

# SENIOR HIKER MAGAZINE



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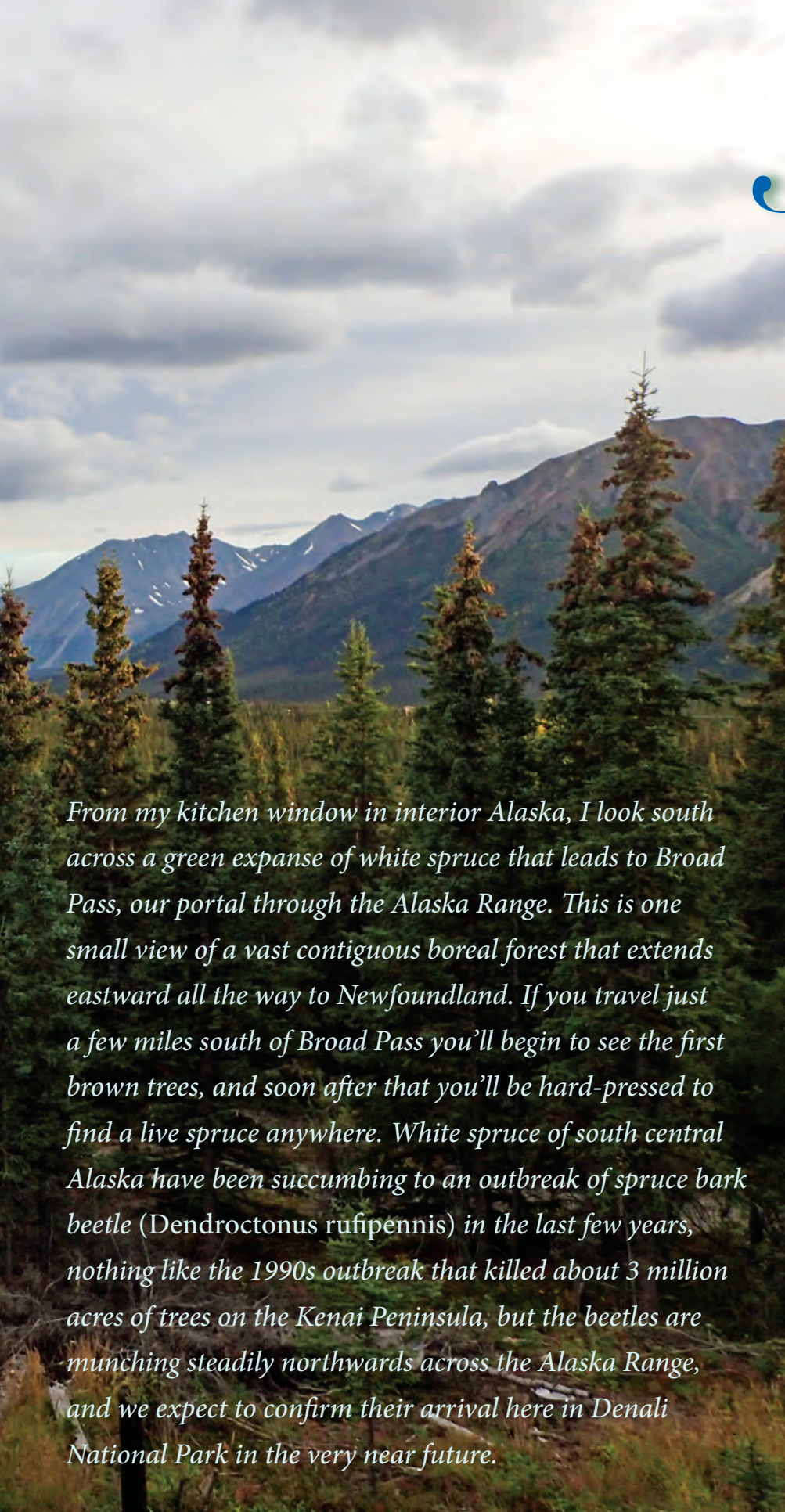




# *Boreal Insects*

Jessica Rykken





*From my kitchen window in interior Alaska, I look south across a green expanse of white spruce that leads to Broad Pass, our portal through the Alaska Range. This is one small view of a vast contiguous boreal forest that extends eastward all the way to Newfoundland. If you travel just a few miles south of Broad Pass you'll begin to see the first brown trees, and soon after that you'll be hard-pressed to find a live spruce anywhere. White spruce of south central Alaska have been succumbing to an outbreak of spruce bark beetle (*Dendroctonus rufipennis*) in the last few years, nothing like the 1990s outbreak that killed about 3 million acres of trees on the Kenai Peninsula, but the beetles are munching steadily northwards across the Alaska Range, and we expect to confirm their arrival here in Denali National Park in the very near future.*

**S**pruce bark beetles, once described to me as “the size and shape of a mouse turd,” seek out windthrow, damaged trees or, as their numbers increase, live trees, in which they bore through the outer bark and lay eggs in the sugar-rich phloem. Mass attack allows them to overcome the tree’s pitch defenses, and they may ultimately girdle the tree, which cuts off the plumbing carrying sugars from leaves to other parts of the tree. Bark beetles are native denizens of the boreal forest and are always present in low numbers. Successful outbreaks are fueled by a ready supply of host trees and a consecutive series of warm summers, warm temperatures allowing the beetles to complete their life cycle in one year rather than two.

