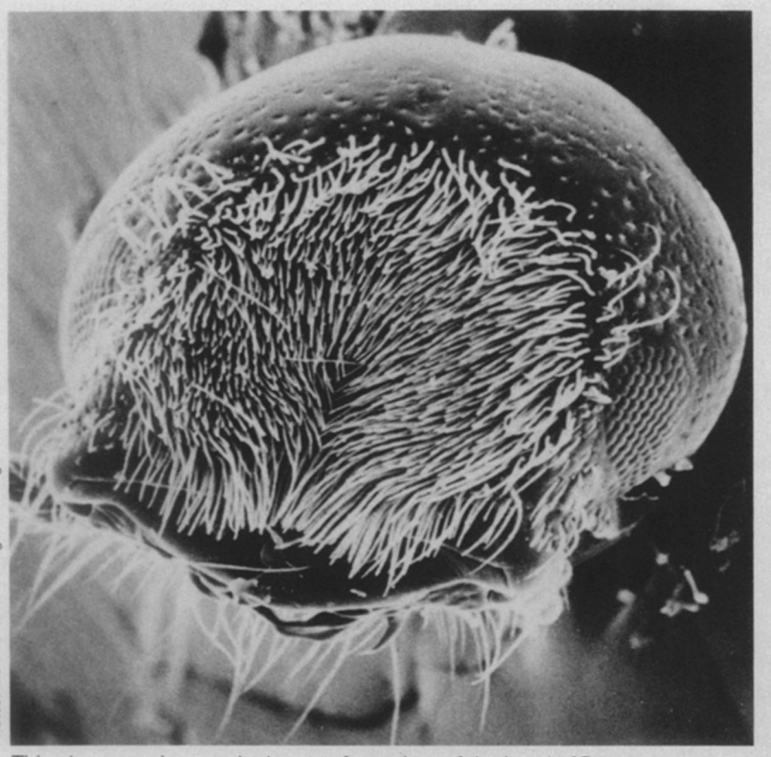
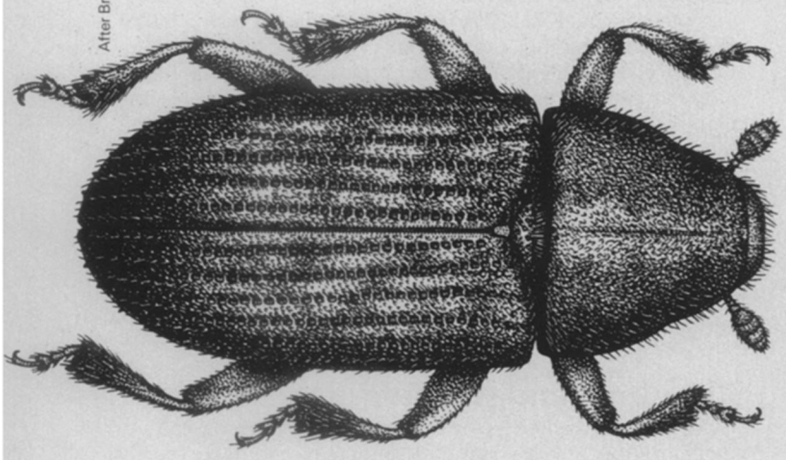
A Bug in the Bark



Photos: Mark A. Philbrick/Brigham Young Univ.

This electron micrograph shows a front view of the head of Dryocoetes confusus. *Because tactile identification is important in the dark tunnels in which bark beetles live, many species have evolved bizarre head structures.*



After Bright and Stark, 1973:149

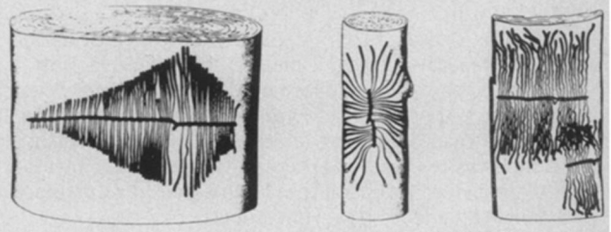
Pseudohylesinus n. nebulosus

PROVO, UTAH — This spring, the vast lodgepole pine forests of Yellowstone National Park are a crazy quilt of greens, reds, oranges and grays. Most of the pines are dead, victims of mountain pine beetles, miniature insect versions of "Jaws" that chomp through trees and leave devastation in their wake.

