains, soils in temperate rain forests tend to be so nutrient-poor that even the trees themselves cannot afford to ignore the epiphytes' contribution. Nadkarni's right hand holds a slender root of the maple itself, which is tapping canopy soil way up in its own crown.

Nadkarni's discovery of roots reaching into rain forest canopies around the world has helped turn our understanding of forest ecology on its head. Scientists now pay more and more attention to the role of canopy flora and fauna in the ecology of forest cycles.

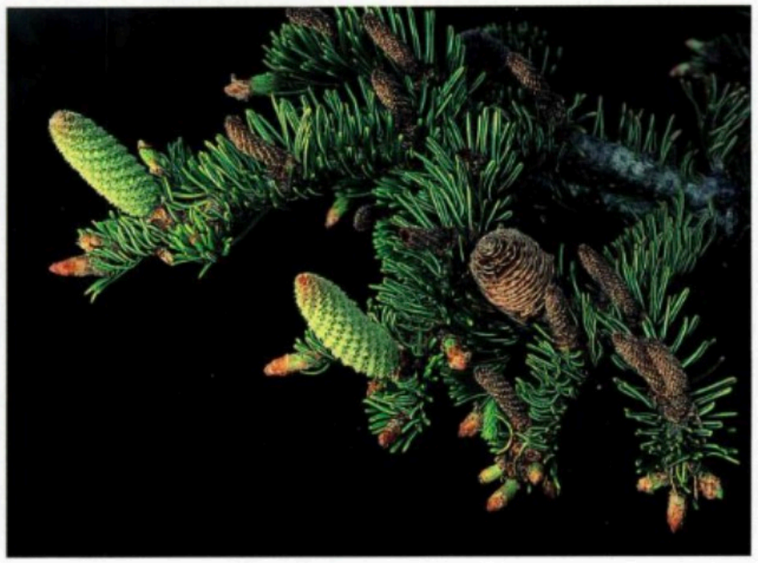
An especially rare surprise is finding the nest of a marbled murrelet (above). Several times a day a parent flies as far as 50 miles from the nest to the Pacific Ocean and back to feed its mottled chick. The adult rests and then places a fish into the chick's mouth and speeds away.

Nervous and easily disturbed by humans, the murrelet, like the old-growth forests it requires for reproduction, has been in rapid decline. Despite efforts of survey teams up and down the Pacific coast, this was one of the few murrelet nests found in the region last year. As a consequence, plans for logging near the nesting site have been halted.

Snag sanctuaries

Skeletons of wood, dead standing trees, commonly called snags by foresters, were inaccessible as research subjects before the canopy crane. Once thought to be a sign of poor forest health, snags actually contribute greatly to biodiversity. Certain plants and fungi colonize the dead surface, while beetles and other insects inhabit the wood. Mammals and birds from woodpeckers to eagles build nests on limbs or in holes, where they have a clear view of approaching danger.

Canopy communities



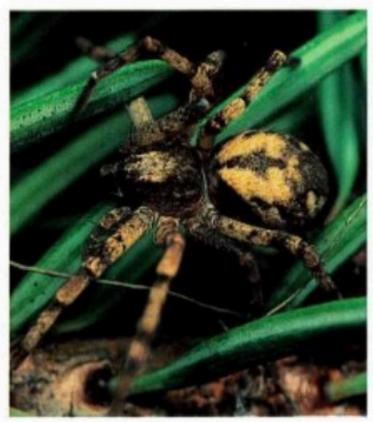
Many old-growth trees are so tall that the epiphyte communities on them vary with height, much as forests themselves vary along a mountain slope. Transplanting lichens to branches, Steve Sillett (left) investigates habitat requirements in the H. J. Andrews Experimental Forest in Oregon.

Research suggests that rich communities develop only after a forest is several centuries old. Canopies of mature forests become, like rumpled terrain, more varied hosts than younger stands, thus promoting variety and richness in epiphyte species.

Sillett and others find that nitrogen-fixing lichens, which most heavily colonize the oldest forests, are especially important ecologically. When wet, such lichens leak excess nitrogen, which may be absorbed by other epiphytes or the tree itself. As old-growth forests of the Pacific Northwest are logged and replaced by young trees, nitrogen-fixing lichens are on the decline—and with them a critical source of forest nutrition.

Canopy insects have special niches. Tim Schowalter of Oregon State University in Corvallis focuses on a caterpillar of the silver-spotted tiger moth (above left), which increases light to the forest floor by eating needles. Arachnids, including the tiny crab spider (right), are numerous, with available insect prey flying up from the ground or wafting in on breezes. Future studies will measure the role of such "tourist" insect species.

Tree reproduction is likewise



difficult to study from the ground. Consider a single branch of a noble fir (top). It has all the following on it at the same time: Large, green first-year female cones; large, gray second-year female cones; small terminal leaf buds; and the slender remnants of female cones.

Net results

Working from Sitka spruce treetops above the Carmanah Valley on British Columbia's Vancouver Island, entomologist Neville Winchester, in white hat, nets insects, aided by assistant Nancy Prockiw, in yellow hat, and others. His survey has found more than 300 new arthropod species and has begun to reveal the life cycles and ecological importance of many others. Temperate rain forests contain a tremendous number of undiscovered species, says Winchester, who teaches at the University of Victoria. "We have a virtually unexplored biological frontier in our own backyard."

Winchester's work finds strong evidence that microhabitats of ancient Sitka spruce canopies are unlikely to develop in second-growth forests. Or, simply put: Loss of habitat will cause extinctions.

Fear that canopy studies will bring rare new species to light and force more logging restrictions has put researchers at risk. Some have been threatened or had equipment or sites damaged or destroyed. I hope the logging community will come to realize that canopy research can help answer how best to manage forests, both to preserve beauty and species richness and to maximize long-term harvesting of North America's priceless trees. □