Spruce bark beetles get a lot of attention because of the scale of damage they can do to our valued forests, but they are just one of an estimated 22,000 species of insects inhabiting North American boreal forests, of which almost half have yet to be formally described.<sup>1</sup> While boreal forests may look somewhat monotonous to us, with their spare inventory of evergreen and deciduous plants, there is far more complexity than meets the naked eye once we delve into the microscopic world of insects.

### **All You Can Eat**

Of all the trees in the North American boreal forest, white spruce is dominant and faithful. In Canada, at least sixty different herbivorous arthropods are known to feed on white spruce,<sup>2</sup> all but three are native residents. They include forty-three

*White spruce leading to Broad Pass, a portal through the Alaska Range. (Photo: Jessica Rykken)*





moths, seven beetles, five sawflies (primitive plant-feeding wasps), two adelgids, one aphid, a spittle bug and a mite. How can so many different animals share one resource? While we humans might size up white spruce as a one-course meal, insect herbivores divide the tree into intricate portions of time and space, feeding, for example, internally or externally on needles of different ages, on sap, pollen, cones, seeds, bark, sapwood, heartwood, fungi associated with wood or roots.

The ways in which insects feed and live on the tree are similarly varied. Many caterpillars and sawfly larvae are free-living on needles, some spin shelters out of silk to hide in, still others mine into needles or cones and feed from the inside. Most beetles bore under bark or into the sapwood; the so-called ambrosia beetles feed on fungus that they culture in their

*Top left: Adult spruce bark beetles are tiny! (Photo: Alex Wenninger)*

*Top right: Pitch tubes on a tree trunk are a telltale sign of bark beetles. (Photo: Robert W. Harding)*

*Above: Spruce bark beetle larvae feed in their galleries in the phloem, or inner bark, of the tree. (Photo: Alex Wenninger)*



tunnels. Aphids and their kin suck plant juices from needles, twigs or branches with their elongate piercing mouthparts. The adelgids are the weirdest of all; they live in odd-shaped galls produced by the tree, and females of some species cover the foliage with a snowy flocculence to protect their eggs.

Most of these herbivores specialize on just one part of the tree, but some, like the notorious eastern spruce budworm (*Choristoneura fumiferana*), are more cosmopolitan in their tastes. Female moths lay eggs on needles in summer; the newly hatched larvae then spin silken shelters in which they overwinter. The following spring, larvae begin their feeding frenzy, primarily



focused on new buds and needles, but if their numbers increase to outbreak levels, they move on to older needles and male flowers, pollen and cones. If needle loss is sustained over several years, the trees may die. Theories abound about what triggers population outbreaks, but a confounding number of factors including climate, dispersal, larval mortality and host maturity

have made accurate prediction of outbreaks elusive.

It is worth emphasizing that outbreaks are the exception, rather than the rule, for insect herbivores feeding on boreal trees. By and large, this delectable assortment of plump

larvae and other insects munch along at densities that predators (including birds) and parasitoids are able to keep in check. As an example, checkered beetles (Family Cleridae) prey on wood-boring beetles by pursuing them down their dark tunnels.

### Wasps in the family

Ichneumonidae have a more devious method for securing their protein. Ichneumonids are one of the most diverse groups on the planet, with estimates between 60,000 and 100,000 species worldwide, many more than all vertebrate species combined. Especially diverse in cool, moist climates, the wasps feed on nectar and pollen as adults, but lay their eggs in or on a variety of insect hosts, most often caterpillars and sawfly larvae. Ichneumonids are parasitoids, different from parasites in that they kill their host, and from predators

*Top: The odd-looking gall inhabited by eastern spruce gall adelgids gives rise to their other name, pineapple gall adelgids (Adelges abietis). (Libby Orcutt)*

*Above: Eastern spruce budworm caterpillars emerge from their silken shelters in spring to feed on foliage. (Photo: Eric Knopf)*





insides before busting out to spin a cocoon nearby. The parasitoid lifestyle is a supremely successful one and many boreal insects besides ichneumonids practice it, including other wasps, several fly families and a few beetles. Spruce budworm alone are consumed by more than ninety species of parasitoid insects.