In 1981, the current pine beetle epidemic killed more than 13 million trees spread across a 4,285,000-acre area in western United States. "The annual losses were approximately the same in 1980," says Thomas H. Hofacker, an entomologist with the U.S. Forest Service. "We expect they'll be about the same in 1982." Particularly hard hit were the pine forests in Glacier and Yellowstone National Parks. Significant outbreaks occurred in Oregon, Washington, Idaho, Montana, Wyoming, Colorado, Utah and in western Canada.

In contrast to the results of a pine beetle infestation, the beetle itself, *Dendroctonus ponderosae,* is inconspicuous and rarely seen. Adult beetles are dark brown or black and average about one-fifth of an inch (5 millimeters) in length. Only a sharp eye detects the initial signs of an invasion. Resin mounds, called pitch tubes, mark the places where female beetles have bored into the trunks of living trees. These pitch tubes represent the tree's attempt to repel or drown the invaders. If the beetles' attack is successful, traces of boring dust, like fine sawdust, appear in bark cracks and around the tree base.

Within several months, fungi carried into the tree by the beetles begin to discolor the sapwood, staining it blue. Under the bark, the beetles drill a network of galleries, where tiny white eggs hatch into legless, white larvae that feed on the inner bark. Eventually, the larvae transform into pupae, then into adults. Finally, the adults emerge and fly to new trees within a few days. Meanwhile, needles on the infested



Although bark beetles are inconspicuous insects, a few species cause considerable damage to forests each year

BY IVARS PETERSON

tree begin to fade and change color, from green to yellowish green, then sorrel, and finally red and rusty brown, several months to a year after the initial attack.

The mountain pine beetle is one of almost 500 bark beetle species found in North America. Many more species exist worldwide, especially in tropical areas. Although most of these bark beetle species do not kill trees, several are major pests. The imported European elm bark beetle is the primary carrier of Dutch elm disease in North America. The southern pine beetle has been a threat to trees in the southern states and in Mexico and Central America for many years.

In a natural forest, bark beetles perform a vital role in maintaining vigorous growth by weeding out weakened, aged or injured trees and in recycling dead plant tissue. However, when their activities conflict with human needs for forest products, some form of control is necessary. To do this effectively requires an ability to identify destructive species and an understanding of bark beetle behavior, in all its variations.

Because bark beetles remain hidden in their sylvan tunnels for most of their lives, few people have ever noticed these insects. Entomologist Stephen L. Wood, on the other hand—traveling throughout the world to track down and characterize bark beetles—has examined hundreds of thousands of them. Wood's fascination with these insects began early, when he had to collect 30 insects for his high school biology class and found his first bark beetle. Now, many years later, based here at Brigham Young University, Wood has completed the 1,359-page volume *The Bark and Ambrosia Beetles of North and Central America* (Brigham Young Univ., 1982).

Wood's specialty is identification and classification. His laboratory office is piled high with beetle specimens — many in boxes and packages bearing exotic addresses and postage stamps from all over the world. Although at one time Wood thought of joining the other researchers out in the field, he sees the importance of his present role. He writes in the preface to his book: "The first and most fundamental step in the solution of a problem in biology is the accurate identification of the organism under investigation. Without it, all else is meaningless, because effective communication is not possible."

However, Wood calls himself a kind of dinosaur. "I'm the only person left in the world who's working on a worldwide basis," he says. "All the others have gone."

Wood's identifications have other uses, too. "About every year or so, I get involved in a decision that has multimillion-dollar implications," Wood says. For example, several years ago, officials in the Guatemala government sent him some beetle specimens because they were afraid the insects were coffee berry borers. Wood confirmed the fear, and immediately the government began a $2 million control project. Later, when the Honduras government thought they had a similar problem, Wood examined specimens and was able to say it wasn't the right species and a control program was unnecessary.

