The Beetles Are Coming

Jeff Mitton

The color of lodgepole pine forests west of the continental divide is changing from green to red to grey. An epidemic of mountain pine beetles is growing and spreading, and many of the lodgepole pines in Vail, Dillon, and Granby are dead. The majority of the beetles have been west of the divide, but the epidemic has crossed the divide; the beetles are forming an epidemic on the eastern slope.

Biologists in the USDA Forest Service predict that all mature lodgepole pines in Colorado could be killed within the next five years. While the current wave of forest death may appear to be an unprecedented catastrophe, bark beetle epidemics are natural and recurrent events. The last epidemic of mountain pine beetles, which spanned 1978 to 1980, thinned lodgepole and ponderosa pine stands from Colorado Springs to the Wyoming border; the area around Sugarloaf was transformed from a dense stand of ponderosa to a meadow.

The life cycle of the mountain pine beetle takes one year in most environments, but can take two years at high elevations or high latitudes. From June through August, adult bark beetles emerge by boring a round hole through the outer bark. Females fly to another tree, and if it has the right bouquet, they bore through the bark to the phloem, or conductive tissue, where they mate and dig a gallery. The female excavates egg chambers at the end of short passageways from the main gallery, and deposits one egg in each chamber. The eggs hatch into larvae that tunnel through the phloem by eating what is in front of them, and defecating frass behind them. The larvae develop through four instars before they pupate. Bark beetles cease activity when temperatures drop below freezing, and can overwinter as larvae, pupae or callow (unpigmented) adults. In late spring, adults become darkly pigmented, and prepare to disperse to another tree.

How can such a small beetle kill immense trees? Beetles overcome trees by coordinating attacks to overcome resin defenses, by destroying conducting tubes as they dig galleries, and with fungal warfare.

Females initiate the galleries, and as they bore through the bark and into the phloem, they sever resin canals, releasing a flood of resin from healthy trees. Flowing resin can “pitch out” the first beetles, and the resin dries into yellow pitch tubes on the bark. Terpenes in the resin are transformed into aggregation pheromones by bacteria in the female’s gut. Attraction pheromones dissipate from the frass, fill the gallery, and leak from the tree to form drifting plumes that attract males and other females to the same tree. If enough beetles bore into a tree, resin pressure drops to zero, and the tree is rendered defenseless. Healthy trees can pitch out hundreds of beetles before losing the battle, but just a few beetles can drain the resin from drought-stressed or diseased trees.

Mountain pine beetles are dotted with mycangia, shallow pits that carry blue stain fungi. As the beetles dig their galleries, they inoculate phloem with fungi, which grows
and spreads, clogging the tubes that transport water and sugars. When enough tubes are cut by boring or clogged by fungi, the tree dies. Larvae feed on the fungi growing in the galleries. The fungi penetrate the wood, staining it a drab blue.

Beetles have evolved mutualistic relationships with microbes and blue stain fungi to kill trees. Microbes in the gut transform terpenes, which are plant defensive compounds, into aggregation pheromones. Blue stain fungi rely on beetles to move them to live trees each summer and beetles rely on fungi for food and to plug up the phloem.

The first evidence that beetles have attacked a tree is pitch tubes on the bark. If the tree succumbs, its needles turn red at the beginning of the following summer. As the needles and bark drop from the tree, it turns ghostly grey.

Mountain pine beetle

Photo by Jeff Mitton