### The Importance of Dead Wood

Forest managers tend to value life over death, but tree stumps, downed logs and standing snags in boreal forests provide critical habitat for thousands of insect species. Like live trees and their attendant insect communities, dead wood is also finely partitioned into countless niches by insects that key in on variables such as tree species, degree of decay, associated fungus, size, posture (standing or fallen), and the part of the tree (e.g., branch, trunk, cavity, heartwood, sapwood).

Insects that use dead wood for finding food or shelter, including those that are associated with wood-inhabiting fungi, are known as saproxylic. Flies are a dominant group, including fungus gnats (Family Mycetophilidae) that develop in and feed on fungi, and flower flies (Family Syrphidae) that live in hollow trunks or tree holes. Cavity-nesting bees in the family Megachilidae use abandoned wood-boring beetle holes in snags or stumps for nesting, while carpenter bees (Family Apidae) chew their own tunnels in soft wood to create nests. Many saproxylic parasitoid wasps have very long ovipositors for reaching hosts hidden deep in wood. At least sixty different families of beetles are known to include saproxylic species. These include wood-boring



*Top: European spruce sawflies (Gilpinia hercyniae) reproduce via parthenogenesis, meaning eggs do not need to be fertilized by sperm. Males are rare. (Photo: Giff Beaton)*

*Above: This Norton's giant ichneumonid wasp (Megarhyssa nortoni) is using its long ovipositor to deposit an egg on the larva of a wood-boring sawfly larva. (Photo: edoswalt)*

*Opposite, top: Adult flower flies (Xylota annulifera) feed on nectar and pollen, but the larvae feed on micro-organisms associated with sap runs and rot holes in trees. (Photo: Denis Doucet)*

*Below: A mating pair of pleasing fungus beetles (Triplax thoracica) on an oyster mushroom. (Photo: Ludo Leclerc)*

because an individual wasp consumes only one prey item in its lifetime.

One typical pathway of ichneumonid development is for the adult female to lay an egg inside a young caterpillar larva with her long ovipositor (although ovipositors resemble stingers, parasitic wasps use these appendages for laying eggs, rather than for defense, as is the case for bees, yellow jackets and other social wasps). The wasp larva develops inside its caterpillar host without immediately killing it, but eventually consumes its



species like the white-spotted sawyer (*Monochamus scutellatus*), whose larvae can sometimes be heard chewing their tunnels under the bark. They also include a diverse array of predators like rove beetles (Family Staphylinidae) and ground beetles (Family Carabidae), and fungivores like the aptly named pleasing fungus beetles (Family Erotylidae).

In Scandinavia, where boreal saproxylic insects have been well cataloged and tree harvesting is on an industrial scale, it is estimated that up to 90 percent of dead wood has been removed from managed forests, leaving at least several hundred saproxylic species threatened with population declines or extinction.<sup>3</sup> Thus, retaining and restoring dead wood for insects has become a conservation priority in managed boreal forests.

### Beyond Trees

Trees define the boreal forest, but water is also an important element. Streams, rivers, lakes, ponds and wetlands are abundant in the boreal landscape. My favorite T-shirt has an image of a swarm of black flies on the front, titled, "Defenders of the Wilderness." On the back it explains, "Black flies hatch only in clean, swiftly running water." Both statements are true. Pear-shaped black fly larvae hook their fat bottoms to silken pads attached to rocks in the stream and acquire food with two elaborate labral fans that filter organic matter from the water. Fixed in place in the current, these abundant larvae make easy prey for trout and salmon, water birds and aquatic insect predators. Those who survive to adulthood emerge from the stream in silvery bubbles of air, the



males swarm and mated females must find a blood meal in order to lay eggs.

Birds and mammals are favored hosts, including humans. Fortunately, in North America, black flies are not known to transmit pathogens to humans, but many birds and some mammals, including moose and bears, are vulnerable to disease vectored by these parasites. Adult black flies also provide an abundant food source to passerine (perching) birds, spiders and other terrestrial arthropod predators. But perhaps that is not their most important service to the boreal wilderness. Who among us has not avoided venturing to a favorite place in early summer because of the fear of clouds of biting black flies? Head nets, DEET and inevitable itchy welts are the price you pay for intruding past these hungry gate keepers, and many choose not to sacrifice their blood or sanity.

The understory plants of the boreal forest, including those found along streams and at edges of ponds, attract their own suite of herbivores and



pollinators. The male catkins of willows are among the first blooms in spring and provide pollen to hungry queen bumble bees emerging from their winter hibernation. Later on in the season, bees will be responsible for pollinating the blueberry, crowberry and cranberry plants that provide



essential food for birds, voles and bears. In forest openings caused by disturbances such as windthrow, insect outbreaks or fire, opportunistic herbs like fireweed attract scores of insect species including bees, flower flies, butterflies, true bugs and tumbling flower beetles (Family Mordellidae).