Distinguishing among the hundreds of bark beetle species is not a simple task and sometimes involves careful, microscopic examination for subtle differences in appearance. However, simply stripping away the bark of an infested tree often reveals gallery systems that identify the genus, if not the species. Some of the tunnel systems are engineering and aesthetic marvels. The native elm bark beetle, for example, creates a butterfly-shaped pattern.

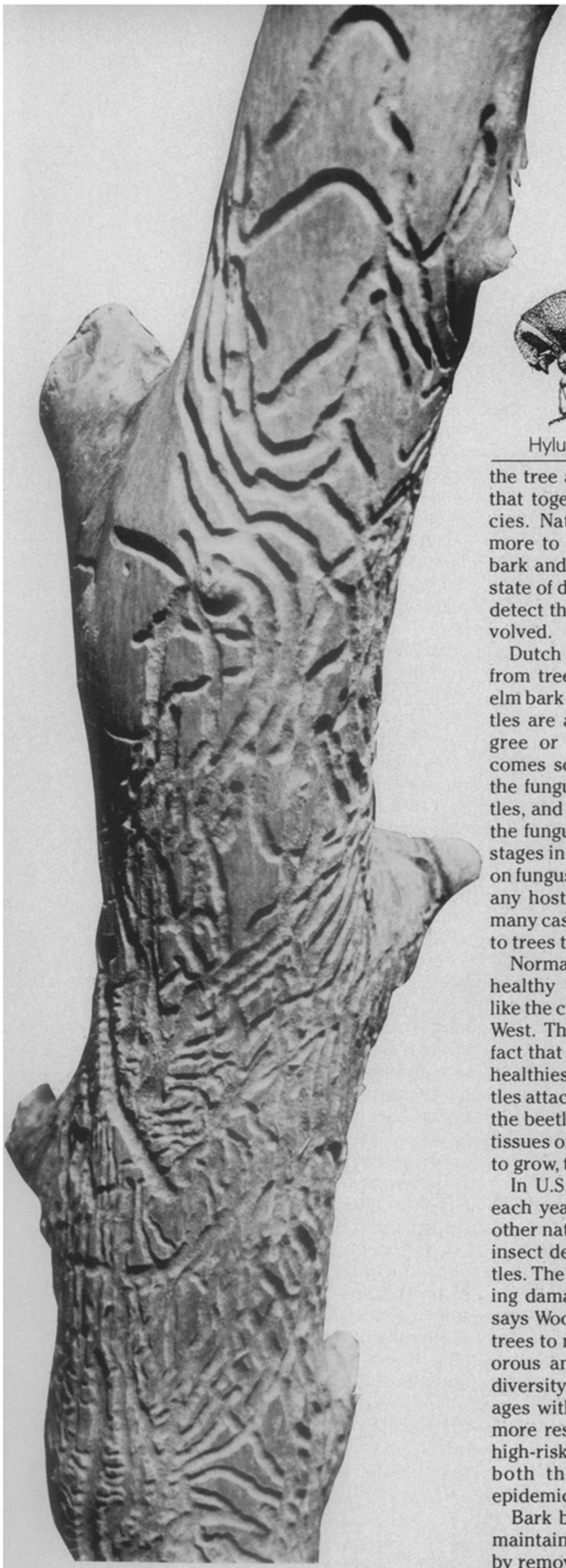
Wood says, "Bark beetles are host-specific; that is, they're restricted to a particular kind of tree or a group of closely related trees. It's very rare to get one beetle that will attack all kinds of timber." These insects are very specialized to meet the requirements of life in a particular climate on a specialized tissue of a restricted host. Some live only in seeds or fruits, others only in twigs of living trees or seedlings in dense growth. One species, appropriately named *Hypothenemus eruditus,* was found boring in the cover of a book.

Living in darkness, bark beetles rely on sophisticated chemical signals, touch and occasionally sound for communication. As a result, some species have developed elaborate, bizarre body structures, especially on the front of the head (because that's all that's "visible" in the narrow tunnels), while almost all bark beetles are a drab brown or black in color.

