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Insects/their relatives help forest stay healthy

by Nancy Jacobson
for Pacific Northwest Station

Note: Nancy Jacobson was a 1996 summer intern at The Oregonian *in Portland under the sponsorship of the American Association for the Advancement of Science. She holds a Ph.D. in entomology from Cornell University. This article was reprinted courtesy of* The Oregonian*; photos are by staff photographer Bob Ellis.*

Looking out over the H.J. Andrews Experimental Forest, you see a sea of green: patches of Douglas-fir plantations of different ages set within an old-growth forest.

And as you walk into that ancient stand, the ground underfoot is springy with mats of dead needles and moss on top of fertile soil and decaying logs. Following a deeply creviced trunk of a Douglas-fir up 160 feet, you see its sun-loving branches above the more shade-tolerant hemlock and redcedar.

But you probably don't notice the myriad of tiny and sometimes secretive insects and their relatives, or arthropods. The roles of these arthropods and what happens to them when the forest is disturbed, only now are beginning to be understood.

Arthropod species abound in the Andrews forest, 50 miles east of Eugene, Oregon. There are more than 3,400 described so far, compared with 143 back-boned animal species such as birds and mammals and 460 species of vascular plants, mainly conifers and flowering plants, according to John Lattin, director of the Systematic Entomology Laboratory at Oregon State University (OSU).

"In one square yard in a mature forest at Andrews, there are more than 100,000 individual oribatid mites," said Andrew Moldenke, an OSU entomologist who does research there.

"Without arthropods' influence in cycling nutrients, you could get some bottlenecks with all the nutrients tied up in trees or dead logs and not available for roots to take up," said Timothy Schowalter, an OSU ecologist who also is an Andrews forest researcher. "We think that's part of the problem with forest health in eastern Oregon. Most of the nutrients have gotten tied up, and now so many trees are competing for limited water and nutrients that something's got to start turning over that material and putting the nutrients back into the soil. The insects and diseases are helping to do that."

"The Andrews forest is healthy because it is on the western slope of the Cascades," said W. Arthur McKee, Willamette National Forest. The experimental forest is run jointly by the Pacific Northwest Research Station, Willamette NF (Blue River Ranger District), and Oregon State University. The Andrews forest was established by the USDA Forest Service in 1948 and is codirected by Fred Swanson, Pacific Northwest Research Station and McKee. Since its beginning, the forest has been used as an outdoor laboratory for ecosystem-oriented research and education.

In the Andrews forest, the 70-90 years of fire suppression typical of Forest Service land is within the normal range of time between natural fires. A healthy forest floor, 150 years old and more, is strewn with logs, often from being blown down during storms. But to break them down to return the nutrients to the soil is no simple task. The outer bark is full of waxes and defensive chemicals. Bark beetles are undeterred by these defenses and chew their way in. Termites can then follow. Both bark beetles and termites feed on the relatively nutritious and undefended inner bark during the first 2 years.

Bark beetles carry fungi into the log. The fungi and the termite's gut microorganisms can slowly break down the cellulose in the outer wood, the sapwood. The inner wood, or heartwood, is better protected chemically, especially in Douglas-fir and cedar, so it is not as susceptible to insects and fungi.

Eventually even it succumbs, and water can percolate throughout the log. Decaying logs provide nitrogen (a natural fertilizer) and water hot spots where other trees can start to grow. The skeletons that are left sink into the landscape, and you see them as rolling contours on

Bark beetles and termites feed first on the thin layer of inner bark of a decaying log just outside of the sapwood where the bracket fungi are growing. Photo credit: Bob Ellis, The Oregonian.

the forest floor. "If you do a soil core through an old-growth forest, what you find is that it's just log after log after log, centuries of logs," Schowalter said.

"Bug poop" grows trees

Moldenke takes a different view of soil. He looks at it under the microscope and sees living organisms, their fecal pellets and their dead carcasses. Moldenke likes to sum up the recycling done by soil arthropods as "bug poop grows trees."

In the litter, a particularly important arthropod for keeping nutrients recycling is the cyanide-producing millipede. It is found in all ages of forest at Andrews.

The millipede can chew dead needles and other leaves more quickly than other arthropods. Bits of leaves stay intact through digestion, making smaller pieces available for smaller mouths. After each pass-through, fungi and bacteria can attack the

tissue along the edges of these pieces, turning nutrients into forms a plant can use.

Moldenke said the millipede acts as a "can opener" for the fungi and bacteria's "canned food" of dead leaves.

Nutrients also are passed up the food chain before becoming available to the plants again. And even the best defenses aren't perfect. Shrews occasionally suck the blood from cyanide-producing millipedes, but the "agile butcher-jawed" ground beetle feeds solely on it. "The beetle paralyzes the millipede by pinching the nerve cord with its huge jaws," Moldenke said.

Schowalter has found that feeding arthropods up in the branches can increase soil fertility in young Douglas-fir plantations. Arthropods, such as sawfly larvae and some mites, that chew on needles, expose the trees' tissues to rain that washes nutrients to the ground.

Nutrients also are tapped by insects, such as aphids and scales, that suck the tree's fluids from its leaves. If there are not too many munchers and suckers, the trees compensate by growing more needles.

Many birds prey on canopy arthropods. But 30 percent of the total number of arthropods collected in the canopy are predators as well: spiders and certain mites, beetles, wasps, and flies. Schowalter has seen a predacious snout mite prying up the shell of a scale insect. About one-third of the scale insects in his canopy samples had escape holes made by adult parasitic wasps after spending their youth feeding on the scale's insides.

Plantations are not deserts

"The very early stages of clearcut, whether older trees are left or not, are by no means a biological desert," Moldenke said of soil and litter arthropods when the clearcut isn't burned or subject to erosion or soil compaction. Instead, he and others have found that the organisms often were just different.

In an old-growth forest, where the litter is deep, most spiders sit and wait for their prey to come by, often capturing them in small webs. The relative openness and greater light of the plantation is better for litter spiders that hunt visually and chase their prey.

Bees also are much more common in lit, open areas. They are important pollinators of understory plants, though most trees are pollinated by the wind.

Arthropods in young plantations can move around well, because they are adapted to finding widely separated open areas where trees have blown down or a fire has burned through. Old-growth forest, on the other hand, provides insects with diverse but constant conditions. Consequently, many of the arthropods there cannot fly.

This has implications for the forest fragmentation caused by logging. Clearcutting has largely stopped, but experiments still are being done to determine whether leaving trees singly or in clumps as refuges will allow movement between old-growth forest fragments.

Schowalter has found that trees 150 years old and older have 20 to 30 percent more arthropod species than do young plantation trees. That's because there is much greater variation in the succulence, toughness, and the amount of defensive chemicals in the needles at various levels of the canopy in the older trees. "If you lose 25 percent of the species, does it matter? It probably depends on which proportion you lose," Schowalter said. If species are left that do the same things as those that were lost, it may not matter too much unless climate changes or something else happens and those that were lost were better at surviving under the new conditions, he said.

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