The forest floor is another boreal realm populated by a vast diversity of arthropods. Soil, moss and litter teem with microscopic animals like mites and springtails. The latter (Order Collembola) are most easily noticed on snow, the little leaping snow fleas that

congregate in your boot tracks in early spring. Two common mite groups in boreal soils include Megostigmata, mainly predators, and Oribatida, important decomposers. An Alaskan biologist made an unverifiable (but often quoted) calculation that the combined weight of mites and springtails living in one square mile in the Alaskan boreal forest is equal to that of forty-three moose. These microarthropods, in turn, provide abundant food to voracious forest floor predators such as ground beetles (Family Carabidae), rove beetles (Family Staphylinidae), spiders and centipedes. A recently discovered and surprising role that mites and springtails play is the transport of sperm between mosses, especially important when conditions are dry and the sperm are unable to travel in water film.

### Disturbance

Fire is an integral natural process in boreal forests and maintains a mosaic of habitat types. Depending on the timing and intensity, fire kills organisms and destroys habitat, but it also creates new habitats for colonization. Many boreal insects are well adapted to fire, some may survive a burning landscape in place, like wood borers or soil arthropods, while others invade burning or recently burned areas. These pyrophilous species include smoke flies (Family Platypzeidae), dance flies (Family Empididae), long-horned beetles (Family Cerambycidae) and metallic wood-boring beetles (Family Buprestidae). The black fire beetle (*Melanophila acuminata*) is remarkable in that it uses infrared receptors located at the base of its



Top: Springtails (*Orchesella villosa*) come in many shapes and sizes but all have an appendage under the abdomen that snaps them into the air like fleas. (Photo: Thomas Barbin)

Bottom: *Bombus* genus bumble bee feeding on fireweed. (Photo: Jessica Rykken)



midlegs to detect radiant heat from fires many kilometers away. Adults arrive at an active burn in large numbers, mate, and females lay their eggs under the bark of burnt trees.

Fire and insect outbreaks can have reciprocal effects. Trees wounded by fire are often less resistant to invasion by wood-boring insects. Insect outbreaks can alter forest stands by defoliating and killing trees, opening up the canopy, and letting forest floor fuels dry and accumulate, thus affecting the timing, extent and intensity of subsequent fires.

There is an extensive volume of literature about the effects of various forest management practices on the diversity of boreal insects, especially those living on the ground, in the soil and associated with dead wood. In general, conclusions suggest that a mosaic of different-aged stands should be maintained, large forest reserves must be protected and, ideally, connected and dead wood is an essential forest resource that must be preserved. The neat and tidy, even-aged monocultures farmed by many timber companies are as biologically diverse as an Iowa corn field. For boreal plants and animals, a messy forest is a healthy forest.

Boreal forests span northern latitudes, where rates of warming from climate change are above the global average. Related phenomena include earlier snow melt in spring, melting permafrost, changes in snowpack and precipitation regimes

*Above: Black fly larvae filter their food from swiftly flowing water. (Photos: James Bailey and National Park Service)*



and increased frequency and intensity of fire. For boreal plants and animals, these changes will have various consequences. Some are more obvious. Around here we see more and more landslides caused by melting permafrost that denude slopes of their vegetation; fires burn longer and hotter and kill more organisms. Other effects will be more difficult to measure, such as migratory birds and their insect prey responding to different cues in the spring, potentially leading to a mismatch in timing of supply and demand. Shifts in species ranges are also occurring, with white spruce moving visibly northwards and upslope into the tundra. It is less clear if they will take their full complement of insects with them.



### The Challenge

The biggest challenge of sharing the delights and intrigue of the insect world is this: it's difficult to appreciate what you can't see. So here's my challenge to you: next time you hike in the forest, take time to refocus your eyes in the cracks and crevices, poke about under logs and bark and leaf litter, peer into tree holes and down hollow trunks, investigate branches and flowers and leaves. Look for telltale signs of those who have been there: mined or munched leaves, galls, silken shelters, beetle holes and galleries, eggs and cocoons.<sup>4</sup> Bring with you the curiosity and awareness of a ten-year-old. You'll be richly rewarded.

### Notes

1. Danks, H.V., and R.G. Footitt. 1989. Insects of the boreal zone of Canada. *The Canadian Entomologist* 121:626-690.
2. Natural Resources Canada. <https://tidcf.nrcan.gc.ca/en/trees/factsheet/38>
3. Siitonen, J. Forest management, coarse woody debris and saproxylic organisms: Fennoscandian boreal forests as an example. *Ecological Bulletins* 49:11-41.
4. Eiseman, C. and N. Charney. 2010. *Tracks and signs of insects and other invertebrates: a guide to North American species*. Stackpole Books, Mechanicsburg, PA. 582 pp.