"These bark beetles are successful in a forest because they can congregate," Wood says. "It takes literally thousands of them to kill a tree." This makes pheromones, chemical messengers that announce to others of the species the location of a suitable host or the availibility of mates, very important in regulating the lives of bark beetles. The beetles also react to odors produced by weakened, injured or diseased trees. Although many researchers are investigating pheromones and their effects, no effective method of control based on pheromones exists yet.

In European elm bark beetles, for example, ultraviolet radiation from the sun stimulates the emerging beetles to fly, sometjmes as far as several kilometers. During flight, the beetles respond to the odor of weakened trees. When a female beetle finds a potential breeding site, it releases a pheromone with the result that a tree found by a single female becomes the target of a mass invasion. Researchers have isolated three compounds, one from

After Edson, 1967:58



Often bark beetle species can be identified from the distinctive patterns they carve in wood. Shown are the galleries created by the bark beetle Scolytus robustus *in a stick of white fir.*

Hylurgopinus opaculus

after Kaston 1936:614

the tree and two produced by the beetle, that together attract beetles of that species. Native elm bark beetles respond more to substances released from dying bark and favor trees in a more advanced state of decline. Somehow, the beetles can detect the subtle chemical differences involved.

Dutch elm disease is a fungus carried from tree to tree by spore-contaminated elm bark beetles. Wood says, "All bark beetles are associated with fungi in one degree or another. This relationship becomes so intimate in some of them that the fungus cannot exist without the beetles, and the beetles cannot exist without the fungus." Some beetles, during certain stages in their development, can feed only on fungus spores. These beetles can live in any host that the fungus can tolerate. In many cases, the fungus does more damage to trees than do the beetles.

Normally, bark beetles do not attack healthy trees, except during epidemics like the current pine beetle outbreak in the West. The beetles take advantage of the fact that during hot, sunny days, even the healthiest trees tend to wilt. If enough beetles attack during this period, within hours the beetles introduce fungi into the living tissues of the trees. "Once these fungi start to grow, the tree is dead," says Wood.

In U.S. forests, insects kill more trees each year than the combined total of all other natural factors. More than half of the insect destruction is caused by bark beetles. The best method of control is removing damaged or unthrifty trees promptly, says Wood. In national forests, thinning of trees to make remaining stands more vigorous and activities to increase species diversity or to create patches of different ages within a forest also make the forest more resistant to attack. The removal of high-risk trees in managed areas reduces both the frequency and intensity of epidemics.

Bark beetles play an important role in maintaining the health and vigor of trees by removing stagnated growth and by accelarating the recycling of dead material. Thus, in national parks, where there is no control program, the current devastation in the mature lodgepole pine forests will lead to new growth and more beautiful and healthier forests in the future.

Stephen L. Wood has spent more than thirty years collecting, identifying and classifying the thousands of bark beetle species scattered throughout the world. In his office at Brigham Young University, Wood has about 100,000 specimens on pins and almost as many preserved in liquid.

In commercial forests, insecticides mixed with oil are sometimes sprayed on beetle-infested trees, but the most effective chemicals also kill other animals, including bark beetle predators. "Predators are a significant factor in controlling bark beetles," Wood says. "Predators, like woodpeckers, and parasites probably kill more than half of every generation routinely."

"As the human population gets larger, our timber resources will become more important to us," says Wood. "These beetles are going to become more important as killers of trees. We have to figure out ways to combat them."

The best control methods require a detailed knowledge of individual bark beetle species. Of the thousands of species, fewer than 200 are really destructive. "They're among the most difficult of all insect groups in which to identify the species," Wood says, "and yet, you have to have them precisely identified for the research to be meaningful. It's very satisfying to be able to help other people do their research. I'm isolated here all by myself, working in a private university, but I'm really on a team working with thousands of people out there."

Wood jokes, "I'm the only person in the world who has ever been carried all the way around the world by a beetle. The only place I haven't been to is Africa, and I'm looking forward to the trip." □